ON THE WATERFRONT

Promotor: ir. L. Horst, emeritus hoogleraar in de irrigatie

Co-promotor: dr B. Crow, Assistant Professor in Sociology, University of California at Santa Cruz, U.S.A.

On the Waterfront

Water distribution, technology and agrarian change
in a South Indian canal irrigation system

PROEFSCHRIFT

ter verkrijging van de graad van doctor
op gezag van de rector magnificus
van de Landbouwuniversiteit Wageningen,
dr C.M. Karssen,
in het openbaar te verdedigen
op vrijdag 16 oktober 1998
des namiddags te vier uur in de Aula

Peter Paul Mollinga

ISBN 90-5485-927-X

Address of correspondence:

Peter P. Mollinga
Niemeijerstraat 9
6701 CL Wageningen
the Netherlands

Cover photo by R. Doraiswamy
Photos 8.1-8.5 by Peter P. Mollinga
Photos 8.6-8.8 by Alex Bolding

Printed by Ponsen en Looijen, Wageningen

This research was financially supported by the Netherlands Foundation for the Advancement of Tropical Research (WOTRO).

STATEMENTS

1. Water control in the Tungabhadra Left Bank Canal command area is contested. For comprehensive analysis of this contestation it is necessary to understand the linkages between water control's technical/physical, organisational and socio-economic/ political dimensions. *(this thesis)*

2. There is no anarchy on the Tungabhadra Left Bank Canal. *(this thesis; cf. Hart, 1978; Wade, 1990)*

3. While social constructivist analyses of design processes in farmer managed irrigation systems have generally focused on the role that farmers/water users play in these processes, social constructivist analyses of design processes in Indian canal irrigation need to take the mechanisms that exclude farmers/water users from design as a central theme. *(this thesis, chapter 4)*

4. The class-related spatial distribution of land and water in the Tungabhadra Left Bank Canal command area shows that in canal irrigated contexts spatial relations as structured by the lay-out of the canals, are an integral part of the relations of production. *(this thesis, chapters 5 and 6)*

5. a) The issue of water rights is underemphasised in policy and academic discussions on canal irrigation in India. *(Saleth, 1996)*
b) Analyses of rights and entitlements to canal irrigation water should focus on the interlinked nature of the relations that determine resource access. *(this thesis, chapter 6)*

6. The technical and managerial creativity of field-level Irrigation Department engineers is larger than generally acknowledged. Because that creativity is seen by the engineers themselves and by outsiders as a coping or making-out strategy, and because it is located in a hierarchical bureaucracy with a prescriptive management style, its potential to function as a resource in management reform remains untapped. *(this thesis)*

7. The state and characteristics of outlet structures and the features of rotation schedules express the balance of power between the different actors involved in water control. *(this thesis, chapters 7, 8 and 9)*

8. In the Tungabhadra Left Bank Canal irrigation system rent-seeking is not the main mechanism in water distribution practices. Analyses of the relationship between Irrigation Department officials and farmers/water users in other South Indian canal irrigation systems that describe this relationship as one of constant and antagonistic confrontation, mediated by bribe payments and political pressure, can therefore not be generalised. What needs to be developed is theory that explains the conditions of possibility of different configurations of state-water users relationships in canal irrigation systems. *(this thesis, chapter 7; cf. Wade, 1982a, 1990 and Ramamurthy, 1995)*

9. Populism supports the persistence of the protective irrigation model at policy level and unequal distribution at irrigation system level, but the recent initiatives of the Andhra Pradesh government suggest that it can also provide an ideological basis for an irrigation management reform agenda.

(this thesis, chapters 3 and 10; Peter, 1998)

10. The paradigmatic difference in the study of natural resources management between the Irrigation and Water Engineering group and the Erosion and Soil and Water Conservation group is one of the factors that hinders the emergence in Wageningen Agricultural University of an interdisciplinary approach to integrated water resources management in tropical regions.

11. Those who make a point of criticising neo-marxist analyses of capitalism for its structuralist, functionalist, determinist, linear or otherwise epistemologically undesirable characteristics, tend to undervalue the empirical evidence produced by neo-marxist authors regarding the ontological force of capitalist development.

(cf. Long and van der Ploeg, 1994)

12. Those who want to stay in touch with the realities of Indian everyday life are well advised to regularly travel by bus.

Peter P. Mollinga

On the waterfront. Water distribution, technology and agrarian change in a South Indian canal irrigation system

Wageningen, 16 October 1998

CONTENTS

Figures

Tables

Maps

Boxes

Photos

PREFACE

The completion of a Ph.D. thesis is an appropriate moment for the acknowledgement of intellectual debts. Ph.D. research work often is a phase in which ideas and approaches get consolidated by prolonged focus on a single theme. My theme was the combination of the social and technical analysis of irrigation, on the basis of a study of water distribution in a canal irrigation system in South India. Through this intensive study a position from which further work will be done has been defined. Before that standpoint and perspective become a black box it is useful to recognise the imprint of different people, ideas and events on it.

The intellectual trajectory of this book probably started in the early years of my study at Wageningen Agricultural University. In 1979 the *richtingsgroepbestuur* (the board of the student organisation for the study programme) of which I was a member organised a day for public discussion entitled *Tropische Cultuurtechniek: meer dan techniek alleen* (Irrigation and water engineering: more than technology alone). The poster showed a bulldozer threatening to run over farmers, who ran away with their hands in the air. This awareness of the social dimensions of my technical profession has remained my leading motive.

In terms of research the next major step was the fieldwork on water management in small lift irrigation systems in the Senegal river valley in 1983, done together with Ton Meijers. The research showed that the agency assumption that the valley farmers, who had an irrigation experience of only a few years, wasted irrigation water, was unfounded. We found quite sophisticated farmer-made systems of water distribution rules, which had gone unobserved by intervention agencies. This field experience for once and for all convinced me of the knowledgeability and capability of farmers, before I even knew that phrase.

Then followed a period in which irrigation had disappeared somewhat behind the horizon. My membership of the *Imperialisme Kollektief*, followed by a 2½ year period at the *Studium Generale* department was a most inspiring period. We organised an international congress on *Technology and agrarian underdevelopment* (1985) and the first *Political economy of agriculture in the Third World* course (1987). The politics of the former activity was to argue and lobby for a chair at Wageningen Agricultural University on Technology and Development, an aim that was achieved many years later. Of the latter it was to reform the Wageningen development-oriented curriculum into a more interdisciplinary and problem-oriented direction. The course was institutionalised, but the success of the overall reform effort has been at best partial. The intense interaction with the comrades and colleagues from the IK and SG has profoundly shaped my academic and political preoccupations.

We had also come into contact through these activities with the Development Policy and Practice research group at the Open University in Milton Keynes, U.K. In 1988 and 1989 Jos Mooij and I spent a wonderful 1½ years of study and writing on the themes of agrarian change, technology and the state. The work with the DPP group put the sometimes somewhat idiosyncratic debates in Wageningen in perspective, and added critical realism and labour process theory to my intellectual repertoire. I thank the DPP group and specifically David Wield, Ben Crow, Henry Bernstein and Terence J. Byres for their support and supervision. The latter's references to Ishikawa's and Boyce's work on irrigation in Asia triggered my interest in the water control concept.

At the end of the period in Britain the return to irrigation took place. I took up the challenge to combine my social science interests with my irrigation background. A research proposal was written and submitted to WOTRO, through the department where I had graduated. Lucas Horst and the late Jacques Slabbers provided all the necessary support. A group of like-minded colleagues greatly stimulated each other's work in this formative period. The closest exchange was with Geert Diemer, Paul Hoogendam, Wim Kloezen and Joost Oorthuizen.

That intellectual advance is a collective process also expressed itself in the support group that was formed with a set of fellow Ph.D. researchers: Roland Brouwer, Kees Jansen, Jos Mooij and Marina Endeveld. We helped each other through the difficult process of proposal writing and fieldwork, and later the thesis writing. We also organised, together with Henry Bernstein, the *Agrarian Questions. The politics of farming anno 1995* conference in Wageningen.

With regard to the research itself, I thank the Institute for Command Studies and Irrigation Management, Bangalore, and particularly its director, the late Dr B.K. Narayan, for providing the institutional affiliation that allowed me to do the research, and for the practical assistance extended. The permission of the governments of Karnataka and India to do the research is gratefully acknowledged, as well as the financial support at different stages of the project by the Open University at Milton Keynes, Wageningen Agricultural University and WOTRO (the Netherlands Foundation for the Advancement of Tropical Research).

I owe a lot to my research assistants, R. Doraiswamy and M. Sudharshan. They took up their work on the condition that they would camp in the research area for a full agricultural year on an almost permanent basis. The work and living conditions in Raichur district were not easy. All three of us had lost weight and gone through several attacks on our physical health by the end of that year. But they had also secured a continuous data set on water distribution, agricultural practices and other issues that was crucial for the research. Through the social relations and networks they built in the communities and offices we worked in, trust was created that made the research more enjoyable and increased the quality of the data collected. I was very fortunate that R. Doraiswamy could also join the new research project that started in 1996.

Four Dutch students did M.A. or M.Sc. thesis research during the fieldwork period. They were Alex Bolding, Annet Smits, Kees van Straaten and Rick Verhoeven. The value of their work will be clear from the reference made to it in different chapters. The students also provided a very welcome sounding board and opportunity for discussion, which stimulated my own fieldwork.

A lot of information given by farmers and officials was collected with the promise of privacy, and therefore I must thank them anonymously. This academic research project, like many others, depended on their willingness to devote time to and share personal experience with an outsider, without a return of the favour through practical contributions by the researcher to the solution of the problems discussed. The hospitality and openness experienced in the field underlines the feeling of privilege associated with doing research in India.

In terms of practical assistance in the data collection a special mention has to go to the documentation service of the *Deccan Herald* and the Department of Economics and Statistics, both in Bangalore. Many government offices in Raichur district and Bangalore provided valuable statistical material. Without the help of the librarians and Xerox machine operators of the Institute for Social and Economic Change and the University of Agricultural Sciences (Bangalore), the Andhra Pradesh State Archives and Osmania University (Hyderabad), the India Office Library and Records (London), Karnataka University and the University of Agricultural Sciences (Dharwad), the Raichur Research Station, Mysore University, and Jawaharlal Nehru University (New Delhi) my reference list would have been a lot shorter, and my understanding a lot more limited. K.K.S. Murthy of Select Bookshop (Bangalore) contributed to my sense of history and collection of old irrigation books.

I thank my supervisors Lucas Horst and Ben Crow for their support, guidance, confidence and patience during the fieldwork and writing phase. Colleagues and students of the Irrigation and Water Engineering group I thank for providing a context for discussion and development of the ideas in the thesis. I apologise that its finalisation has taken so long.

Frans van Ernst and P.J. Kostense made most of the drawings. Indira Simbolon took a burden of my shoulders by typing and editing the list of references.

Dr Ramachandraswamy and Sharda taught me the basics of the Kannada language. Though I must have disappointed them by not taking sufficient time to fully master the language, my limited command of it has been very useful in the research and for living in Karnataka in general. The classes in their house are remembered with great pleasure. Subash Menon was a friend from almost day one. On the first day we met he helped me to steer my unaccompanied luggage through customs, and he and Radhika have continued to extend their help and hospitality since then.

I thank my parents for stimulating my inclination to study, and for not questioning how I spent my study time. Last and foremost I acknowledge the invaluable support of Jos Mooij, my partner in many endeavours. Without our companionship this research would probably never have taken place.

Wageningen, 24 July 1998

Glossary and abbreviations

ayacut	=	irrigated or irrigable area
bhatta	=	rice (paddy)
CAD	=	Command Area Development
CADA	=	Command Area Development Authority
cusec	=	cubic foot per second
DES	=	Directorate of Economics and Statistics
DOA	=	Department of Agriculture
DRLAD	=	Development and Rural Local Administration Department
duty (in acres/cusec)	=	design parameter that indicates how many acres of a crop can be cultivated with a constant discharge of irrigation water of 1 cusec
GOAP	=	Government of Andhra Pradesh
GOHYD	=	Government of Hyderabad
gowda	=	member of the village elite/big man
GOI	=	Government of India
GOKAR	=	Government of Karnataka
GOMAD	=	Government of Madras
GOMYS	=	Government of Mysore
GONOH	=	Government of the Nizam of Hyderabad
hatti	=	cotton
ICC	=	Irrigation Consultative Committee
IIC	=	Indian Irrigation Commission (of 1901-03)
IIMI	=	International Irrigation Management Institute
ID	=	Irrigation Department
jowar	=	sorghum
kabbu	=	sugarcane
kharif	=	first season of the agricultural year; starts May/June when the monsoon rains begin (*mungaaru* in Kannada)
KWDT	=	Krishna Water Disputes Tribunal
Mandal Panchayat	=	elected council of a group of villages
Mandal Pradhan	=	president of the *Mandal Panchayat*
MLA	=	Member of the Legislative Assembly (State parliament)
MP	=	Member of Parliament (Union parliament)
MOAI	=	Ministry of Agriculture and Irrigation
MOI	=	Ministry of Irrigation
MOIP	=	Ministry of Irrigation and Power
MOWR	=	Ministry of Water Resources
PC	=	Planning Commission
PD	=	Planning Department
PWD	=	Public Works Department
rabi	=	second season of the agricultural year; starts August/September towards the end of the rainy season (*hingaaru* in Kannada)
sowcar	=	rich and influential farmer who is also a moneylender
taluk	=	administrative subdivision of a district
TBP	=	Tungabhadra Project
TMCft.	=	Thousand Million Cubic feet
UI	=	Unauthorised Irrigation
VCP	=	Violation of Cropping Pattern
Zilla Parishad	=	elected district council

1

INTRODUCTION

Raichur is not Hollywood, but it surely is a theatre of dramatic events. Eventfulness is a major attraction of research on water distribution in large scale canal irrigation systems. South India's protective irrigation systems are cases of scarcity by design, and the encounters of water, technology and people that take place in them, are often spectacular. A difference between a Hollywood waterfront and the one in Raichur District - the stage of this script - is the absence of a happy end. There are no Marlon Brandos, or Raj Kumars, who come to the rescue of deprived tailenders. A simple dividing line between the 'good guys' and the 'bad guys' also does not exist. We do find complex patterns of social interaction and struggle, by actors with multiple interests and divided loyalties, around the distribution of a resource crucial for agricultural production. The outcomes of this struggle have strong implications for the livelihoods of water users, their relations with each other and the governing institutions of the state, and the political, economic and agro-ecological dynamics of the region. If water distribution is a play, it is a deadly serious one.

1.1 SUBJECT OF THE BOOK

This book discusses irrigation water distribution in the Tungabhadra Left Bank Canal. This reservoir-fed canal system is located in Raichur District[1], Karnataka State, India (see map 1.1). Part of interior South India, it is a drought prone area with low and erratic rainfall, that suffered from recurrent famines in the past.[2] To protect rainfed crops against drought and the population against famine, a large scale irrigation system was constructed in Raichur District. The system is operational since 1953. By means of a 227 kilometers long main

[1] From November 1997 Raichur district has been divided into two districts: Koppal district and Raichur district. When I refer to Raichur district in this book I mean the undivided district.

[2] Average rainfall in the district is approximately 600 mm, varying between almost zero and 1300 mm in different years. Rain mainly falls in the period May/June to September/October. The mean daily maximum temperature is 40°C in May and the mean daily minimum is 29°C in December. Peak temperatures in the summer months can go up to 45-46°C. Soils are mainly the moisture retentive 'black cotton' soils (vertisols). Food crops grown in rainfed agriculture were predominantly coarse grains (sorghum and millet) and pulses. Cotton was the main commercial crop. See *Mysore State Gazetteer* (1970) for more background information on Raichur District and the Tungabhadra Left Bank Canal, including a list of famines.

canal, 87 secondary canals called distributaries, and thousands of pipe outlet structures the system aims to spread water thinly over a command area of 240,000 hectares.

The intended supply of small amounts of water to as many villages and farmers as possible has not materialised. Instead of single-season supplementary irrigation of crops like sorghum, millet and groundnut, there is a high incidence of double cropping and intensive irrigation of rice and sugarcane. The cultivation of these economically remunerative but very thirsty crops implies a highly unequal distribution of irrigation water and of the economic benefits of irrigated agriculture. The Tungabhadra Left Bank Canal is an extreme but not exceptional case of uneven agrarian development under irrigated conditions.

Access to water, or more precisely, control over water allocation and distribution, is a, if not the, key variable in the pattern of agrarian change in the Tungabhadra Left Bank Canal command area. The description and analysis of the contestation of water control by the different people involved in irrigation forms the core of this book. This contestation takes place at different levels of the irrigation system (outlet, distributary, and main canal), and has technical/physical, organisational/managerial, as well as social, economic and political dimensions. An attempt is made to integrate these different levels and dimensions of water control into a single analysis.

1.2 MAIN CONCERNS

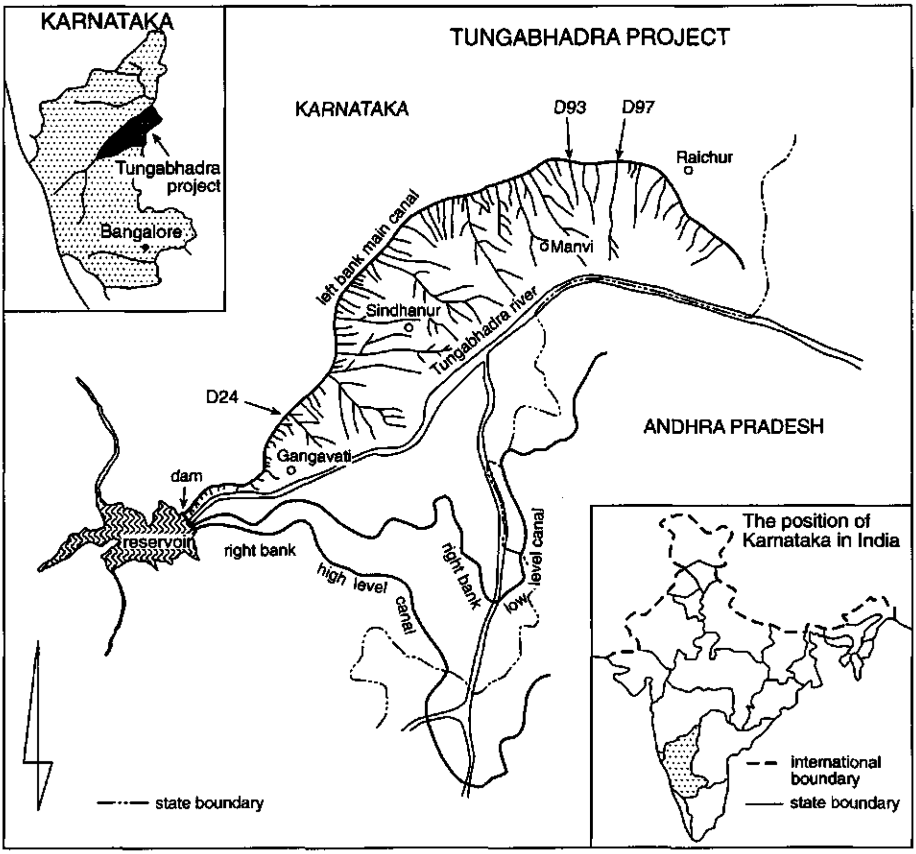
Two concerns are - thus - central to this book. The first, practical and specific concern is to understand what is happening in canal irrigation in South India in order to address the question how these systems can develop into more efficient and equitable operations. The second, academic and general concern is to contribute to the further development of interdisciplinary analysis of irrigation. The legitimation of this academic concern is again a practical one. I believe that an interdisciplinary approach is a necessary (but certainly not sufficient) condition for successful transformation of existing irrigation practices.

Choosing this formulation, I explicitly locate this book in the science of irrigation as an applied field. In the final analysis, the purpose of the book is to seek solutions to real world problems, and not the erection of theories as an aim in itself. At the same time the book is highly critical of the 'normal professionalism' in irrigation, in which every discipline perpetuates its own problem definitions and its own standard solutions, without taking much notice of other perspectives (Chambers, 1988).

Chambers' critique of irrigation professionalism still has great relevance, but some of the gaps in irrigation analysis have started to be filled since the publication of his book. A number of approaches and conceptual frameworks have been forwarded that take a more systemic look at irrigation. Examples are Uphoff's notion of socio-technical systems (Uphoff, 1991), recent efforts to systematise performance assessment analysis (Small and Svendsen, 1992), the neo-institutional economics framework for understanding collective action in irrigation (Ostrom, 1990), and the inclusion, in many parts of the world, of institutional components in previously exclusively technical interventions (for India see for example Maloney and Raju, 1994; Sivamohan and Scott, 1994). These developments in theory and practice imply increased recognition of the multi-dimensionality of irrigation.

It is the contention of this book that despite this movement towards more integrated approaches in the mainstream of irrigation studies, most frameworks fail to conceptually link the technical, organisational and socio-economic/political dimensions of irrigation satisfactorily. In chapter 2 this statement is substantiated through a discussion of three

Map 1.1: Location of the Tungabhadra Left Bank Canal irrigation system in Raichur district, Karnataka State, India



Source: Jurriëns, Ramaiah and van Alphen (1988:23) (slightly adapted)

conceptual problems in current approaches. These are:

1) the treatment of irrigation technology as a black box in both social and technical science approaches to irrigation,
2) the simplified concept of human agency commonly used in irrigation analyses, and
3) the absence of a concept of social power in most analytical frameworks.

An approach to remedy these defects is developed in the same chapter and elaborated in the rest of the book. The approach's conceptual focus is 'water control in sociotechnical systems'. Water control is defined as politically contested resource use. The critique and the alternative approach also reflect on models for irrigation intervention. The concept of government-controlled planned intervention is questioned and a 'policy as process' perspective advocated instead.

1.3 METHOD

The method chosen to address the concerns outlined above is the intensive study of one particular case, the Tungabhadra Left Bank Canal irrigation system (on the case study method see Yin, 1984).

One reason to opt for the case study method were the characteristics of available studies on canal irrigation management in South Asia. There is ample documentation on how South Asian canal irrigation systems *should* be managed, and no dearth of reports listing the many problems that occur in canal irrigation systems. There are surprisingly few detailed and comprehensive studies on the way the systems are *actually* managed, operated and maintained, how these phenomena should be explained, and what the wider effects of these irrigation practices are.[3] Policy initiatives for management reform in canal irrigation may as a result bear little relation to the practicalities of irrigation on the ground (or rather, on the canals). A larger number of 'grounded' studies could provide a more realistic basis for policy debates on the desired transformation of these systems. Within the given time frame of the research one intensive case study was the maximum achievable.

Another reason to opt for the case study method was that this research ventured into relatively new and unknown terrain, both substantively and methodologically. The research was complex in different ways. Irrigation systems, particularly large ones, are by nature complex in the sense that they are composed of heterogenous elements, which are part of a whole structured through levels and in other ways. The research was complex in the sense of difficult because it wanted to study water control's different dimensions, implying a call on conceptual frameworks and methodologies from different disciplines. The causal connections that needed to be brought to the surface were, at least to this researcher, far from obvious.

The research started at the local level with the investigation of water distribution in three tertiary units. These were units comparable in complexity and size with the small scale systems investigated earlier by the author and his colleagues.[4] For reasons of intellectual stimulation, tertiary units were chosen in a head end and a tail end distributary of the system: distributaries 24 and 93, at a distance of about 100 kms apart.[5] Units were chosen with some degree of water scarcity. The assumption was that social interaction would particularly

---

[3] This study would not have been impossible without the existence of a number of studies that do approach the ideals of empirical 'thickness' and comprehensiveness. References are given in chapter 2.

[4] The research for this book was based in the Irrigation and Water Engineering research group at Wageningen Agricultural University, the Netherlands. With regard to the investigation of water distribution practices, the group gained experience in smaller scale, farmer-managed irrigation during the 1980s (reported in Diemer and Slabbers, 1992 and Diemer and Huibers, 1996). My own experience was with small scale (20 ha) lift irrigation in the Senegal river valley, done together with Ton Meijers (Meijers and Mollinga, 1991). Colleagues who started to work in larger systems from a similar perspective in the late 1980s and early 1990s were van der Zaag (1992), van Bentum (1995) and Pradhan (1996).

[5] These numbers are the numbers of non-existing distributaries, but they indicate the approximate location of the distributaries in the system (see map 1.1).

be visible in situations of medium scarcity, and much less in situations of abundance or very severe scarcity (see Wade, 1988a; Uphoff, Wickramasinghe and Wijayaratna, 1990). Tertiary units were so selected that the group of water users consisted of 40 to 50 households in each of the two locations. Forty to fifty was a number considered large enough to be able to identify different categories of farmers/water users, and not too big to be researchable through intensive research (see Sayer, 1984 on the concept of intensive research). Tertiary units with a mixed population of local and settler farmers were selected.

After basic insight in the situation in the tertiary units had been gained, the research moved up the canals. It followed the water and the water users from these units to division points along the canals, to the offices of Irrigation Department officials, to the houses of politicans, to the markets where farmers sell their produce, to the villages, to the shops of seed and fertiliser traders, and even to the halls of the Karnataka High Court and Parliament. The intention was to map as comprehensively as possible the set of practices, relations and institutions that the farmers from the tertiary units were engaged and embedded in, as far as these were relevant to understand water control.[6] The inspiration by social-anthropological research techniques should be evident (see for example Long, 1989).

A major methodological problem of this approach is located in the phrase 'as far as these were relevant to understand water control'. Without a fully developed conceptual model or substantive theory, and without much empirical data on comparable situations, the identification of relevant relations and phenomena was very time-consuming and stressful. In fact, far too much data was collected on some aspects, and perhaps not enough on others.

More generally speaking, professionally oriented interdisciplinary research on irrigation has at least two gaps to bridge. The first is the conceptual gap between the technical and the social sciences, and the second is the gap between theory and practice, or knowledge and action.

The first gap is most easily bridged. The research was designed like most academic work. It took a societal issue as its research object, but was not directly linked to intervention or change processes, and did not have the ambition to conclude with a set of prescriptions for action. It could fully focus on making conceptual contributions to further the cause of interdisciplinary irrigation science.

Research designs that allow impartial and reflexive analysis have their merits, particularly in conflictuous contexts like water distribution, and in cases where the approach to intervention is part of the problem. However, this distance to the research object also makes it more difficult, if not impossible, to bridge the second gap, that between knowledge and action. This gap exists for all academic research that is designed as indicated above, but it is particularly acute in the case of interdisciplinary research. This risks to speak to none of the disciplines it seeks to integrate, in both the academic and the action oriented world.[7]

---

[6] Because of time and scale reasons the evidence collected at the lower levels of the system is 'thicker' and on higher levels it is 'thinner'. Going upwards, some of the institutions and practices were black-boxed to keep the fieldwork manageable. The order of presentation of the research material on water distribution runs parallel to the order of investigation. What has become invisible in the organisation of the book is that the conceptual framework was developed to a large extent while struggling with the empirical material, and not before it, as the chapter sequence now suggests.

[7] A typical mechanism in universities is that research groups with an interdisciplinary mandate are institutionally marginalised by giving them the same position as the disciplinary groups. They thus become, as it were, a new discipline. The pressures for this come from the other groups (an

(continued...)

It also makes relatively large demands on the readers of the texts that it produces, because interdisciplinarity assumes familiarity with a number of professional and academic fields.

By its size alone, a scholarly work of more than 300 pages can hardly be expected to have much of an impact on the reality that it describes and analyses. The gap between theory and practice can only be bridged by setting knowledge to work in concrete action. However, the desire to bridge the knowledge-action gap has affected the mode of presentation of this book.

Except in chapter 2, I have tried to avoid the use of conceptual jargon in the main text. I have attempted to present the empirical material in a theoretically structured and coherent manner without labouring the theoretical underpinnings. I try to let the facts speak, while being aware that the facts never speak for themselves.

In addition, the theoretical focus single-mindedly is the development and application of a conceptual framework for the interdisciplinary analysis of water distribution in canal irrigation. One of the problems in interdisciplinary research is the temptation to engage in and try to contribute to the disciplinary debates from which insights and concepts are eclectically drawn. I have tried to stay object-focused in theorisation and not to diverge into disciplinary preoccupations. I clarify my position in the different disciplinary fields where necessary, through references and short discussions in footnotes and boxes, and more generally in chapter 2. Theoretical conclusions can be found in the concluding sections of the empirical chapters and in the concluding chapter of the book.

I hope that this way of dealing with theory and conceptual jargon has made the book more accessible to its main target group, irrigation professionals and students, than it would otherwise have been.

1.4 STRUCTURE OF THE BOOK

After this introduction, the book in chapter 2 opens with a discussion of the conceptual framework that it employs for its analysis. This discussion leads to the formulation of the central research question of the book.

Chapter 2 not only provides the basis for the analyses presented subsequently, but is also an effort to summarise more generally the approach of the Wageningen-based research group to the study of the management and use processes in actually existing irrigation systems. In many respects, the ideas in it are the result of a collective learning process, rather than my own individual ideas. Obviously, this is not an effort to dodge responsibility for the content of the chapter.

Then follow three contextual and historical chapters. In chapter 3 the phenomena of protection and localisation are discussed. Protection refers to the design characterictics of the large scale canal irrigation systems constructed in the dry areas of South Asia since colonial times. The chapter discusses the regionally specific forms that protection against drought and

[7](...continued)
integration role is quickly perceived as an overseeing and evaluation role) and from the interdisciplinary groups themselves (the need to consolidate work space that was often acquired with great difficulty). Examples are departments of gender studies and technology and development groups. Mechanisms in the action oriented world can be derived from Chambers' discussion of normal professionalism (Chambers, 1988). One of the conclusions that I have drawn from this is that transformation towards interdisciplinarity has to start from within the disciplines rather than be advocated from the outside.

famine has taken. It situates the case study and suggests its wider relevance. Localisation is the form of government land use planning that was tried in South India to control water use (and secure its spread) by means of legal-administrative control of the cropping pattern in irrigation systems. Insight in the features and failure of localisation are essential to understand present water distribution problems.

Chapter 4 discusses the different steps and phases in the evolution of the idea to construct a large scale irrigation system in the Tungabhadra valley. This story starts in the mid-19th century. The chapter discusses the long-drawn negotiation of the main design characteristics of the system, which include its location, total available water, the size of the command area, the cropping pattern to be adopted and the alignment of the main canal.

In chapter 5 the socio-economic context of water distribution is discussed. The chapter shows the quite dramatic impact of irrigation on agricultural development in Raichur district (expansion, intensification and commoditisation). The settlement of farmers from the coastal areas of neighbouring Andhra Pradesh is discussed in some detail because of its importance for the process of growth and social differentiation. After the presentation of a typology of farming households-enterprises, the chapter concludes with a discussion of the geographical dimensions of access to water and social differentiation at pipe outlet command area and distributary level.

These three contextual and historical chapters serve as background and introduction to the core of the book, the analysis of water distribution practices at different levels in chapters 6 to 9. In chapter 6 the reproduction of unequal water distribution at pipe outlet command area (tertiary unit) level is discussed for each of the three outlet command areas that were investigated. The chapter identifies some of the mechanisms through which rich and middle peasants manage to reproduce their dominance over small and poor peasants. Water distribution relations are interlinked with credit and employment relations, in which small and poor peasants have dependent positions. But, this relation is two-sided and leaves some room to manoeuvre for the deprived.

Water distribution practices at distributary level are discussed in two chapters. In chapter 7 the institutional dimensions of water distribution are the focus. The chapter discusses the different organisational forms, particularly rotation schedules at distributary and subdistributary level, for the mediation water of scarcity. It also looks at the strategies of different actors involved - farmers, Irrigation Department staff and politicians - to cope with the struggle over scarce water.

In chapter 8 the focus is the irrigation distribution technology, particularly the design and construction of the pipe outlet structures that connect the distributary canals with the farmers' fields in the tertiary unit. This point of contact is analysed as the contested material interface of water users and the state. It is argued that the interactions of these groups shape as well as are shaped by the technical characteristics of the distribution device.

The last chapter on water distribution practices is chapter 9. It is located at the main canal level. The chapter describes the changing arrangements for distribution of water in the main canal over the four main canal management divisions. It discusses institutional responses within the irrigation bureaucracy to scarcity at main canal. It shows that irrigation bureaucracies may be more flexible and prone to change than images of rigid hierarchical empires tend to suggest. But at the same time it shows that the problem to achieve institutional change at this level remains quite enormous.

In the concluding chapter, chapter 10, the main focus is management reform in protective irrigation. The chapter first discusses the constraints and opportunities for management reform that can be derived from the analysis in preceding chapters. This discussion is also a summary answer to the central research question. After that the different perspectives that exist on the need for management reform and the problems that need to be solved are discussed. The third entry into the management reform issue is a discussion of the process of irrigation reform policy formulation and implementation in Karnataka. The chapter and the book conclude with a research agenda for management reform.

2

ON THE WATERFRONT

Conceptual groundwork for interdisciplinary irrigation studies

The objective of this chapter is to provide the conceptual basis for the analysis of water distribution practices in the Tungabhadra Left Bank Canal in subsequent chapters. The chapter is also an attempt to present a theoretical starting point for interdisciplinary analysis of irrigation more generally. Interdisciplinarity in this book particularly refers to the integration of technical and social science perspectives on irrigation.

Theoretical endeavours to develop conceptual frameworks usually start with detailed reviews of the literature in the field. I will not present such a review here because a number of reviews that identify the gaps and limitations of the irrigation literature already exist (see for example Chambers, 1988; Jurriëns and de Jong, 1989). Recently, Ramamurthy wrote a review of the irrigation literature from a perspective very close to the one adopted in this book (Ramamurthy, 1995). Moreover, her review underpins a study of irrigation practices in a South Indian canal irrigation system. There is no need to repeat her excellent contribution.

A general conclusion that can be drawn from these reviews and critiques is that there seem to be very few bridges across the gap between the technical and social irrigation sciences. A more appropriate metaphor for the connection between the two disciplinary shores would be that of a ferry, across a river with hazardous currents, allowing only intermittent presence on either side, but no continuous traffic and intermingling of ideas. More plainly put, I want to suggest that an interdisciplinary approach to irrigation requires a critique of some of the main theoretical premises of the professional irrigation literature, and, to a lesser extent, of some of the academic irrigation literature's premises (the distinction is explained below). The premises I have in mind are the following.

1. The conceptualisation of technology.
2. The understanding of human agency and practice.
3. The (absence of a) concept of social power.

A consequence of this evaluation of the irrigation literature is that in order to develop an interdisciplinary framework for irrigation studies it is necessary to draw on a number of literatures that have very little to do with irrigation. In this chapter I will liberally perform such acts of appropriation.

Section 2.1 gives a summary evaluation of the professional irrigation literature as an introduction to the rest of the chapter. In the remaining sections I outline the conceptual basis of the approach used in this book. Section 2.2 argues that irrigation systems are inherently sociotechnical systems and therefore require a sociotechnical approach for their analysis. On the basis of that discussion I design a descriptive model of irrigation systems as structurally embedded irrigation activities at different system levels (section 2.3). The concept of practice discussed in section 2.4 theoretically elaborates the notion of irrigation activities. The discussion provides a set of operational concepts, based on a particular concept of human agency, for the concrete investigation of the day-to-day happenings in sociotechnical irrigation systems. In section 2.5 the main concept of the book is introduced: water control. Three dimensions of it are identified: technical, organisational, and socio-economic/political. Through a discussion of the concept of social power water control is defined as a case of politically contested resource use. In section 2.6 I formulate and discuss the central research question of the book. It is the first step away from the general conceptual discussion in the preceding sections towards substantive theory on the Tungabhadra Left Bank Canal case. In section 2.7 I conclude the chapter with a description of the structure of the book in terms of the central research question.

2.1 THE PROFESSIONAL IRRIGATION LITERATURE: A SUMMARY EVALUATION

With professional irrigation literature I refer to three bodies of intellectual work: the irrigation engineering, irrigation economics and irrigation management literatures. The adjective professional derives from the close linkage of these three literatures with donor and government funded irrigation practice and intervention.[1] An alternative description would therefore be the intervention or action-oriented literature.

The irrigation engineering literature is mostly disciplinary work on the hydraulics of canals and structures, construction engineering, crop water requirements, irrigation efficiencies, and other topics.[2]

Economics, particularly neo-classical economics, has always been very important in government-sponsored and government-managed irrigation. In colonial times it was used to calculate the financial returns to government investment in irrigation (see chapter 3). It is now similarly used for calculating benefit/cost ratios and internal rates of return to evaluate the feasibility of irrigation projects, and the role of irrigation in economic development.[3] More recently the discipline of economics has become more important in the field of

[1] Examples are the Water Management Synthesis Project in Pakistan, the Command Area Development (CAD) programme in India, and the National Irrigation Agency (NIA) experience in the Philippines. The location of the International Irrigation Management Institute (IIMI) in the CGIAR (Consultative Group on International Agricultural Research) network, and the location of IPTRID (the International Programme on Technology Research in Irrigation and Drainage) - till recently - in the World Bank also illustrate the intervention orientation and donor association. For critical discussion of some of the implications of the strong intervention and donor orientation, see Bloemen and de Moor (1983) and Heybroek and Witter (1981).

[2] Indian irrigation textbooks that cover these issues and which are used in this book are Ellis (1950) and Mahbub and Gulhati (1951).

[3] The size of the irrigation economics literature is substantial. For India see Dhawan (1988) and Bharadwaj (1990) for an overview and references.

irrigation studies through the use of approaches like rent seeking analysis and game theory for understanding institutional processes (Repetto, 1986; Ostrom, 1990).

The irrigation management literature has emerged since the 1970s as a response to the disappointing performance of the irrigation systems that were newly constructed in the 1950s and 1960s in a massive wave of irrigation investment (for a review focusing on South Asia, see Chambers, 1988). In the 1970s and early 1980s most attention went to the organisation of water distribution and maintenance and the organisation of water users in water users associations at the local, tertiary unit or outlet command area level. More recently main system management and the irrigation bureaucracies have also become a focus in research. Performance assessment is now a main theme, linked to irrigation management transfer and decentralisation, and the introduction of market principles (volumetric pricing, tradable water rights) in management. Here there is a strong link with irrigation economics.[4]

In addition to the professional irrigation literature there is what could be called a more academic literature on irrigation. It is much less linked to irrigation intervention practices. I refer to historical, geographical, social-anthropological, political-economic and other studies on irrigation, aiming to understand ongoing processes more than directly desiring to change them.[5] An alternative, but not very elegant description would be the understanding-oriented irrigation literature. These studies are usually independently conducted by universities and research institute staff. Though there are definitely linkages between the 'professional' and the 'academic' literatures on irrigation (both in persons and in ideas), they have to a large extent remained two separate worlds.

Summarised at the most general level, my criticism of the premises of the professional irrigation literature consists of three points.[6]

1) *The treatment of technology as a black-box.* This means that engineers as well as social scientists tend to consider technology as something that may be used or abused, but which is inherently neutral. Irrigation engineers tend to be unaware of and/or uninterested in the way technologies are shaped by and in their turn shape institutional and other social relations. The little space the 'social perspective' has found in the irrigation engineering debate is in the discussion of technology-management interactions (for discussion see Horst, 1996; Levine, 1980; Pradhan, 1996). But opening the black box of irrigation technology is a much broader exercise, as will become clear below. An appreciation of

---

[4] See for example Murray-Rust and Snellen, 1993; Nijman, 1993; Rosegrant and Binswanger, 1994; Small and Svendsen, 1992; Vermillion, 1996.

[5] For India, such academic studies include - focusing on canal irrigation - Gorter (n.d), Jairath (1984), Pandian (1990), Ramamurthy (1995), van Schendel (1991), Sengupta (1991), Stone (1984), Wade (1988a) and Whitcombe (1972).

[6] I limit myself to ontological points, that is premisses regarding the nature of irrigation reality. I leave aside the epistemological and methodological premiss of the dominantly positivist approach to investigation and explanation in the professional irrigation literature. For a critique of positivism see Sayer (1984). There is an emerging debate in India between different methodological paradigms, as dominant in economics and social anthropology (see Bardhan, 1989). For irrigation in India, the first occasion that I know of where these contrasting paradigms were (largely implicitly) discussed, was the 1995 conference in Madras on 'The political economy of water in South Asia. Policy problems and proposals'. Explicit formulations of the listed points of criticism are found mostly in the work of people working at the interface of the professional and academic spheres. Some references are given below.

the social dimensions of technology is generally also absent in the economics and management professional literature on irrigation.[7]

2) *A limited concept of human agency.* With concept of human agency I refer to the basic idea about what motivates people's behaviour, and how that behaviour should be analysed. In the irrigation economics and management literature the concept of human agency is usually that of the utility maximiser or optimiser and the rational decision maker, weighing the costs and benefits of alternative choices. In contrast to this I suggest that human behaviour is a much more complex affair, which requires less idealised and simplified models.[8]
3) *The absence of the social relations of power.* Institutional and other social relations are seldomly perceived as relations of power in the professional irrigation discourse. Human relations and institutions are thought of in assumedly more neutral terms like (in)effectiveness, (in)efficiency and (ir)rationality.[9] Social interaction is often modelled as decision-making (Nijman, 1993) or communication (Scheer, 1996), without incorporation of notions like interests, conflict and struggle. In contrast I argue that social power is a crucial element in understanding relations among people (and between people and things for that matter). This book tries to show that the technological and institutional forms of water distribution must be understood as the embodiment of particular configurations of power relations.[10]

In part of the academic irrigation literature the second and third points are quite commonplace, and this literature can therefore be usefully employed to enrich the professional irrigation debate. The first point, on technology, is the more problematic one. In most academic studies of irrigation, technology is equally treated as a black box.[11] I will devote considerable space to the argument that this cripples attempts at a comprehensive understanding of irrigation.

In the following sections the validity of this critique will be argued for in reverse so to speak. I outline a framework which incorporates the three criticisms given above. I suggest that the presented framework allows more comprehensive analysis of irrigation situations. The proof of that pudding lies in the reading of the full book.

---

7) See for example Diemer and Huibers (1996) for a summary critique of the the professional irrigation literature on this point. Also see Diemer and Slabbers (1992).

8) See for example Anderson (1980) and Giddens (1984) for general discussion of the concept of human agency. For a discussion of concepts of human agency used in performance assessment models, see Mollinga (1994). For critiques of neo-classical and neo-institutional economics regarding their concepts of human agency, methodological individualism and the failure to analyse social relations of power see Bardhan (1991), Callinicos (1987), Hodgson (1988) and Sen (1977). Also see Zey (1992). For critiques of the neo-classical economy approach to irrigation/water resources see Green (1996) and Morris (1996).

9) For a review of Indian irrigation economics making this point, see Bharadwaj (1990). She argues for the development of a 'social relations perspective' in Indian irrigation economics. Dhawan (1993) is a very critical discussion of Bharadwaj's review.

10) For general critiques of the irrigation literature which incorporate one or more of the three points discussed, also see Manzungu and van der Zaag (1996), Sengupta (1985) and Vincent (1997).

11) An example of this is Attwood (1985), to which Bolding, Mollinga and van Straaten (1995) was written as a response. In the South Asian context Wade is one of the few social science irrigation analysts who addresses the technology issue (see Wade, 1990). Also see Pfaffenberger (1988) and Sengupta (1993).

[redacted] OTECHNICAL PHENOMENON

[redacted] nprehensive understanding of irrigation requires a framework [redacted] ial science perspectives. The basic assumption underlying this [redacted] nherently a socio-technical phenomenon.

[redacted] ystem) is not new to irrigation studies. Box 2.1 gives a [redacted] and one from Huppert (1989), which are representative [redacted] term.

[redacted] vork the technical part of the adjective remains a black box. [redacted] structure of [redacted] ely similar [redacted] rganization" [redacted] he does not [redacted] ies give rise [redacted] of systems. [redacted] not move [redacted] hannel and [redacted] (*ibid.*:51, [redacted] pproach to [redacted] ion is put in [redacted] a separate [redacted] ency factors [redacted] (Huppert,

> **Box 2.1: Socio-technical systems and processes**
>
> "Both human and physical aspects interact continually and profoundly in irrigation enterprises, so a hyphenated construct of irrigation as a socio-technical process seems appropriate." (Uphoff, 1986:4)
>
> "Irrigation systems are socio-technical systems, i.e. they embrace both social and technical system components and subsystems. The essential attributes of socio-technical systems include:
> - close interrelationships between structural, social and technological features;
> - openness of the systems to their system environments;
> - an emphasis on conversion processes in which inputs imported from the system environment are transformed in a conversion process (throughput) and exported to the system environment as outputs." (Huppert, 1989:27)

[redacted] ons the term [redacted] by a critical [redacted] technology, [redacted] is therefore [redacted] tion I will [redacted], based on a [redacted] shaping or [redacted] gy.[12] [redacted] construction [redacted] technology [redacted] ons of irrigation artefacts.[13] The basic idea is that irrigation

---

[redacted] truction of technology that I have found particularly inspiring is [redacted] (and in that particularly Winner, 1985 and Noble, 1985), Callon [redacted] al paper (Pinch and Bijker, 1984) and the reply to it by Russell [redacted] es (1987). For a critique of the now firmly established school of [redacted]

[redacted] acts (tools) here, and disregard technology as human labour power [redacted] nology as knowledge (for this threefold division, see Kloezen and [redacted] the most easily recognised embodiment of technology, and their [redacted] he core of the professional competence of irrigation engineers. I [redacted] nology for the hardware component of irrigation. The other two [redacted] matically come into focus when artefacts are studied in context. [redacted] ntly in irrigation design processes, and human labour power when [redacted] tion activities.

technologies not only mediate people's relationships with bio-physical processes, but also shape the people-people relationships that are part of irrigation.[14] The social dimensions can be specified in three points: social requirements for use, social construction and social effects.

Social requirements for use

Irrigation technologies put demands on the management structure of the irrigation system in which they are used. To illustrate this point for large canal systems, the device by means of which water is 'handed over' from the irrigation agency managing the main system to farmers managing the local irrigation units, can be taken as an example.

The outlet or division structures that connect the main system and the local irrigation unit can be designed in different ways. These different designs allow different types of operation and regulation of supply. Fixed, non-adjustable structures are easy to handle, require no water level measurements, cannot easily be mismanaged, require few management staff, but have low operational flexibility and, at least on paper, lead to low water-use efficiencies. Gradually adjustable structures on the other hand are complex to handle, require regular water level measurements, can easily be tampered with, require high staffing levels, but have high operational flexibility, and, at least in theory, lead to high water-use efficiencies (see Horst, 1987). The design of the outlet structure thus shapes the management structure.

This point can be theoretically formulated and generalised by stating that irrigation technologies have social requirements for use.[15] This means that particular social conditions have to be fulfilled for the technologies to work effectively, and that different technologies require different enabling conditions.

Social construction

Irrigation technologies are developed and designed with particular forms of cooperation and management in mind. The purposes that technologies have to serve, and the institutional forms through which these purposes should be achieved, are reflected in the technical design characteristics of irrigation artefacts. Two historical examples regarding canal irrigation are the genesis of the Romijn outlet structure in the colonial period in the Dutch East Indies to protect the interests of the sugar planters (ter Hofstede and van Santbrink, 1979), and the search for tamper-proof modular outlets in British India in order to introduce market principles and volumetric supply in water distribution in canal irrigation (Bolding, Mollinga and van Straaten, 1995).[16]

This point can be theoretically formulated and generalised by stating that irrigation technologies are socially constructed. This means that *(i)* technology development and design

---

[14] People-people relations are an inherent part of irrigation because irrigation systems in most cases involve more than one user. Cooperation among users, and often of users and government or other agencies' personnel, is necessary to make use of the infrastructure. Even in single-user cases like individual well irrigation, there is interdependence of different individual users at the regional or watershed level. This becomes clear when over-extraction of groundwater takes place.

[15] For this and the following two concepts see Mollinga and Mooij (1989) and Kloezen and Mollinga (1992). Lacroix (1981:162) and van der Ploeg (1991:108) use the French term *mode d'emploi*, which expresses the same meaning as social requirements for use.

[16] Other examples of social construction of irrigation technology can be found in van Bentum (1992, 1995), de Bont (1992), Dia *et al.* (1996), Froentjes and de Ruiter (1991), Gerbrandy and Hoogendam (1996), Horst (1996), Maat and Mollinga (1994) and Meijers (1992). Also see Pfaffenberger (1988).

are social processes in which different stakeholders interact (communicate, negotiate, take decisions, struggle, etcetera), and *(ii)* that the nature of that process and the different perceptions and interests of the stakeholders shape the technical characteristics of the technologies (together with the properties of the materials used and the nature of the (bio)physical mechanisms involved).

Social effects

The third way in which irrigation technologies are social objects is most simply put by stating that irrigation technologies have social effects. Through its effects on crop production, people's health and other things, irrigation affects people's livelihoods.[17)] These effects are technology-dependent. For example, irrigation allows more intensive cropping systems, and may thus generate economic growth and employment. Individually controlled sprinkler irrigation systems enabling intensive cultivation of horticultural crops will have different growth and employment effects than continuous flow gravity canal systems spreading water thinly for supplementary irrigation of foodgrains like sorghum and millet. Another example is that some types of irrigation allow the spread of an important resource over large numbers of people and may therefore be important tools for politicians to reproduce political support in their constituencies. The latter is one of the crucial features of protective irrigation systems (see chapters 3 and 7).

These three concepts, the social requirements for use, social construction and social effects of irrigation technology, provide the basis for a definition of irrigation systems as sociotechnical systems.[18)] A comprehensive understanding of irrigation requires addressing both dimensions simultaneously, and not consecutively and separately, as is usually done. The absence of a hyphen between socio and technical is deliberate.

2.3 A DESCRIPTIVE MODEL OF IRRIGATION SYSTEMS

After establishing the sociotechnical nature of irrigation systems, I now turn my attention to the question how these systems can be modelled. It can be deduced from the discussion above that irrigation systems consists of a heterogeneous set of elements, and that they need to be studied in context. The questions that need to be addressed are the following.

1) What are the constituent elements of irrigation systems and what are the relations between them?

[17)] For discussion of a 'livelihood perspective' on irrigation, see Chambers (1994). Also see Guijt and Thompson (1994), who make the additional point that water is supplied not only to crops and people, but also to landscapes. This brings the issue of the ecological sustainability of irrigation into focus. The best known debates on the social effects of irrigation are that on the so called green revolution (Anderson *et al.*, 1982; Byres, 1981; Harriss, 1985) and, more recently that on the effects of large dam projects (Dhawan, 1990; Singh, 1997).

[18)] The term sociotechnical is most appropriate at the irrigation system level. At the watershed level it would perhaps be more appropriate to speak of a socio-natural system (Bennett, 1990) or a socio-ecological system (Gallopin, 1994, quoted in Singh and Titi, 1995:18, footnote 1). At the level of the farm the term socio-agronomical system might be used. On social agronomy, see Chayanov (1925) and van der Ploeg (1993), and for an application in irrigated agriculture, van Bentum (1995: chapters 8 and 9). This book discusses irrigation at the irrigation system level, and not at the watershed or catchment and farming system level.

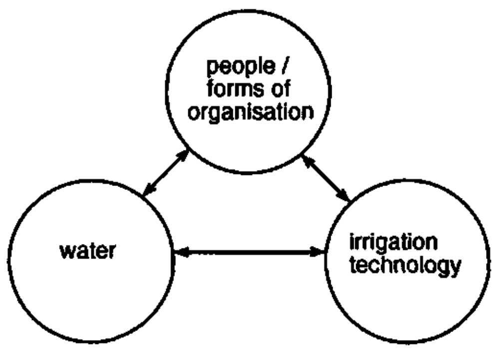
2) How does the 'context' in which these systems function affect the irrigation activities going on within the systems (and *vice versa)*?

A labour process perspective

My starting point for answering these questions lies outside the domain of irrigation. More than a century ago Marx undertook to analyse how the 'forces of production' and the 'relations of production' were connected to each other in capitalist manufacturing and industry, and how this interrelation structured societal change. He developed a general concept of the labour process in which both the technical and the social elements of production found a place. He proposed that every labour process, that is every human activity aiming to produce a useful product, consisted of three elements: *(i)* the personal activity of man, i.e. work itself, *(ii)* the subject of that work, and *(iii)* its instruments (Marx, 1977/1867:chapter 7).

When we regard an irrigation system as a labour process with the objective to bring water from A to B in order to grow agricultural crops, Marx's elements can be translated and represented as in figure 2.1 (additional elements of labour process theory are referred to in section 2.6).

Figure 2.1: Elements of irrigation as a labour process



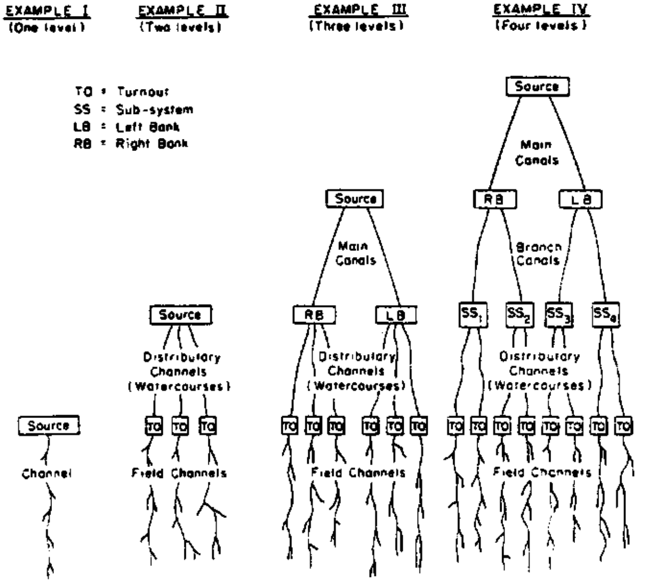
Irrigation activities

The triangle of people, technologies and water summarises in a single formula all activities that take place in irrigation systems. Further operationalisation is possible by looking in more detail at exactly which activities are part of irrigation. Uphoff has provided a useful and comprehensive description of irrigation activities. He distinguishes three types, each subdivided into four activities: control structure activities (design, construction, operation, maintenance), water use activities (acquisition, allocation, distribution, drainage); and organisational activities (decision making, resource mobilisation, communication, conflict management) (Uphoff, 1986:38-40, 42). Other classifications of activities and processes in irrigation are also available (see Chambers, 1988; Huppert, 1989). The exact classification one favours depends on the purpose of the analysis in which it is used, and the overall approach to irrigation. The general point is that irrigation consists of many different activities that need to be executed in combination.

System levels
A further element of the descriptive conceptualisation of irrigation systems is that they consist of a number of levels. Hydraulically, irrigation systems are made up of different levels of canals, which are connected by the outlet and division structures discussed above. Figure 2.2 shows differences among irrigation systems in terms of their number of levels.

The levels-model can be extended upward by seeing irrigation systems as parts of a watershed, and watersheds as parts of regional, continental and world wide agro-ecological systems. Downward the model can be extended by including the different levels of the drainage system, from field drain to ocean. In short, the whole hydrological cycle can be seen as a system with many levels.[19]

Figure 2.2: Levels in irrigation systems



Source: Uphoff (1991:33)

The sociotechnical point is that these levels are not only hydraulic or ecological levels, but also social levels. At each of the levels there are different institutions in relation to water flow at that level. These range from national and international policy making and legislation, to collective action at canal system level, to intra-household cooperation in field irrigation.

The social levels are organisationally linked just like hydraulic levels are technically and physically linked. For example, the connection of a secondary and a tertiary canal is not only a division structure with gates and locks, but also the person of the water distributor, who

[19] The hydrological cycle is actually a circulation system with different 'compartments'. The levels metaphor applies when only part of the cycle is considered.

may have different institutional attributes in relation to his or her appointment and payment by and accountability to farmers, the government, or other irrigation agencies.

The notion of levels as relatively autonomous domains of irrigation activity invites the application of systems theoretical approaches to irrigation. There have however been very few applications of systems theory to irrigation that attempt to capture its sociotechnical complexity. One of the conceptual (and practical) issues is that there is no simple coincidence of hydraulic and social levels. How these precisely interconnect, and how their intersection is the subject of renegotiation in irrigation activities, is an empirical question, and not one of theoretical assumptions.[20]

The context

As noted above, irrigation activities are not self-contained, isolated activities, but they are part of wider processes. Irrigation activities as we encounter them in practice have a number of conditions of possibility. With conditions of possibility I refer to the circumstances that enable the conduct of irrigation activities.

There are material and social conditions of possibility. The rainfall pattern and soil fertility are examples of material conditions of possibility. We notice this when rain does not fall and rivers and groundwater aquifers dry up, or when soils become saline or suffer from erosion. Other examples are the existence of passable roads in the irrigation system in order to make gate adjustment and other management activities possible, and working telephones to make frequent communication between different administrative divisions in the system feasible. When the right material conditions are not fulfilled, irrigation as usual can no longer take place.

There are also many social conditions of possibility. Some examples are the following.

* A farmer who uses a pumpset to lift groundwater to his fields can only do this when he has a right to put a pumpset in his field, and extract water from the groundwater aquifer below it. This right is part of the legal system of property rights in a society (for a legal-anthropological perspective on law and property rights, see Benda-Beckmann and van der Velde, 1992).
* When water is very expensive farmers may use it judiciously, while they may not be very particular about water use efficiency when it comes free of cost. The price of water depends on several factors, among them government water pricing policy (see for example Shah, 1993 and Moench, 1994).
* When farmers who happen to have land in the same irrigation system need to cooperate to distribute water among themselves, this may be easier or more difficult depending on differences in class, caste, gender, ethnic and other social relations (for references see chapter 5).

---

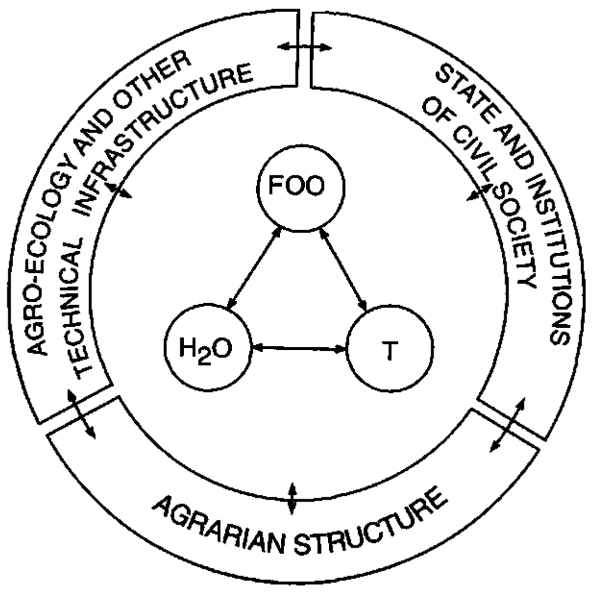
[20] One recent attempt to develop a comprehensive model of irrigation systems is Small and Svendsen's model of irrigation as a whole consisting of nested subsystems (the irrigation, irrigated agriculture, agricultural economic, rural economic and politico-economic subsystems), relating to each other through inputs and outputs (Small and Svendsen, 1992). The model seems to be influential. It appears on the cover of the guidelines for preparation of operational plans for irrigation systems in India (INCID, 1994). Elsewhere I have discussed the limitations of this type of modelling (Mollinga, 1994). Two problems are the ontological separation of the different subsystems and the fixity of their boundaries.

The different conditions of possibility for irrigation activities can be generically classified in three categories.[21]

1) The *agro-ecological system and technical infrastructure* (climate, weather, vegetation, soil, topography, technologies other than the irrigation system itself).
2) The *agrarian structure* (markets for labour, land, technology, credit, inputs and outputs, and social relations like class, gender, ethnicity, religion, caste and kinship at household, village/community and other levels).
3) The *state and the institutions of civil society* (government line agencies like the Irrigation Department, the legal system, policy making institutions, development NGOs, social movements, education and training institutes, international donor and lending agencies, local government institutions, and others).

The discussion above is summarised in figure 2.3 which gives a graphical representation of structurally embedded irrigation activities.

Figure 2.3: Irrigation activities in context



FOO = forms of organisation
T = technology

The descriptive model, summarised in figure 2.3, gives a partial answer to the two questions posed at the beginning of this section. It identifies the constituent elements of irrigation systems, the activities that take place in them, the levels at which these occur, and it gives a generic classification of the elements of the context in which the systems function.

---

21) No theoretical claims are attached to this classification. See section 2.6 for more discussion.

The descriptive model is a static model because it does not elucidate the nature of the relationships between the elements, activities and levels, and how these shape each other. How to understand the dynamics of irrigation systems is outlined below in two steps. The first is to look at irrigation systems as embedded practices, and to explicate the concept of practice. The second step is to introduce the concept of water control.

2.4 IRRIGATION AS A PRACTICE

An explication of the concept of practice provides the first part of a framework for analysing the sociotechnical structure and dynamics of irrigation activities in irrigation systems. I start with a definition of the concept, after which it is operationalised.[22]

"The production or constitution of society is a skilled accomplishment of its members (...)" says Giddens (1976:102). This skillful product emerges through "regularised types of acts", that is, human practices (*ibid.*:75). Practices are thus what people do, in a structured, and structuring, fashion. Social interaction is the type of practice in which people encounter each other.

The concept of practice provides a practical programme for investigation of actually existing irrigation, and it will be used as such in this book. It also contains a number of basic propositions on the nature of human agency and social interaction. These propositions are not themselves the subject of theorisation in this book. They are presented in some detail below because the adopted perspective is not commonly used in irrigation studies. In four subsections I discuss the characteristics of the human behaviour that drive practices, the means mobilised to conduct them, where practices take place, and how they are structured and what is at stake in them.

Human agency

Implicit in the definition of practice given above is a concept of human agency which says that people are knowledgeable and capable actors. People are active players in creating new social and material environments, even when they have to operate within a context that is only partially of their own making, and with motivations that are only partly conscious (Giddens, 1984:chapter 2; Bourdieu, 1977:chapter 2; also see Long, 1989).

It is not unimportant to stress the knowledgeability and capability of the actors involved in large scale canal irrigation management. Water users are not infrequently described as illiterate, uneducated and wasteful. Irrigation officials are often talked about in pejorative terms as well, as being unmotivated, poorly trained and corrupt. Such a perspective on the main players in water management hardly allows serious consideration of their actions, skills, concerns and perspectives. It hinders both analysis of water management as it actually occurs, and the grounding of interventions on such analysis.

The knowledgeability and capability of people does not mean they can do what they like (or like what they like, as Bourdieu, 1977 stresses). Actors are always positioned (and positioning themselves) in a particular context. The relationships in which an actor finds him/herself both constrain and enable his/her possibilities for action. Social position also

---

[22] In the technical irrigation discourse practice is sometimes used as 'water application practices', with surface irrigation, sub-irrigation and overhead irrigation as the basic categories (Withers and Vipond, 1974:35). This is not the meaning adopted here. The term is sometimes also used to describe the *theory* of irrigation or water distribution practices, rather than *actually existing* practices, or the two are not clearly separated (see for example contributions in IWRS, 1982).

refers to the set of dispositions of actors. Bourdieu describes these as "a subjective but not individual system of internalised structures, schemes of perception, conception and action" (Bourdieu, 1977:86). The disposition concept tries to link the external conditions and internal motivations of action.[23]

Again this is not an unimportant point to make in irrigation studies. Strongly dominant in social science approaches to irrigation is the perspective from economics of people as individual utility maximisers (see section 2.1 above). Farmers are often portrayed as profit maximisers, irrigation officials increasingly as rent maximisers. These are images of rather one-dimensional men in a world of individuals where positioning is regulated through the (imperfect) market. Studies like those of Merrey on the role of *izzat* (honour) in Pakistan Punjab's local irrigation organisation, and van der Zaag's study on the behaviour and strategies of the *canalero* (water guard) in a Mexican canal system, show that people's position in water management is a much more complicated affair (Merrey, 1983; van der Zaag, 1992). The rationality of actors' behaviour cannot be reduced to a single variable.

Strategies and resources

What practices are and what human agents do can be illuminated by several additional concepts. The first is that of strategy. People devise plans to achieve their objectives. As Giddens points out, the analysis of social interaction is the "analysis of strategic conduct", focusing on "strategies of control within defined contextual boundaries" (Giddens, 1984:288-293). A large part of this book is devoted to the analysis of strategic action of the different actors involved in water management in the Tungabhadra Left Bank Canal. This includes the activities of farmers 'above the outlet' (Chambers, 1988), the management styles of the Irrigation Department canal level officials, and the role of politicians as resource brokers.

Actors employ resources in their strategic conduct. People use particular means to achieve their ends. Callon aptly calls the resources that people mobilise and deploy intermediaries (Callon, 1992). Intermediaries are the things that a person puts between him/herself and the objects and other persons s/he wants to relate to. Callon classifies the different types of intermediaries in four categories: 1) texts (language, policy documents, administrative forms, manuals and textbooks, laws, ordinances, etcetera), 2) artefacts (material objects, including technologies), 3) people, and 4) money.

For physical relationships the concept of intermediaries is easy to understand. When an irrigator wants to regulate a water flow in a stream or canal or on his/her field, s/he puts artefacts like weirs, drops, division structures, pipes, siphons, pumps and/or sprinkler installations between him/herself and the water. The relationship between people and water is mediated by technologies.

Such mediation also exists in the case of social relationships. For example when a farmer wants to communicate with a government irrigation official to improve water supply, s/he may talk to the official personally, speak with him/her on the telephone, offer to pay the official a bribe, write the official a letter or petition, file a case against the official/department at the local court, or ask a local politician to exert pressure on the official.

---

[23] For further discussion see Giddens (1984:chapter 2) and Bourdieu (1977:chapter 2). Also see Haraway (1991) on 'situated actors'. The concept of lifeworld is close to that of dispositions (Long, 1989). For application of these ideas to irrigation see Diemer (1990), Ubels (1989), van der Zaag (1992) and Scheer (1996).

In these different instances of communication and interaction the intermediaries are different. When the farmers talks to the official personally the intermediary is language: the spoken word. When they talk on the telephone the technology of the telephone system is the additional intermediary. In the case of bribe payment the intermediaries are language and money. When writing a letter, written text and the postal service are the intermediaries. The court case brings in several people as intermediaries like police officers, advocates and judges. The politician who can influence the behaviour of government officials is another example of a person acting as an intermediary. The intermediary in the relationship between the farmer and the politician may be the vote at election time, and that between the politician and the official, the former's power over the latter's transfer (Wade, 1982a). The intermediaries in the transfer relation are texts (administrative rules for example) and money (payments by officials to politicians to influence their transfer for example).

Arenas and domains of interaction

Practices take place in arenas. Arena is a metaphor more than an analytical concept. It wants to convey the image of the spectacle of daily life going on in delimited social, spatial and time 'areas'. These areas may conceptually more precisely be described as domains of interaction (Villarreal, 1994). These are "(...) areas of social life wherein practices are routinely organised within specific locales and where certain authorities, values and identities are recognised, reproduced and transformed." (*ibid.*:59) Further description of the concept can be found in box 2.2.

Box 2.2: Domains of interaction

"Activities within domains involve a heterogeneity of relationships -that could be labeled political, economic, religious or emotional- and they intertwine power relations that draw upon diverse normative frames." (Villarreal, 1994:59)
"Interaction within a domain is usually focused around certain activities (...), or it can centre around the functioning of an institution (...)." (*ibid.*59)
"The notion of domain, as I see it, is more concrete [than Bourdieu's concept of field]. It implies a quite precise location in time and space, it entails linkages to institutions, and it involves specific actors who engage in particular struggles. (...) Interaction within a domain (...) entails specific links to institutions, resources, relevant outsiders, and to diverse projects. It is within these areas of social life that power networks are created and strategies are repressed, channelled or isolated. Within domains of interaction practices of control and authority are given form and legitimated and normative frames are transformed in accordance with shared understandings. But because we are speaking of interaction, of the negotiation and struggle between different 'forces', domains are not isolated from other domains. They must not be seen as autonomous fields of social action. Actors pull with them codes and interpretations pertaining to other domains relative to their lifeworlds and revalorise them within a specific domain." (*ibid.*:207)

The boundaries within which practices take place are technological, social, and are defined by time and space. Technological and social boundaries were referred to above in the discussion of irrigation systems levels: hydraulic units also constitute social domains of interaction. In this subsection I concentrate on the time-space dimensions of irrigation and their relevance for social interaction, which were not yet discussed.

The time-space coordinates of irrigation plus the nature of water, "this infuriating substance which moves about and changes form" (Chambers, 1988:41), often makes the technical and institutional organisation of water management highly differentiated and complex, particularly in systems with many users.[24] Irrigation water is not a resource that can be collected by water users at central distribution points, like people can buy stamps in post offices, rice and sugar in fair price shops, or fertiliser at fertiliser outlets. Irrigation water has to be delivered at the doorstep, or rather the field bund. In creating a service network for this, agencies that assume responsibility for water distribution have to adapt their technical and institutional infrastructure to the undulations of both space and time.

The spatial dimensions of irrigation include the following elements. Because crop production is generally soil-based, the use of irrigation water implies that irrigation systems have to spread water widely geographically, particularly of course in large-scale systems. A further aspect of this is that soil quality generally varies over the command area of an irrigation system. This creates different demands for water in different parts of the system. If additionally farmers grow different crops in different parts of the system, and the weather is locally variable, many complications for tuning supply to demand exist.

The time dimension of irrigation is twofold. It relates to *(i)* the rhythms of the climate and the weather, and *(ii)* the growth cycle of crops. The rhythms of the climate and the weather influence the timing of both the supply of and the demand for irrigation water. The rainfall pattern influences the discharge of the river from which an irrigation system may take its water. It also influences the demand for irrigation water when it falls in the command area of the irrigation system (see Pandian, 1987 for an excellent analysis of rainfall as a means of production; also see Berkoff, 1990, Burns, 1993 and Wade, 1995 for discussion of the importance of agro-ecological characteristics for irrigation organisation). Temperature may influence river discharge through its effects on snowmelt, and crop water requirements through its effects on evapotranspiration. The growth cycle of crops also influences demand for irrigation water because crops have different water requirements in different parts of the growth cycle (Doorenbos and Pruitt, 1977). Ideally, water supply should be adapted to all these variations.

The characterising feature of irrigation therefore is the need to achieve an often highly locally specific (up to the level of plots and parts thereof) temporal allocation of water in space (Carlstein, 1982:269-286; also see Moore, 1989:1738-1741). Irrigation requires specific technologies and institutions to deal with these time and space characteristics. Concretely, a large number of control points is needed, spread over a large area, implying a surveillance system with personel that is spread out, and moving around a lot to check all the control points. The system also has to be able to respond effectively, both technically and institutionally, to local and general changes in the supply of and demand for water.

The space-time characteristics of irrigation and the qualities of water are not just the setting, or the 'given' set of constraints within which irrigation has to take place. Time, space, and the properties of water are strategically used, contested and adapted by people when they conduct the activity of irrigation. Some examples that appear in this book are the flexibility of the geographical boundaries of the irrigation system (through re-use of drainage water for irrigation and the installation of lift irrigation in tail-end areas), the adoption of crop varieties with different maturation times in response to expected water availability, the

---

[24] Differentiation and complexity refers to actually existing management practices. Management models are often wonders of uniformity and simplicity.

creation of in-field and on-farm storage of water to irrigate rice nurseries during canal closure periods, the shift of domains of authority of farmers and government officials during the day and the night, the shifts in what are head end and what are tail end areas over a period of several decades, and the complex and diverse systems of turn-taking in outlet commands.

It can be concluded that the boundaries of domains of interaction are not fixed but flexible, technologically, institutionally as well as in time and space. The boundaries themselves may be negotiated in the practices going on within them.

Rules and routines; interfaces and issues

A further feature of practices is that they have regular patterns. They consist of routines, and are structured by rules (Giddens, 1984). These imply cooperation and coordination of action. Some of the routines described in this book are: forms of rotational water distribution among farmers at outlet level, forms of conflict management at distributary level, and management routines within the Irrigation Department at main system level. Institutionalisation thus is a central aspect of practices.

At the same time practices are characterised by discontinuities or interfaces. Long defines social interface as "a critical point of intersection or linkage between different social systems, fields or levels of social order where structural discontinuities, based upon differences of normative value and social interest, are most likely to be found (Long, 1989:1-2). At these interfaces "the goals, perceptions, interests, and relationships of the various parties may be reshaped as a result of their interaction, (*ibid.*:2). This interaction may be constructive and consensual, but it may also be antagonistic and divisive. Rules may be disregarded, routines may break down, and as a result the institutionalisation of practices may be undermined. Rules and routines can not be taken for granted, but have to be reproduced continuously.

An example of an important interface in canal irrigation is the already mentioned outlet structure, where the transfer of water from the government managers to the farmer users is physically designed to take place. It is a discontinuity because it is the meeting point of the different interests of different (groups of) water users and the government management, and the varying perceptions of equity, efficiency and other normative categories that regulate the different actors' behaviour.

The discontinuities and interfaces in water management define quite concrete issues around which interaction takes place. The basic issue in large-scale canal irrigation is that of resource distribution: who gets how much water and when.[25] Derived from this are issues like the opening and closure dates of the canal system, the setting of gates at control points, water levels to be maintained in canal sections, crops to be grown and not to be grown, and the repair and maintenance of canals and structures.

These very practical issues are not 'just' practical issues, but they are part of more general issues, like the reproduction of the social relations that define the agrarian structure, the incidence of poverty, the intensification of agriculture, the maintenance of ecological sustainability, and the form of political representation and democracy. The outcomes of water management practices therefore have to be measured not only in terms of the physical pattern of water distribution or other indicators internal to the system, but also in terms of their

[25] How quantity and timing are expressed and measured varies. Sometimes there is very little exact knowledge on this. This lack of exact knowledge doesn't necessarily mean however that distribution is less of an issue. The contrary may very well be true.

effects on the wider process of rural transformation of which irrigation is part (see Chambers, 1994).

2.5 WATER CONTROL

In this section I discuss how the concept of water control can be usefully employed to analyse the processes within irrigation systems and their connections with the wider context in which they are embedded. The concept of practice provided the methodological means for that; the concept of water control is the basis for substantive theorisation.

In the irrigation literature water control is a very commonly used term. It is used in the engineering literature, the literature on organisation and management, as well as in the academic social science literature analysing irrigation from a rural development perspective. In neither of these literatures large conceptual claims are attached to the term. However, the complementarity of meanings in these different discursive domains makes water control an excellent candidate to play the leading conceptual part in an interdisciplinary approach to irrigation. The first role water control can play as a concept is to bring the different dimensions of irrigation as treated in the different literatures under one heading. The second role is to theorise the relationships between these different dimensions. The discussion below follows this order.

Three dimensions of water control

In the engineering literature water control refers to the physical control of water flow by means of irrigation technology. A recent publication by the Worldbank is called *Modern water control in irrigation* (Plusquellec, Burt and Wolter, 1994). It provides a classification of different methods of technical water control in irrigation systems (see box 2.3). It also describes the different irrigation technologies available for equiping an irrigation system. Plusquellec, Burt and Wolter's contribution is one in an international debate on different design principles for canal irrigation systems. Apart from the high-tech oriented 'modern

Box 2.3: Water control (technical)

"Several control strategies are being used in irrigation schemes throughout the world:
* Proportional control
* Adjustable flow-rate control
* Upstream control
* Downstream control
* Remote monitoring
* Remote control

This list is not complete because each method inclused several subclassifications. For example, proportional control may be nonadjustable or adjustable. Downstream control may be centralized or local, and local downstream control may be on sloping or level-top canals or pipelines. The term 'upstream control' describes a control method that maintains a constant water level upstream of a check structure or, less frequently, a method that maintains a constant flow through the check structure." (Plusquellec, Burt and Wolter, 1994:35) water control' view, there are concepts of 'structured design' (Shanan *et al.*, 1986) and 'proportional division' from source to field (Horst, 1996). The use of water control in the sense of water control technology is also common in the social science literature (see for example Burns, 1993; Mitchell and Guillet, 1993).

In the irrigation management literature water control is used in a broader sense than its technical meaning alone. In that literature water control also refers to managerial control of the water distribution process, and other organisational processes in the irrigation system. Some quotations are given as examples in box 2.4.[26)]

To control and to manage are almost synonyms. Webster's New Dictionary of Synonyms gives the following description of the two verbs. "*Conduct, manage, control, direct* are comparable when they mean to use one's skill, authority, or other powers in order to lead, guide, command, or dominate persons or things. *(...) Manage* usually implies the handling, manipulating, or manoeuvering of a person or persons or a thing or things so as to bring about a response or submission to one's wishes or attempts to use, guide, lead, or command. (...) *Control* stresses the idea of authoritative guidance and suggests a keeping within set or desired bounds (as of accuracy, efficiency, propriety, or discipline); it implies a regulating or restraining often by getting or keeping the upper hand." (*Webster's*, 1984:174)

Box 2.4: Water control (organisational)

"(...) by organizational control I mean that the group of farmers are in control of distribution and conflict resolution within their group, and that the group has the right and the ability to negotiate with other entities over the delivery of water to their group." (Hunt, 1990:144)

Huppert defines four basic management functions: planning, organising, leading and controlling. Controlling is defined as the "the continuous monitoring and adjustment of all activities of an organisation in line with pre-determined plans and standards." (Huppert, 1989:35)

"On the 22nd August 1973, the learned Advocate General of Andhra Pradesh conceded that this Tribunal has no power to direct the vesting of the control and administration of the *Rajolibunda* headworks and the common canals within Mysore State limits in the Tungabhadra Board. However, he prayed that it should make suitable recommendations for vesting control and administration of the aforesaid works in a joint control body." (GOI/KWDT, 1973-I:54)

"Water control as used in this paper is defined as the ability of farmers to plan adequately and in time for cropping decisions by having the required volumes of water available at the appropriate time and places for crop needs plus increments sufficient for leaching requirements and evaporation losses. As defined, proper water control ensures that end users will have a relatively high degree of predictability of water supplies for making cropping decisions and meeting crop needs. (...) Effective water control is a function of several complex sets of variables. Along with the physical, technical and economic factors, complex social and institutional factors are also worthy of serious study." (Lowdermilk, 1990:155)

Irrigation management, or water control in the organisational sense, thus is about the regulation and control of human behaviour, particularly with regard to the forms of cooperation necessary to make irrigation systems function.

[26)] Also see Vaidyanathan (1983) and Freeman (1989) for use of 'water control' in discussions of irrigation organisation.

Box 2.5: Water control (socio-economic and political)

North India
"The relevant power structures engaged in controlling and directing the supplies of water were typically those of the cultivating body within the village itself, and the picture which emerges from the enquiry into water-course management conducted in the early 1870s (...) is one of petty elites often able to reinforce their multi-faceted advantages within the village through their control over the allocation of scarce water. These village elites were not unduly affected as government control extended down the hierarchy of distribution channels and progressively confined local control to within the village boundaries." (Stone, 1984: 202)
West Bengal (India) and Bangladesh
"[I]rrigation, or, more broadly, water control, constitutes the key technological constraint to agricultural growth (...). This hypothesis is confirmed by strong relationships between water control variables and various aspects of agricultural performance. (...) The irrigation-yield *correlations tend to rise through time, implying that irrigation's leading role has been* strengthened with the increase in fertiliser use and the introduction of HYVs. (...) In the light of this, it is remarkable that water control in West Bengal and Bangladesh remains so little developed. [T]he agrarian structure in Bangladesh and West Bengal has impeded water control development, by adversely affecting the possibilities for resolution of the associated public goods problems (...). The alternative to costly and often ineffective attempts at bureaucratic control of water allocation would be control by organisations of the irrigators themselves, who are in a much better position to monitor and enforce agreements and have strong incentive to do so. One possible reason for the general failure of such institutions to emerge at the local level is that inequalities among water users make it more difficult to achieve social control. It may be easy to enforce compliance from relatively small and powerless cultivators, but effective limitation of water use by richer and more powerful individuals is another matter." (Boyce, 1987:198-199, 229, 233)
Mexico
"The irrigation law of 1926 was pushed through by President Plutarco Elías Calles. This law nationalised private irrigation systems, and established the National Irrigation Commission (CNI). (...) Starting in 1930, it created a series of irrigation districts. (...) From its foundation the CNI was highly political. The creation of new irrigation projects was politically motivated, as the central government, located in Mexico City, manoeuvered to tighten its control over regions that had resisted national control. (...) Projects along the border with the United States were initiated to strengthen Mexico's position in bilateral conflicts over water and even territorial sovereignty. (...) The trend towards increased state control was slowed by a law passed in 1947 that allowed for private holdings of irrigated land. The new law sanctioned the expansion of private agriculture in irrigation districts, as well as the transfer of water rights when land was confiscated by the state for redistribution. (...) This law allowed the private sector greater opportunity to control irrigated land and water resources. (...) Today in Mexico, irrigation districts are one of the most important units of administration of agriculture and water resources. The districts are run by a committee of the CNI that is responsible for decisions about crops to be planted, distribution, types of fertilisers and insecticides to be used by farmers, and maintenance of the system. Yet the [Ministry of Water Resources] and the Ministry of Agriculture generally set the policies and have veto *power over committee decisions. (...) President José López Portillo, in a major bureaucratic* restructuring, combined the two [ministries] in 1977 (...). The reorganisation (...) [was] plagued by problems of compartmentalisation, centralisation, and competitive planning and budgeting (...). [D]espite the rhetoric, little power was transfered to the local level. The control of irrigation districts continues to be dictated from Mexico City. (Enge and Whiteford, 1989:5-7)

A further extension of the scope of irrigation studies lies in the attention for water control in the socio-economic and political sense. This usage of water control addresses the conditions of possibility of technical and managerial water control.

Box 2.5 gives examples from historical work on irrigation in India and Bangladesh, in which it is argued that the socio-economic differentiation of farmers prevented the emergence of effective forms of cooperation among water users.

An example of water control in the political sense is also given in box 2.5. The case is pre-turnover Mexico, where, as in many other parts of the world, irrigation served as a means for the state goverment to politically and economically control peasant farmers.

From the examples given in box 2.5 it can be concluded that the relation between technical and managerial control on one hand, and socio-economic and political control on the other, is two-sided. Socio-economic and political conditions influence what happens inside irrigation systems, and irrigation practices within irrigation systems have implications for the evolution of these conditions (also see section 2.6).

The three dimensions of water control are summarised in table 2.1.

Table 2.1: Three dimensions of water control

Dimension	*Association/meaning*	*Disciplines*
Technical control	Guiding-manipulating-mastering of physical processes	(Civil) engineering, soil mechanics, hydraulics, hydrology, agronomy, meteorology, agro-ecology
Organisational control	Commanding-managing of people's behaviour	Management science, extension science, public administration, organisation sociology
Socio-economic and political control	Domination of people('s labour) Regulation of social processes	Political economy, economics, rural sociology, political science, social anthropology, gender studies, agrarian history

Water control: politically contested resource use

The three different dimensions of water control described above represent three different abstractions from a single phenomenon: irrigation as it confronts us in everyday life. This means that they describe different features of a single object.[27] In more practical terms: you can't have changes in one dimension without changes in the other two.[28]

To theorise these intimate dimensional relations further, it is necessary to take a closer look at the concept of control. Its associations as a verb have already been discussed above. As a noun, its synonyms are authority, jurisdiction, command, sway, dominion, and, analytically most important I want to suggest, power (*Webster's*, 1984:188, 624).

---

27) In fact, the three dimensions are each aggregations of a series of different abstractions. Abstraction is here used as in Sayer (1981). He notes that different abstractions cannot "simply [be] 'added up', but need to be synthesised; that is, their combination qualitatively modifies each constituent element." (*ibid.*:7) The social and the technical dimensions of irrigation need to be defined in each other's terms.

28) See Bolding, Mollinga and van Straaten (1995) for detailed empirical illustration.

In the most general sense power refers to the transformative capacity of human action: the application of means to achieve outcomes (Giddens, 1976:110). Or in a dictionary definition: the ability to exert effort for a purpose, the ability to act or be acted upon, to effect something, or to affect or be affected by something (*Webster's*, 1984:623).[29] In this general sense power refers to both bio-physical and social processes.

But power has a more specific meaning as well.

> 'Power' in the narrower, relational sense is a property of interaction, and may be defined as the capability to secure outcomes where the realization of these outcomes depends on the agency of *others*. It is in this sense that men have power 'over' others: this is power as *domination*. (Giddens, 1976:111)

Social power is - thus - not only found in the context of irrigation practices, where perhaps it is most easily recognised (as wider relations of economic and political power for example). It is also internal to irrigation practices, and necessarily so.

Theoretical and empirical evidence of the importance of this meaning of social power in irrigation can be found in different places. Wittfogel's grand effort to develop a theory of hydraulic societies has been convincingly criticised, but has left us with the insight that irrigation can be very important for state power and its legitimation (Wittfogel, 1957; Worster, 1985; Ramamurthy, 1995). The experience of the green revolution, with irrigation as a leading input, even when that experience is varied, has sensitised us to questions of social differentiation and, in India, the increasing political power of the class of large farmers (Byres, 1981; Brass, 1995).

At a lower level of aggregation there are some dramatic examples of power struggles around irrigation systems. These include land issues in the Bakolori project, Nigeria (Adams, 1988), gender relations in the Jahaly Pacharr project in Gambia (Carney and Watts, 1991), the displacement of tribal people in the Narmada valley project, India (Dhawan, 1990; Singh, 1997), and struggles around planned intervention, commoditisation and livelihoods in the Mahaweli Ganga project in Sri Lanka (Schrijvers, 1985; Siriwardena, 1989).

At the micro-level there are several examples of the importance of relations of class (and caste) power in Indian canal irrigation (Thorner and Thorner, 1962; Jairath, 1984, Gorter, n.d., 1989; Ramamurthy, 1995). Similar case studies exist for other parts of the world (see for example Konings, 1981; Wallace, 1981; Barnett, 1981).

The events described in this literature are not exceptional cases where things got out of hand, but only the more spectacular examples of the general importance of social relations of power in irrigation. The different interests of the different people involved in irrigation may translate into conflict and spectular or tragic events, or they may not. In both cases they structure the unrolling of irrigation as a social process.

I thus argue that it is the concept of power that binds the three dimensions of water control together. Put differently, management institutions and technical artefacts can be understood as the embodiments of particular social relations of power, and, the other way around, socio-economic and political power in irrigation takes concrete shape in particular forms of organisation and technologies.[30]

---

[29] Synonyms of power in this general meaning are force, energy, strength, might, and puissance (*Webster's*, 1984:623). In the context of irrigation power is most often used to refer to hydro-electric power generated at dams or canal drops. This -obviously- is not the meaning used here.

[30] I do not argue that irrigation can be understood by *solely* looking at the social relations of power. That would be a form of reductionism. Giddens argues that the study of social interaction involves (continued...)

In dynamic, process terms the implication of the argument is that irrigation practices are inherently political practices. Political is used in this expression in the sense of Kerkvliet's 'everyday politics' (as contrasted to formal, party and state politics). Kerkvliet defines politics as

> the debates, conflicts, decisions, and cooperation among individuals, groups and organisations regarding the control, allocation, and use of resources and the values and ideas underlying these activities. (Kerkvliet, 1990:11)

On the basis of this definition of politics water control can be defined as an example of politically contested[31] resource use.[32]

2.6 THE CENTRAL RESEARCH QUESTION

The concepts and the descriptive model that were presented above are what the subtitle of this chapter says: conceptual groundwork for more detailed theorisation of specific irrigation situations. Any move beyond this general conceptual ensemble requires more precise specification of the research object, and the dimensions of it that will be the focus of analysis.

As indicated in chapter 1 already, this book is a case study of the Tungabhadra Left Bank Canal irrigation system, which is a protective irrigation system located in the semi-arid and drought prone part of South India. The focus of analysis are the water distribution practices

---

[30](...continued)
looking at the interplay of meanings, norms and power (Giddens, 1976:104, 161). Of these three, the concept of power is conspicuously absent in irrigation studies, which is the reason to emphasise it so strongly here. The integration of the first two elements, meanings and norms, in irrigation studies is ongoing, be it from rather different perspectives than Giddens'. 'Meanings' are increasingly part of the irrigation discourse, for example in the emphasis in many policy initiatives on the importance of perspectives of users for designing efficient and sustainable irrigation systems (see for example Maloney and Raju, 1994; Sivamohan and Scott, 1994). 'Norms' are present in the growing discussion on rules and rule-making in irrigation (see for example Ostrom, 1990, 1992). For an interesting analysis of the cognitive and ideological dimensions of agrarian change in western Maharashra triggered by the introduction of modern agricultural technology, including irrigation, see Appadurai (1990).

[31] The term contested is preferred over negotiation on one hand and struggle on the other. Negotiation mainly has consensual associations, struggle those of open conflict. Contestation is the more encompassing term. Political contestation is perhaps a tautology. The felt need to include political in the formulation reflects the lack of analyses of 'politics' in irirgation studies.

[32] The description of water control as a case of contested resource use places the study of water control in a current of interdisciplinary studies on natural resources that tries to transcend the dichotomy between human culture and behaviour and the physical environment which sustains them (Bennett, 1990:435; for these approaches see for example Dahlberg and Bennett, 1986; Moran, 1990; Smith and Reeves, 1989; Maass and Anderson, 1978; for a call for the integration of a human ecology and political economy perspective on irrigation, see Meinzen-Dick, 1989:7). This literature speaks of socio-natural systems, where I speak of socio-technical systems. Apart from applicability to different levels (see footnote 18), this difference in terminology illustrates the greater emphasis on the technological mediation of (wo)man's interaction with the natural world in the socio-technical approach than in the broader socio-natural approach. In political ecology/eco-socialist approaches to the relation between society and the environment technology plays a more important role, but these have -to my knowledge- not been applied to irrigation (see Pepper, 1993; Johnston, 1996).

in this system at outlet command area, distributary canal, and main canal level. Notwithstanding the fact that protective irrigation is found across the subcontinent from Pakistan to South India, and that water distribution may be considered to be the core process in these systems, this focus implies that the domain of generalisation for the findings and explanations in this book is highly circumscribed.

The focus of analysis within this circumscribed domain is summarised in the central research question of the investigation. It goes as follows.[33)]

> *How do the pattern of commoditisation, the form of state regulation and the characteristics of the technical infrastructure shape, and how are they in turn shaped by, the forms of organisation of water distribution in the Tungabhadra Left Bank Canal irrigation system?*

In terms of the descriptive model outlined above, the focus is on water distribution practices, with special emphasis on forms of organisation and technology, and two of the three contextual elements: the agrarian structure and the state and institutions of civil society. Water, the third element of water distribution practices (see the descriptive model above) is treated automatically, because it is the subject of both technology's and people's behaviour. The third type of structure, the agro-ecological environment, is treated as a given, and its relation with irrigation not the subject of theorisation.[34)] In other words, my analysis of water distribution as politically contested resource use does not include a 'political ecology' perspective, but limits itself to the longer standing concerns of agrarian political economy, commoditisation and regulation (the latter two concepts are explained below).[35)]

The 'shaping and being shaped by' formulation is a reference to the complex debate on the relation between practices and human agency on one hand and social (and other) structure on the other. Water distribution practices on one hand, and commoditisation and regulation on the other, have a complex relationship of mutual shaping. In Marx's words, water distribution practices, as the concrete research object, are a "concentration of many determinations, hence unity of the diverse" (Marx, 1973:101), and the relation between practices and the structures in which they are embedded is seen as one of reproduction and transformation.[36)]

---

33) The shortest research question that could be formulated is: what are the characteristics of water control in the Tungabhadra Left Bank Canal? The question as formulated in the main text is a first step away from the general concept of water control towards its operationalisation in substantive theory for a particular time, place and research object.

34) This among other things would have required a broader focus on water. That focus is now limited to irrigation water, or water as far as it is used for irrigation.

35) For references on the 'political ecology' perspective see footnote 32. The reason to leave it out of the scope of the research has to do with my own interest, expertise and the manageability of the field research. For some discussion of the ecological dimensions of irrigation in the Tungabhadra Left Bank Canal command area, see chapter 5, section 5.1.

36) As Bourdieu notes "the truth (...) of interaction is never entirely contained in the interaction" (Bourdieu, 1977:81), but also lies in the structures that condition that interaction, and that are reproduced and transformed through it. This is what Giddens calls 'the duality of structure', and what informs Bhaskar's 'transformative model of social activity' (Giddens, 1976, 1984; Bhaskar, 1979a, 1979b). I follow Bourdieu's and Bhaskar's usage of the structure concept rather than Giddens'. Giddens' main point is that practices *have* a structure (Giddens, 1976:121). The more difficult issue is how different structured practices relate to each other. The position I take on this issue is that there are different hierarchically ordered social levels with emergent properties at each of the levels (for relevant discussion see Levins and Lewontin, 1985; Rose, 1987; Giddens, 1984;

(continued...)

The 'mutual shaping' point also applies to the relations of the elements within water distribution. Water, technology and people are internally related. This means that the properties of each of the elements as evident in existing water distribution practices, can not be defined or understood without reference to the other elements.[37] In the research question the shaping role of technology is emphasised.

To conclude this section I discuss the concepts of commoditisation and regulation, which unlike the other elements of the research question have not yet been elaborated.

The commoditisation concept is taken from the neo-marxist debate on the agrarian political economy. It analyses agrarian change as a process of capitalist development (or the development of capitalism in agriculture), emphasising class relations, accumulation and social differentiation. I do not engage with the debate on capitalist agrarian development in India at a general level, or try to defend a particular position in that debate. I use this literature[38] heuristically to describe the general features of the development of the agrarian economy in the Tungabhadra Left Bank Canal command area and to develop a categorisation of farming households-enterprises (see chapter 5). The latter is important to understand the relations between head enders and tail enders and large and small farmers in water distribution (see particularly chapter 6). My emphasis is what I call the geography of social differentiation. I want to show that in this canal irrigation system the pattern of social differentiation is shaped, in a rather complex manner, by the way the irrigation technology has structured the social and physical landscape.[39]

My usage of the concept form of regulation is equally heuristic. Its reference is the regulation school of thought in political economy, which emphasises that accumulation and other economic processes require or presuppose particular forms of social regulation, that is

---

[36](...continued)
Bhaskar, 1989). Giddens (1984) argues that the 'organic' model cannot be applied to social reality; Bhaskar wants to argue for a "qualified anti-positivist naturalism" (Bhaskar, 1979a:108; also see 1979b:124-137) It can be noted that this view does not imply any form of structural determinism (which is the target for example in the discussion of structure in Long and van der Ploeg, 1994). For concrete research the important point is not so much this general ontological standpoint, but the question, in a particular context, which institutions are (not) transformed and transformable through local practices, and how.

[37] For the concept of internal relations see Sayer (1984). Examples of internal relations for each of the three elements are the following. The concept of water scarcity can not be defined in bio-physical or locational terms only, but has to include social factors like demand and history. The hydraulic characteristics of outlet structures acquire their meaning under specific conditions of scarcity and state-water user relationships. And lastly, the characteristics of forms of organisation cannot be understood from a socio-organisational logic only, but analysis has to include the structuring factor of infrastructural design.

[38] For India contributions that I have found inspiring, apart from those referred elsewehere in the book, were Banaji (1977), Bhaduri (1983) and Breman (1993). General literature from the 'peasant debate' that has shaped my thinking includes, apart from the classic marxist authors, Bernstein (1979), Bolhuis and van der Ploeg (1985), Brass (1986), Friedland, Barton and Thomas (1981), Goodman, Sorj and Wilkinson (1987), Guyer (1984), Long *et al.* (1986), Meillassoux (1981), Neocosmos (1982), Mann and Dickinson (1978), Richards (1985), and Whatmore *et al.* (1987).

[39] In the original formulation of the research project 'pattern' had a much more ambitious content (see Mollinga, 1989). The starting intention was to identify different patterns of commoditisation associated with different modes of water distribution. 'Pattern' referred to different patterns of capitalist agrarian development. To develop this line of enquiry a comparative approach across systems and regions is required.

particular sets of institutions.[40] More concretely, I use the concept to simultaneously refer to Benevenuti's TATE (Technological and Adminstrative Task Environment) concept, and Burawoy's concept of the political and ideological apparatuses of production (Benvenuti, 1975, 1991; Burawoy, 1985). Both authors, like the regulationists, seek to understand the technological and institutional processes and mechanisms in which productive activities are embedded, and which govern their internal dynamics.[41] Both concepts invite the researcher to very specifically identify the modes of technological and institutional regulation that exist in a particular situation, and urge the researcher not to make *a priori* assumptions about determinant institutions. The concepts also stimulate the researcher to look for a diverse set of forms of regulation. As will be shown, the forms of regulation relevant for water distribution practices are many.

2.7 CONCLUSION

To conclude this theoretical chapter I describe the structure of the remainder of the book in terms of the central research question.

Chapters 3, 4 and 5 introduce the main theoretical themes of the book. Chapter 3 analyses localisation and protection as forms of state governance, that is a particular form of regulation. Chapter 4 introduces the theme of the social dimensions of irrigation technology by a historical sketch of the design process of the Tungabhadra Left Bank Canal system and its outcome in terms of design characteristics. Chapter 5 discusses the pattern of commoditisation in the command area of the Tungabhadra Left Bank Canal. After sketching

---

[40] See Koning (1994) for the application of regulation theory in the context of agriculture. On the concept of regulation in agriculture also see Frouws (1995).

[41] Benvenuti's framework is valuable because it was specifically developed to analyse agricultural production, and because it emphasises the regulating role of technologies. Technologies are conceptualised as an ordering principle or language, constituting a system of prescriptions, that express or embody particular social relations of power. Burawoy's framework is particularly interesting because of its discussion of the connections between processes internal to production (the micro-apparatuses of domination) and external to production (the regulating or dominating institutions), and because of its emphasis on the politics of production. With the latter expression he refers to the political and ideological effects of the organisation of work outside the direct sphere of productive activity. In production men and women transform raw material into products, reproduce particular social relations, and also an *experience* of those relations (Burawoy, 1985:7-8). Both Benvenuti's and Burawoy's analysis are (primarily) set in the context of relatively strongly regulated production processes: European farm enterprises in Benvenuti's case, and factory regimes under colonialism, capitalism and socialism in Burawoy's case. Though my approach to the analysis of water distribution practices is modelled on this work, the context is a different one. The regulating capacity of the state managers of India's canal irrigation systems is not very large, and the state administration is certainly not the hegemonic actor. Water users do not "participate in and strategise [their] own subordination" or are "accomplices in [their] own exploitation" in the same manner as Burawoy analyses for factory workers (Burawoy, 1985:10). It should also be noted that irrigation and water distribution are only part of farming households-enterprises' livelihood and accumulation strategies, and the analysis of water distribution therefore does not capture the full social experience of the actors involved. However, the general point made by Benvenuti and Burawoy (in slightly different ways) that the organisation of production has political meaning, and that those directly involved in it are knowledgeable and capable actors pursuing particular projects in their participation in the reproduction and transformation of the structure of regulation, can be applied to water distribution very well.

the main features of the economic boom related to irrigation it discusses the geography of social differentiation in the command area.

These three themes reappear and are concretised in the chapters on water distribution practices, chapters 6 to 9. Elements of all three themes are found at all system levels at which water distribution is discussed, but the emphasis is different at each of the levels.

The theme of commoditisation is prominent in chapter 6 on unequal water distribution at the outlet command area level. It shows how elements of the agrarian structure, particularly credit and employment relations structure access to irrigation water. The social differentiation of water users plays a role in all chapters implicity because the farmers who are 'economically and politically sound' at the outlet level are the ones who play the dominant role, as far as water users are concerned, at higher levels of the system.

The theme of regulation and governance particularly appears in chapters 7 and 9. In chapter 7 the topic is state-water users relations at the distributary canal level, and the role of politicians in the mediation of this relationship. The forms of organisation that emerged in the interactions between these actors are discussed. The chapter gives a different interpretation of the state-water users-politicians relation than the increasingly popular management-by-bribe-and-political-pressure perspective. In chapter 9 institutional processes within the Irrigation Department are discussed which emerged in response to the escalation of water distribution conflicts. This chapter amends, to some extent, the picture of the Irrigation Department as a inflexible hierarchical organisation. It shows that opportunities for reform are sometimes utilised, but also that there are fundamental constraints for a paradigm shift in the approach to management.

Lastly, the social dimensions of irrigation technology theme particularly figures in chapter 8. There the material linkage between water users and the state, the pipe outlet structure, is the focus of attention. It is shown that the outlet structure is both the site and the subject of the struggle between the different actors involved in water distribution, and that its design and construction features both constrain and enable the emergence of particular forms of organisation.

3

PROTECTION AND LOCALISATION

State governance and South Indian canal irrigation

This chapter has two objectives. The first is to explain the concepts of protection and localisation and describe the contours of protective irrigation as a specific type of irrigation. The second is to discuss, in general terms, protective irrigation policy and practice as an instance of state governance.

Protective irrigation is a specific form of large scale canal irrigation found in the semi-arid, drought prone areas of the Indian subcontinent. In protective irrigation systems water is scarce by design. These systems were and are built for supplementary irrigation of crops that require little water to mature, or for partial irrigation of cultivators' landholdings. The protective design necessitates rationing of irrigation water. The rationing method conceived in South India, and first applied in the Tungabhadra valley, is called localisation. It is a strategy for controlling water distribution through the legal prescription of the cropping pattern. By mainly prescribing so called 'irrigated dry' crops and allowing irrigation in one agricultural season only, available water can be spread over a large area and a large number of people.

The term protective irrigation emerged as an element of British colonial irrigation policy in the 19th century. Protective irrigation undertook to supply limited quantities of water to subsistence-oriented peasants growing traditional food crops. In the occasion of drought, crops and livelihoods would be safeguarded, famine and social instability prevented, and colonial rule secured. After Independence protective irrigation became part of the new government's policy for agricultural development, emphasising both growth and equity objectives: production and productivity increase, and the spread of the benefits of development over different sections of the population and different regions. In the colonial as well as in the post-Independence period protective irrigation systems are an attempt by their government owner to regulate the pattern of agrarian change and to legitimate state power by means of a particular form of resource distribution.

Theories of the Indian state and politics have hardly been applied to irrigation, and existing approaches tend to focus on a single dimension of a complex and contradictory reality. There is a dearth of detailed studies of actual state governance practices in irrigation as elsewhere (Sathyamurthy, 1998).

This chapter is organised as follows. I start, in section 3.1, with a discussion of the three different meanings carried by the concept protective irrigation: *(i)* as a general term denoting insurance against drought and famine by irrigation, *(ii)* as a financial-administrative class of works in colonial irrigation policy, and *(iii)* as a specific type of irrigation. Of the latter, the technical, organisational and socio-economic characteristics are given. In section 3.2 I discuss the localisation concept. First, the origins of the concept are traced in Madras Presidency. This is followed by a brief discussion of the diversity in ways of implementing localisation. The section is concluded with a discussion of the monitoring of localisation.

The first two sections show that a big difference between designed and actual use of protective irrigation systems exists in many cases, and has done so for a considerable period of time. This divergence between theory and practice of protective canal irrigation systems raises the question why the model has remained a central element of Indian irrigation policy till today - because that it has. The explanation is largely a political one. The political logic of populism preserves the model of protective irrigation in policy and in design. This interpretation is discussed in section 3.3. The chapter concludes, in section 3.4, with a summary of the main points of the previous sections, and a discussion of some theoretical problems in the interpretation of protective irrigation as a form of state governance. An interpretation of protective irrigation policy and practice in state-theoretical terms is not straightforward.

3.1 PROTECTIVE IRRIGATION

Protection in general

The British colonial rulers of India began to construct irrigation systems in the first half of the 19th century (Whitcombe, 1972; Stone, 1984). The first canals in the alluvial plains of the North Indian rivers and in the deltas of South India were improvements and extensions of existing canals. The first large wholly new canal system was the Ganges Canal, opened in 1854. At Independence in 1947, 13.6 million hectares of canal irrigation had been created.

Canal irrigation was an important instrument of colonial rule. As Stone states,

> It was intended to serve the perceived interests of its masters (...). In its design, modes of operation, and intended effects, canal irrigation was ultimately a cultural expression, representing the priorities and aspirations of its western architects, and was inextricably bound up with some of the most vital aspects of colonial rule. (Stone, 1984:8)

The contribution of irrigation to the sustenance of colonial rule had many dimensions.

> (...) on a policy level it was simultaneously linked with famine prevention, revenue stability, the settling of unruly tribes, expansion of cultivation, extended cultivation of cash crops, enhanced taxable capacity, improved cultivation practices, and political stability. (*ibid.*:9)

These different dimensions were mutually reinforcing, but also contradictory. The stabilisation of crop production and the expansion of cultivation contributed to the prevention of famine, but maximising revenue and extending cash crop cultivation worked against it (Ramamurthy, 1995:151-152).[1]

Protection against famine was an important objective of colonial irrigation policy. Some have argued that this objective was little more than window dressing for the real, surplus extraction, objectives of colonial irrigation (Whitcombe, 1972 has this flavour). However, the social costs of political instability could be very high (as in the 1857-58 Mutiny or First War of Independence), and the financial costs of famines and famine relief measures as well

---

[1] For an analysis of colonial revenue and other policies as a cause of famine, see Dutt (1900) and B.M. Bhatia (1991). For critical discussion, see for example McAlpin (1983).

(see for example Famine Commission, 1880 and Indian Irrigation Commission (IIC), 1903). Famine prevention was a real objective, that is an objective with real effects, important for the legitimation of colonial state power.[2]

The presence of irrigation was thought to protect a region against drought and famine. The Famine Commission wrote that

> [i]t has hitherto been held in the Irrigation Department that an area is protected, of which a third part is or can be irrigated in a season of drought by a canal drawn from a permanent river, or by wells not liable to dry up. (Famine Commission, 1881-Appendix V:1)

The emphasis on protection not only implied a minimum percentage of area irrigated, but also a maximum. The Indian Irrigation Commission (1901-03) considered that irrigation "completely protect[s] from famine an area which (...) may be said to vary from twice to four times the area annually irrigated." (IIC, 1903-I:22) In order to maximise protection at a regional level irrigation had to be extended over an area as large as possible. In North India a standard of 42.5% of the cultivable area was set in the 1870s as the maximum claimable proportion of irrigated area for a village (Stone, 1984:204).

In this first, oldest and most general usage of the term protective irrigation no particular type (canal, tank, well) or scale of irrigation is implied, nor any other financial or agronomic characteristic.[3]

Protective irrigation as an administrative-financial class of works

In the last quarter of the 19th century protective irrigation acquired a second, more specific meaning. It became the counterpoint of productive irrigation, a concept developed in the same period.

After a disastrous attempt at canal irrigation development through private companies around 1860 (Atchi Reddy, 1990), the Government of India decided *(i)* that canal irrigation should be a state activity, and *(ii)* that it was to be financed from loans (see Banerji, 1995:73-79 for a detailed account). The latter was decided because the earlier system of government financing of irrigation from the general revenues did not allow quick expansion of canal irrigation. The loans policy was effected from 1868-9 (Famine Commission, 1880-II:146). Canal irrigation became a commercial investment on which profit was expected to be made. This was formalised in 1879 when a Select Committee of the House of Commons introduced a 'productivity test'. A criterion was designed to decide whether investment in a

---

[2] It is not fully correct in my view to characterise colonial irrigation policy as the combination of charity and commerce as Ramamurthy does at one point (Ramamurthy, 1988:5). The imperial desire to provide famine protection is not primarily informed by charitable feelings (though this is definitely part of the discourse), but by cost and political considerations. Ramamurthy herself quotes Buckley (1904:321) who says that canal irrigation is not only a "profitable property, a sound financial investment (...) far better, [it is] an active force ever potent to tie the populations to their rulers, to render them happy in their homesteads and contented with their surroundings; a condition which cannot but tend to political advantages and security" (Ramamurthy, 1988:16). In Ramamurthy (1995) the same quote concludes an argument similar to the one presented here (pp.150-158). In Buckley (1905), which I referred, the quote appears on the same page.

[3] The IIC (1901-03) designed a formula by which the degree of protection of a particular area could be calculated. In Madras Presidency efforts were made to base irrigation investment decisions for protective irrigation on a classification of districts by means of their different degrees of protectedness and the returns to be expected, involving detailed debate on the formula to be used for this (see Madras Board of Revenue, Proceedings 24.8.1931).

particular irrigation system was warranted or not. The criterion calculated the net financial results of the project as a percentage of the total capital outlay. This rate was set at different levels between 3.75% and 6.5% in different periods (Public Works Committee, 1879; see GOI/MOIP, 1972-I:249-251 for discussion and figures). The systems that passed the test and were sanctioned were called productive irrigation systems.[4]

The investment criterion reinforced the already existing focus in canal irrigation development on the alluvial plains of the North and the deltas of the South. In these areas system construction was relatively cheap, because no reservoirs were needed or possible, and construction was easy in that terrain because it was regular and flat. However, some of the most drought and famine prone areas were located in the interior areas of India, particularly in the Deccan region[5], where many streams rivers are not perennial or have very low baseflows, and the terrain is irregular and undulating. Irrigation systems in this region were more expensive to build and therefore less remunerative. Some of the most drought and famine prone areas thus remained unprotected.

The Famine Commission of 1878-80, appointed after the severe famine of 1876-78, drew attention to the indirect benefits of irrigation.

> It has been too much the custom, in discussions as to the policy of constructing [irrigation] works, to measure their value by their financial success (...). The true value of irrigation works is to be judged very differently. First must be reckoned the direct protection afforded by them in years of drought, by the saving of human life, by the avoidance of loss of revenue remitted, and of the outlay incurred in costly measures of relief. But it is not only in years of drought that they are of value. In seasons of average rain-fall they are of great service and a great source of wealth, giving certainty to all agricultural operations, increasing the out-turn per acre of the crops, and enabling more valuable descriptions of crops to be grown. From the Punjab in the north to Tinnevelly at the southern extremity of the peninsula, wherever irrigation is practised, such results are manifested; and we may see rice, sugar-cane, or wheat taking the place of millets or barley, and broad stretches of indigo, stretching at a season when unwatered lands must lie absolutely unproductive. (Famine Commission, 1880-II:150).

Although this statement was incomplete[6], the Famine Commission's plea for consideration of the indirect benefits of irrigation had some impact. A Famine Relief and Insurance Fund (Famine Fund for short) was created in 1882. Half of the yearly contribution of 15 million Rupees (supplied from the general revenues) could be used for 'protective works'. First railways and irrigation had to share the 7.5 million Rupees, but later it was fully used for irrigation (Famine Commission, 1898:325-331; also see IIC, 1903-I:61, 80). The irrigation systems constructed under this administrative heading were called protective irrigation systems. These were systems that could not pass the productivity test, but were still constructed for reasons of famine prevention.[7]

---

[4] The term 'productive public works' was used for the first time in 1876; in the period between 1869 and 1876 these were called 'extraordinary public works' (Famine Commission, 1880-II:147).

[5] The Deccan or Deccan Plateau is the dry peninsular upland area of India. The most important rivers crossing it are the Godavari, Krishna (with Tungabhadra as a tributary) and the Cauvery.

[6] The problem of 'unwanted water' in black cotton soil areas was already apparent at this time (see section 3.2).

[7] The qualification 'productive' or 'protective' was given at the time of sanctioning the project, and did not necessarily coincide with actual performance (see IIC, 1903-I:81 for an example). The IIC (1901-03) argued for a different classification system on the ground of the confusion thus caused, but without success.

During the last two decades of the 19th century few protective irrigation systems were constructed.[8] It was only after a series of further famines that protective irrigation policy was put on a firmer footing. The Indian Irrigation Commission (1901-03) was explicitly appointed to "report on the irrigation of India as a protection against famine" (IIC, 1903-I:1). In the resolution through which the commission was appointed it was stated that

> [a]s regards new works (...) the main question is not whether they will be likely to prove directly remunerative, but whether the net financial burden which they may impose on the State in the form of charges for interest and maintenance will be too high a price to pay for the protection against famine which they may be relied on to afford. (IIC, 1903-I:2)

The Indian Irrigation Commission (1901-03) went much further than the Famine Commission of 1878-80 in relaxing the sanctioning criterion for protective irrigation (IIC, 1903:36-38). As can be seen from table 3.1, the construction of protective irrigation systems accelerated in the first decades of the 20th century.[9]

Table 3.1: Area of productive and protective canal irrigation in undivided India in the colonial period (excluding Princely States)

	Productive irrigation (million hectares)	*Protective irrigation (million hectares)*	*Protective irrigation as a % of the total*
1878-79[a]	1.88	0	0
1900-01[a]	4.40	0.14	3
1947[b]	11.4	2.17	16

a) Source: IIC (1903-I:25)
b) Source: GOI/MOIP (1972:261)

Protective irrigation in this second, administrative-financial meaning remained in use till well after Independence (GOI/MOIP, 1972:251). In 1964 a different investment criterion was introduced, the benefit/cost (B/C) ratio. Since then the term protective irrigation is no longer formally part of the irrigation planning discourse, but remains in use in the first meaning already discussed and the third meaning, to be discussed directly below.[10]

---

[8] Banerji (1995:73-126) discusses in detail the stagnation of irrigation development generally in the last quarter of the 19th century (after the 1869-1876 period of growth). This stagnation was, according to his analysis, the combined result of the introduction of famine insurance taxes in the late 1870s and of making the States responsible for raising loans (and sufficient revenue to meet the interest charges).

[9] This increase should probably not only be explained from an increasing concern with famine prevention, but also with the gradual exhaustion of opportunities for construction of systems as remunerative as those of the 19th century. The increase in protective irrigation construction may also be the result of a general push for increasing irrigation investment by the Public Works Department from a concern for departmental reproduction and expansion. However, substantiation of this hypothesis requires research outside the scope of this book.

[10] The replacement of a financial results criterion by a benefit/cost ratio reflects the broader concerns of irrigation policy (in terms of agricultural growth and development generally) in the post-Independence compared to the colonial period. For detailed discussion of Indian irrigation policy

(continued...)

Protective irrigation as a particular type of irrigation

The two meanings of protective irrigation discussed above, already suggest a number of elements of the third meaning: protective irrigation as a specific type of irrigation. Protective irrigation systems are large scale canal systems, found in the semi-arid, drought prone regions of the Indian subcontinent, particularly the Northwest and the Deccan. These systems aim to spread available water thinly over a large area and number of farmers.

This aim is not only a thing of the past, but also of the present. Irrigation policy documents provide evidence for this. In the report of the Irrigation Commission (1972) the principles of irrigation policy in water scarce/land abundant areas are described as follows.

> In areas other than those with ample water resources (...) our policy should aim at securing the maximum crop production per unit of water. (...) the policy should be to benefit as large a section of the community as possible and at the same time enable farmers to obtain reasonable yields. Surface irrigation systems should be designed to irrigate compact blocks, the blocks being dispersed over a large area to benefit large numbers of farmers. The number of irrigations can be fewer than are required for high yields. (GOI/MOIP, 1972:112-113).

The National Commission on Agriculture (1976) expressed an identical view (GOI/MOAI, 1976-VI:24-25). More recently, the Government of India's *National Water Policy* document, published in 1987, states that "[t]he irrigation intensity should be such as to extend the benefits of irrigation to as large a number of farm families as possible, keeping in view the need to maximise production." (GOI/MOWR, 1987:9) The concept of protection remains a prominent feature of Indian irrigation policy.

The general aim of protective irrigation translates into specific, and related, technical, organisational and socio-economic characteristics, which make it a type. The model of protective irrigation described below is based on scattered evidence and interpretative reading. It is an invitation to further research because systematic documentation on protective irrigation systems is lacking (see Jurriëns and Mollinga, 1996 and Jurriëns, Mollinga and Wester, 1996 for more detailed discussion). It is therefore also impossible to give an accurate quantitative estimate of the area covered by protective irrigation systems in this third meaning. My guesstimate is that protective irrigation comprises about 40% (11 million hectares) of India's 27.8 million hectares of canal irrigation.[11]

Technical design characteristics

Canal irrigation systems are commonly designed for supplying the full water requirements of the crops to be grown in the system, and as a contiguous, one-piece command area. The first design principle maximises the yield of the crop per unit area. The second minimises the construction costs per hectare, because the total canal length and the number of structures

[10](...continued)
after Independence, see Ramamurthy (1995). In 1983 the internal rate of return criterion was introduced (*Report of the Committee on Pricing of Irrigation Water*, 1992/1994:2.11).

[11] The figures used for this calculation were taken from the Eighth Five Year Plan document (GOI/PC, 1992-II:86), and refer to the potential of major and medium irrigation utilised at the end of the Seventh Plan (1990). I assumed that all major and medium canal irrigation in Punjab, Haryana, Rajasthan, Gujarat, Maharashtra and Karnataka and half of Andhra Pradesh's, is of the protective kind, and that the resulting overestimation for these States is compensated by not considering Tamil Nadu, Madhya Pradesh, Uttar Pradesh and other States. In addition to Indian protective irrigation, most of Pakistan's large scale irrigation (14 million hectares; Sufi, Ahmad and Zuberi, 1993) is also of the protective kind.

required are minimised. Neither of these principles apply to protective irrigation. Typical design characteristics of protective irrigation systems are low irrigation intensities and high duties.[12] By planning irrigation of part of the irrigable area under the canals only, and by limiting irrigation on a particular piece of land to one crop per year, the water is spread over a large area, and only part of the area commanded by the canal is irrigated. By designing a large area to be irrigated per unit discharge, supplementary irrigation is implied. The intention is to avoid crop failure on as large an area as possible, rather than to irrigate for maximum yield per unit area.

A further design characteristic is that protective systems are completely supply oriented. This means that water supply into the system is not determined by actual, and fluctuating demands in the field. Fine-tuning supply to demand, which is needed to maximise yield, is not the aim. For safeguarding the crop, the exact timing of irrigation turns is not too important, as long as these turns are regular and reliable.[13] The supply orientation combined with the desire to keep the systems as cheap as possible (because they were 'unproductive' systems yielding little revenue) has led to a minimum of regulating devices for controlling water levels between the intake of the system (weir or dam) and the outlet command areas at the farmers level.[14] The systems are designed for continuous flow and/or 'automatic' distribution (that is distribution with no or very little necessity for adjusting outlets over the season). In this way, the management intensity (number of personnel per acre or unit length of canal), and costs, can be kept low.[15]

Organisational characteristics

The low management intensity just mentioned is a first organisational characteristic. A second characteristic is that of hierarchy. The supply orientation of protective systems fits well with the top-down organisational structure of the Irrigation Department (see figure 3.1 for the organisational tree plan of the Irrigation Department in the Tungabhadra Left Bank Canal command area). The organisational structure is based on the principle of upward flow of information (data on crops, water levels, etcetera) and a downward flow of instructions

---

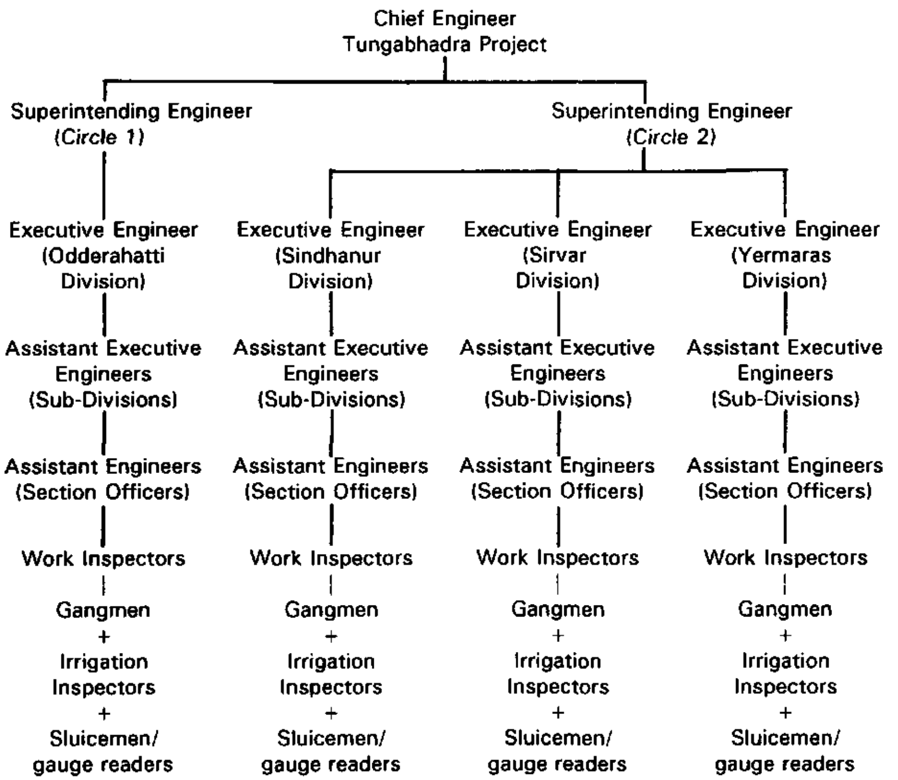
[12] Irrigation intensity expresses the intensity of use of the command area of an irrigation system. When irrigation intensity is 60%, 60% of the land is cultivated with an irrigated crop once per year (or 30% is double cropped, etcetera). When it is 200%, all land is cultivated twice with irrigated crops per year. Duty is the South Asian concept that expresses the area that can be irrigated with a unit discharge of water. It is usually given in acres per cusec (cubic foot per second). It is the inverse of 'irrigation allowance', which is usually expressed in l/s.ha (liters per second per hectare).

[13] Perry calculated, using the FAO CROPWAT software, yield losses of crops like wheat and cotton in Northwest India, when fixed water delivery schedules are used instead of flexible water delivery schedules responding to varying crop water requirements. He concluded that "any losses in production per unit area are likely to be very small for traditional field crops, and outweighed by offsetting gains in terms of easier system management and higher returns to water" (Perry, n.d.:1).

[14] There are no cross-regulators in protective irrigation systems. For the main canals there may also have been the consideration of navigation. In the colonial era many of the large canals were designed as water transport routes. The Tungabhadra Left Bank Canal was also designed in this manner (see chapter 4). Weirs would have implied locks, which are expensive and slow down travel.

[15] I have not come across a systematic comparison of staffing levels in canal irrigation systems across the world. Wade (1988b:493) found that the density of irrigation staff in Korean irrigation systems is five to eight times higher than in the Indian protective systems. Merrey (1998) compares Egypt's and Pakistan's staffing levels. The levels in Pakistan (mostly protective irrigation) are much lower.

Figure 3.1: Organisational tree plan of the Irrigation Department in the Tungabhadra Left Bank Canal command area



(see Wade, 1982a on the theory and practice of bureaucratic organisation in the Irrigation Department). The organisational structure has little managerial flexibility, but this is also not necessary in a system of continuous, and in reservoir systems constant, flows, where supply is not influenced by actual demand.

The third important organisational characteristic is the institutional form of the rationing of irrigation water, which, as explained above, is a defining feature of protective systems. Different strategies of protective water control have been designed in different regions. The literature suggests the following threefold regional division of government water control strategies in protective irrigation (see GOI/MOIP, 1972-I:113-115; Wade, 1976; Basu and Shirahatti, 1991; Jurriëns and Mollinga, 1996; Jurriëns, Mollinga and Wester, 1996).

I: Punjab, Haryana, Rajasthan (India) and Pakistan: In this region the *warabandi* system of rotational water distribution is in operation (Reidinger, 1974; Malhotra, 1982). In this system, farmers receive -in turns- a time share of the available supply proportional to the size of their landholding. A share is insufficient to irrigate all a farmer's land to full crop water requirements. Proportional division structures and semi-modular outlets distribute shortages and surpluses over the command equitably.[16] The turns have acquired legal status, and juridical sanctions for disregarding them exist (see Jacob and Singh, 1972). In this region rationing is effected through directly controlling water distribution. Crop choice is the privilege of the farmer.

II: Maharashtra and Gujarat: Common to Maharashtra and Gujarat is rationing through a crops-plus-water contract system. In the first decade of the 20th century the so called block system was introduced in present Maharashtra. The system was intended to be the first step in the introduction of volumetric delivery and pricing of water (distribution through the invisible hand of the market). It evolved into a permit/lease system for allowing the cultivation of particular combinations of crops in blocks of land for a number of years, mostly six. Farmers were allowed to plant one-third of the block with sugarcane, and two-thirds with 'dry' food crops, while the government assured water delivery for a period of six years. The reservation of two-thirds of the block for 'irrigated dry' foodgrains expresses the protective dimension of the block system. The block system is thus a crops-plus-water contract system.[17]

The water distribution system that belongs to the block system is the *sjeh pali* system (Gandhi, 1979; also see Gandhi and Dhamdhere, 1982). This is a time-based rotation system, like the *warabandi* system, with the difference that the time share of a particular block is calculated on the basis of the surface area of that block and the 'duty normally obtained' for the mix of the cropping pattern (Gandhi, 1979:400, 401).

In Gujarat the system used is that of yearly or season-wise applications of farmers for the cultivation of particular crops, to be sanctioned by the Irrigation Department (see Gorter, n.d.:88-92 on the Ukai-Kakrapar project; also see Patel and Gulati, 1994).[18]

III: Karnataka, Andhra Pradesh and Tamil Nadu: In interior South India the system of 'localisation' was introduced around Independence to achieve protective water control. Localisation is a form of agricultural land use planning in which the government allows and disallows the cultivation of particular crops on particular pieces of land. Because the localisation pattern is fixed, the pattern of water distribution can also be the same over the years. Localisation thus is an effort to regulate water distribution indirectly through controlling the cropping pattern. Localisation is discussed in detail in section 3.2.

Socio-economic characteristics

Economically, protective irrigation strives for high output per unit of water. A protective cropping pattern of light crops increases the total agricultural output of the irrigation system, as compared to concentrated irrigation. It can also be shown that the labour requirements per unit water of a protective cropping pattern are higher than that of a 'wet' cropping pattern

---

[16] Originally the systems were mostly run-of-the-river systems with fluctuating discharges in relation to changes in river discharges due to the rainfall and snow melting pattern in the Himalayas.

[17] For further discussion and references, see Bolding, Mollinga and van Straaten (1995).

[18] Gorter also mentions the existence of rotational forms of water distribution at different levels of the system in the rabi season (Gorter, n.d.:89).

(see Dhawan, 1989 and Rath and Mitra, 1989 for calculations and discussion). It can be argued that from a national economic perspective protective irrigation makes sense because *(i)* it increases agricultural output given the availability of a limited quantity of water, *(ii)* it can generate more employment than 'wet' irrigation, and *(iii)* it spreads the benefits of irrigation over a large number of producers (also see chapter 10).

The type of agrarian structure implicit in the model of protective irrigation originally was family farming primarily oriented towards subsistence production. Protective irrigation emphasises supplementary irrigation of 'irrigated dry' crops, particularly traditional food crops. It aims to stabilise existing production systems, secure subsistence and, on top of that support a limited commercial element. As Perry (n.d.:2) notes, the systems were intended to "stabiliz[e] incomes and provid[e] a secure, if limited base for further economic development".

It should be noted however that while the objective to spread water and benefits has remained central to protective irrigation, the contemporary context is no longer famine protection and subsistence farming. Also in protective irrigation the economic objective has shifted towards the increase of production and productivity, not only of subsistence crops but also of commercial crops. The Irrigation Commission of 1972 writes that "The emphasis has now shifted from the protective use of irrigation, to irrigation as a means of attaining greater production of food, fibers and oilseeds. Irrigation development must necessarily play a very important role in India's quest for self-sufficiency." (GOI/MOIP, 1972:4; also quoted in Ramamurthy, 1995:173) However, because in protective irrigation systems maximisation should be done per unit of water rather than land, and because 'irrigated dry' crops tend not to be the most remunerative, the form of production implicit in the concept of protective irrigation remains one characterised by relatively extensive farming, a low degree of commoditisation and a substantial subsistence component. The water control strategies described above thus are not only a matter of controlling water flows, but also of regulating the dynamics of agrarian change.[19)]

Table 3.2 gives a summary of the technical, organisational and socio-economic characteristics of protective irrigation, and those of non-protective/productive irrigation as a counterpoint. It should be noted that this division in two types is a simplification, but one that is useful for a first understanding of protective irrigation.

A basic contradiction

Protective irrigation's stated objective to maximise the overall production in the command area of the irrigation system (and spread that over all farmers) contradicts the individual production and income maximisation strategies of farmers. The reason is that the maximisation of (cash crop) output per unit of land is a more obvious strategy for individual farmers than the maximisation of the (subsistence) crop output per unit of water. Rice and sugarcane are two important cash crops that happen to consume a lot of water. There are strong economic incentives for farmers to grow these crops, including low water prices, stable markets and produce price protection. Farmers therefore do not adhere to protective

---

19) The 'peasant mode of production' that I posit to be implicit in the concept of protective irrigation fits into the populist framework of which protective irrigation has become part (see section 3.3). However, I hesitate to emphasise this point because there is hardly any explicit discussion on the form of production that is implicit in the concept of protective irrigation. This is perhaps because the realities of the agrarian structure profoundly contradict the implicit model.

Table 3.2: Technical, organisational and socio-economic characteristics of protective and productive irrigation[a)]

	PROTECTIVE IRRIGATION	PRODUCTIVE IRRIGATION
Technical characteristics		
Irrigation intensity	Low (around 100%)	High (200% and more)
Duty (acres/cusec)	High (low water supply)	Low (meeting crop water requirements)
Crops	Low water demanding (sorghum, millet, oilseeds, etcetera)	High water demanding (rice, sugarcane)
Operational design	Supply oriented	Demand oriented
Organisational characteristics		
Water availability	Planned scarcity, requiring rationing	Planned sufficiency, no rationing needed
Cropping pattern	Prescribed/controlled by government (except under *warabandi* system)	Farmer's choice
Water flows	Constant	Varying with demand
Socio-economic characteristics		
Yield optimisation per	Unit of water	Unit of land
Benefits	Spread	Concentrated
Major objective	Food security/poverty alleviation	Agricultural growth
Farm labour	Emphasis on family labour	Emphasis on wage labour
Orientation	Towards subsistence	Towards the market

a) Different versions of this table can be found in Mollinga (1992) and Jurriëns and Mollinga (1996).

cropping patterns. There is a strong tendency towards concentration of irrigation water on rice and sugarcane lands, resulting in unequal water distribution and unequal spread of the economic benefits of irrigation.[20)]

In the next section I discuss the origins of localisation, how it was implemented and the way in which it is monitored. This discussion will make clear why localisation was unable to prevent excess appropriation of water and unequal spread of its benefits.

3.2 LOCALISATION

The government water control strategy in the protective irrigation systems in Karnataka, Andhra Pradesh and Tamil Nadu is called localisation. It was already explained above that localisation is a form of agricultural land use planning that aims to control water distribution

[20)] The difference between 'wet' and 'irrigated dry' crops is not always the same as that between cash and food/subsistence crops. Rice is both a food crop and a cash crop. The same is true of the 'irrigated dry' crop wheat. The lower water consumption of wheat as compared to rice may explain part of the relative success of the *warabandi* system in Northwest India.

in an irrigation system through the legal prescription of the cropping pattern. Juridical procedures exist to prosecute those farmers that violate the localisation pattern.[21]

The main elements of localisation in Karnataka are the following.

1) Irrigation is allowed in part of the irrigable command of an irrigation system, and excluded in another part.
2) Limitation of the irrigation of a localised piece of land to one season (with some limited allowance of two-seasonal and perennial crops).
3) The prohibition or strong limitation of water-consumptive crops, particularly rice and sugarcane, in favour of light crops like sorghum, millet, cotton and oilseeds.

In this section I first discuss the origins of localisation, and after that the procedures for its implementation and monitoring in the Tungabhadra Left Bank Canal.

The origins of localisation[22]

Localisation was first implemented in the Tungabhadra valley (GOI/MOIP, 1972:115). The earliest discussion of the term localisation that I have been able to trace is connected to the Tungabhadra Right Bank Low Level Canal (Raghavan, 1947b).[23] In that document an exercise in 'experimental localisation' is reported for Yemmiganur village of Bellary *taluk*.[24] It was the basis for the later real localisation when the canal was under construction. For the Tungabhadra Left Bank Canal the possibility of localisation was created by the 1948 Hyderabad Irrigation Act.[25] In 1956 the Hyderabad rules for localisation were formally issued (see Appendix 3.1), but localisation in the Left Bank Canal command area had already started in 1952 (GOMYS, 1958-9:139).

Perhaps however, the première of localisation did not take place in the Tungabhadra project, but in the neighbouring Kurnool-Cuddapah (KC) Canal as early as 1949.[26] Whichever canal may have been first, the Tungabhadra valley is the cradle of localisation. How and why it was conceived is much less clear.

Satnarayan Singh has suggested (in NWMP/PMU, 1992-G-05(E)) that localisation has emerged from the necessity in irrigation system design to demarcate the area to be irrigated (the so called *ayacut*). He quotes Ellis' Irrigation Manual to illustrate this point.

---

[21] For Karnataka, see sections 27 to 32 of the Karnataka Irrigation Act, 1965. The word localisation does not actually appear in the Act. The formulation is that the government can prescribe the crops to be grown by publishing a notification in the Official Gazette. However, the terms localisation and localised cropping pattern are commonly used.

[22] I thank Mr. Satnarayan Singh (S.E. Ret.) for very generously giving me access to the material on localisation that he has collected, and for sharing his views and questions on the subject with me. I also thank Robert Wade for allowing me to read a draft chapter on this topic.

[23] This is one of a series of three reports (Raghavan, 1947a, b and c) on the cropping pattern and other aspects of the planning of the right bank low level canal of the Tungabhadra project. The reports were commissioned in 1945 by the Government of Madras Presidency as part of the design process of the canal on the right bank.

[24] A *taluk* is an administrative subdivision of a district.

[25] Under article 67/3I, see GOHYD/Law Department (1956:1097-1160).

[26] In a 1956 government order issuing rules for localisation in the KC Canal (G.O.Ms.No.334 dated 6.2.1956 of the Government of Andhra, Public Works and Transport Department, Kurnool; reprinted in GOAP, 1982-II:87, and in NWMP/PMU, 1992:G-05(E), p.114) it is mentioned that in 1949 *a Special Collector was appointed to be in charge of the localisation work in that canal.* This early localisation in the KC Canal is confirmed in the draft text by Robert Wade referred to in footnote 22.

> *Delimitation of ayacut.*-Whenever a new canal is excavated for irrigation, it is essential to prevent haphazard development of area of cultivation, which might ultimately lead to waste of water. This can best be done by circumscribing the actual irrigable extent by having it regularly defined. This was done in a very systematic manner in the Grand Anicut Canal area of the Cauvery Delta. Block maps showing the contour levels for the whole ayacut were first prepared. This facilitated the ***localizing*** of the ayacut in the most suitable areas and securing the best alignments for channels and field bodhies in the interests of economy and efficiency. Village sites, roads, cart tracks, drainage courses, grazing grounds, cremation places, treshing floors and lands for other communal purposes, that might reasonably be required in years to come were all examined and specifically and permanently excluded from project ayacut. The areas so reserved came to about 3 per cent to 5 per cent of the whole area of the village. (Ellis, 1950:263; emphasis added)

This paragraph is not found in the 1931 edition of the manual (Ellis, 1931:249), suggesting that between 1931 and 1950 the 'delimitation of ayacut' became a more formalised practice. In Barber's *History of the Cauvery-Mettur Project* the process is described in detail (Barber, 1940:429-438). It consisted of four steps: a) the cadastral survey of the proprietary areas, b) the preparation of a Record of Rights, c) the reservation of land for communal purposes, and d) the determination of the *ayacut*.[27)]

Localisation is this procedure with two additional elements: *(i)* the exclusion of part of the command area from irrigation and *(ii)* the prescription of the crop to be grown. The two additions transform localising into localisation, and make it an instrument for implementing protective irrigation.[28)] The answer to the question how, why and by whom these additions were made, lies hidden in the records of the Public Works and Revenue Departments of Madras Presidency and Hyderabad State. At present, I can only offer hypotheses.

First, it can be observed that localisation originated in the colonial period, and that the Revenue Department played an important role in its elaboration (the rules in Appendix 3.1 were issued by the Revenue Department). One retired irrigation engineer that I interviewed on this, characterised localisation as a "regimental, magisterial" form of governance, conceived by a government that could not imagine that its subjects would not do as told. On the Hyderabad State side this may have been particularly strong because of the feudal politico-administrative system prevailing before Independence (for descriptions see Leonard, 1971, 1978; Ramakrishna Reddy, 1987; Ray, 1988).[29)] It can be hypothesised that localisation is as it were an inversion of the land revenue settlement and assessment procedure. Settlement and assessment involved registering how land was actually used

---

27) The delimitation exercise for the Cauvery-Mettur scheme was necessary because the 1924 agreement between the Mysore and Madras governments, on the sharing of the Cauvery waters, limited the command area of the Cauvery-Mettur project to 301.000 acres. This was planned as a contiguous area for cultivating rice. Localizing did not (yet) refer to limiting water use by controlling the cropping pattern.

28) In several of my interviews with retired Irrigation Department engineers, a distinction was made by them between localisation proper (the delimitation of the *ayacut*, the area to be irrigated) and what they called crop localisation, that is fixing the cropping pattern. This may support Satnarayan Singh's suggestion.

29) It could be argued that this top-down attitude was reproduced in a different form in the post-Independence approach of planned development. Ramamurthy (1995:175) notes the attraction of the 'scientific' approach of localisation to technocratically minded planners. This is I think a correct observation, relevant till the present day, but it does not explain why South Indian engineers/planners opted for localisation while in other regions different avenues were chosen.

(irrigated or not, crop, soil quality), to fix the rate of land revenue. When this is done before irrigation arrives, the procedure becomes an instrument of prescription and control.

A second factor that may explain the genesis of localisation is the unfamiliarity of Madras Presidency engineers with local level irrigation. In contrast to their colleagues in North India, they had little involvement with water distribution at the local level. This was mostly arranged by farmers themselves in village units (see Famine Commission, 1881-Appendix V).

Furthermore, the irrigation of 'irrigated dry' crops, which puts new demands on water management, was a new thing. There was little practical experience with it in South India. Ellis mentions that in 1916-17 over 93% of the irrigated area under government canals in Madras Presidency was rice land (Ellis, 1931:3). In Hyderabad State large-scale canal irrigation as such was a new thing for the government. The Nizamsagar project, built in the 1920s and 1930s, was the only experience with large canal systems at the time the Tungabhadra Left Bank Canal was conceived, and this was a rice scheme.

A third factor that may have been important, and on which there is some more evidence, is the debate that was going on in the 1930s, particularly on the Madras side, on the feasibility of 'irrigated dry' cultivation in black cotton soil areas. This debate had two elements. The first was the lack of interest of farmers in irrigation of 'irrigated dry' crops in black cotton soil areas, except in years when the rains failed totally. The Kurnool-Cuddapah Canal in Madras Presidency and the Nira Left Bank Canal in Bombay Presidency were examples of this (Wallach, 1985; Attwood, 1987). The second element of the debate was the suitability for irrigation of black cotton soils. This class of vertisols (Krishnappa *et al.*, 1985, 1986) was feared by soil scientists and other experts to be prone to waterlogging and salinisation when irrigated. Many farmers were also reluctant to irrigate these soils for fear of destruction of the top-soil structure, and for the possibility of excessive weed growth as a result of irrigation. An agricultural research station was established on the Madras side in 1937 to do experiments and settle the matter. It was concluded that the irrigation of black cotton soils had both a considerable yield effect and that there was no danger of waterlogging and salinity provided irrigation was done judiciously: no over-irrigation and good drainage.[30)]

The conclusion that the irrigation planners of the time seem to have drawn from this is that irrigation of black cotton soils required strong water control. The two elements of the debate provided two different reasons for this. The lack of interest implied that farmers would have to be convinced to take up irrigation. This was translated in making irrigation compulsory once the land was localised. Or more precisely, it was considered to make the payment of the high, irrigated rate of land revenue compulsory on land that was localised, whether it was actually irrigated or not (see Gopalan, 1934:64; Raghavan, 1947c).[31)] In this

---

[30)] Debate on this issue has been going on for a long time (see for example IIC, 1903; Mann, 1931; Mehta, 1933; Venkata Ramiah, 1937; Raghavan, 1947a; Krishna, Desai and Krishnamurthy, 1959; Patil and Venkata Rao, 1965; UAS, 1973; Kenchana Gowda, 1978). In 1972 the Irrigation Commission recommended "further studies (...) on the suitability of black soils for irrigation in different regions and climates" (GOI/MOIP, 1972:115-116).

[31)] In the Karnataka Irrigation (Levy of Water Rates) Rules, 1965 it says in rule 3A that "where water is supplied, made available or used for growing any crop or the irrigation of any land but no crop is actually grown water rate shall be levied at the rates prescribed (..) as if the concerned crop was grown."

way the government hoped to induce the development of irrigated agriculture. From this perspective localisation was a means to enforce irrigation, rather than to limit it.

The second element, the need for judicious irrigation of 'irrigated dry' crops on black cotton soil, translated into extensive soil surveys of the area to be irrigated (Mehta, 1933; Venkata Ramiah, 1937). The core criterion for the selection of an area for irrigation was soil quality, combined with topographical position. The latter was particularly important for proneness to waterlogging and salinisation. For each soil-topographical category (called grades), particular crops were thought to be suitable and unsuitable.[32)] This view of the irrigability of black cotton soil provided a rationale for tight control of the cropping pattern.

The origins of localisation are likely to lie in top-down, directive concepts of state governance, combined with a set of specific regional factors. However, the enigma that the choice of localisation presents can only be fully solved through further historical research.

The implementation of localisation

The preparation of the localisation pattern in the Tungabhadra Left Bank Canal seems to have raised few problems.[33)] Interviews with persons involved in localisation in the 1950s suggest that the procedure as described in the rules (see Appendix 3.1) was closely followed. It seems to have been a genuine top-down process with very little local participation. There are only a few indications that the localisation pattern in the Tungabhadra Left Bank Canal was subject to local pressures and considerations. One example is the discussion on the length of the main canal and whether to irrigate on its left side (in the Krishna basin) after reaching the ridge between the Tungabhadra and Krishna rivers at Mile 103 (see chapter 4). Another example of local influence is the agitation of Sindhanur farmers in the early 1960s for additional localisation of rice.[34)]

One of the most intriguing questions with regard to the local shaping of the localisation pattern, is how it was decided at village level to exclude and include particular areas in the localisation scheme. The discretion of the Revenue Officer as defined in the localisation rules (see Appendix 3.1) was enormous. Criteria like 'economic condition', 'adequacy of existing resources' and 'capacity to develop lands without outside assistance' left a lot of room for interpretation. Considering that Raichur district was a very poor area (see chapter 5), these criteria must have implied a bias for localisation of the land of the more well to do farmers.[35)] On the other hand, it is unlikely that many farmers were very keen on getting their lands localised in the early years, as they were hesitant about the blessings that irrigation would bring.[36)]

[32)] These soil surveys were land evaluation *avant la lettre*. Later it was concluded that almost all crops could be grown on almost all soils (see for example Sreeramakrishnaiah, 1979). Farmers' cultivation practices provided the empirical evidence for this.

[33)] I have also found no references in the literature to problems in the localisation process in other systems.

[34)] This information comes from interviews with a retired engineer and agricultural department officer. Also see GOMYS/DRLAD (1962:36; 1963:46).

[35)] This bias existed in other domains. The first loans for tractors that were supplied went to 'big (wo)men' from the district (see GOMYS, 1960-1:129 and 1961-2:50).

[36)] Evidence of this reluctance is the report of a field visit to a canal in Gangavathi *taluk* in the head end of the system around 1960 (Nair, 1961:46-51). In a village where water had been available for two years only three out of 100 farmers had taken up irrigation, and had made seven out of

(continued...)

Localisation, smoothly prepared or not, creates certain problems. A problem that exists in all variations of localisation is its permanence. The Irrigation Utilisation Commission of Andhra Pradesh characterised localisation as highly inequitable because it excludes part of the irrigable command area from irrigation, and thereby condemns part of the farm(er)s to rainfed agriculture only (GOAP, 1982). The report recommends to introduce the North Indian 'water rights for all' system.

Also within the localised command area permanence is a problem. Someone whose land is localised for 'irrigated dry' crops will never be allowed to cultivate sugarcane, rice or garden crops, while a direct neighbour may be allowed to do so for perpetuity. One can easily imagine that farmers consider such differences arbitrary and unacceptable, and see no reason to follow the localisation pattern in their crop choice.

Because there is no homogeneity in the way localisation has been implemented in different canal irrigation systems, the seriousness and implications of some other problems inherent to localisation vary from system to system. A few examples can illustrate this.[37)]

In the Tungabhadra Left Bank Canal the localised area under each distributary canal forms a contiguous area. In principle all land that is commanded by a distributary canal is localised, except high patches, a zone around villages as protection againt malaria, and land reserved for other purposes. When the area to be localised had to be limited, the distributaries were shortened.[38)]

On the other side of the river in the Tungabhadra Right Bank Low Level Canal, a very different pattern is found. There distributary canals run for long distances through areas of non-localised land to reach localised patches near villages. These villages and the block(s) of localised land belonging to them sometimes lie at kilometres distance from the distributary canal. Compared to the Left Bank Canal the possibilities to extend irrigation beyond the localised area are large (see Boss, 1998).

Another example of diversity in the implementation of localisation is that in the Tungabhadra system rice is among the localised crops. In Karnataka this is not the case in systems that were built later, and rice is not or hardly grown in these systems.[39)] Absence of rice will obviously make a huge difference for the inequality of water distribution and the occurrence of waterlogging and salinisation.

A third example of diversity concerns the separation in time of the irrigation of different areas. Localisation involves irrigation of part of the command area in the *kharif* season and part in the *rabi* season. The rationale of this separation is that it reduces the canal capacity needed, and thereby the construction costs, compared to the situation that all this land would be irrigated in one season. It also spreads agricultural labour requirements over the year.

In the Tungabhadra Left Bank Canal this separation of *kharif* and *rabi* irrigation is often found in the same outlet command area. Outlet command areas which have 'irrigated dry'

[36)](...continued)
535 acres irrigable. The agitation referred to above of the Sindhanur farmers a few years later shows that the attitude of at least some farmers quickly changed.

[37)] However, a fuller treatment of this would require comparative research across systems.

[38)] This was necessary in tail end distributaries to stay within the limit of the total sanctioned area.

[39)] It has been suggested to me that this exclusion of rice in newer systems is a lesson learnt from the Tungabhadra system. Its absence in practice has to do with the shorter opening period of the main canal (not exceeding 8 months), the absence of migrant farmers (see chapter 5), and it is also attributed to the type of (black cotton) soil found in these other project areas. I have not been able to verify the latter explanation.

crops localised usually have 50% in *kharif* and 50% in *rabi*. It is not easy to see how in one outlet command area some people will abstain from irrigation and wait till the next season, while others do irrigate.[40]

In the Tungabhadra Right Bank Low Level Canal the *kharif/rabi* separation has been designed in a more implementable way. Blocks the size of a number of outlet command areas have been localised for the same season(s). In the 'off' season the outlet gates are not only closed but cemented. It is very clear to farmers which part of the command area of a distributary is irrigable in *kharif* and which in *rabi*.

Monitoring localisation

The problems discussed above suggest that monitoring the implementation of localisation is not an easy matter. In older systems like the Tungabhadra Left Bank Canal, chances of successful monitoring were further reduced by effectively leaving farmers free to cultivate the crops they preferred well into the 1960s, and probably the early 1970s. No sanctions seem to have existed in the early years for non-adherence to the localisation pattern.[41] This was a period when the construction of the canal system was unfinished, not all land was made suitable for irrigation, and therefore water was abundant. It was also a period when India needed to boost its food production. That the government did not pursue the implementation of localisation with great vigour in this period and allowed farmers to maximise production per unit land, is therefore quite understandable.

Legal procedures to control the cropping pattern were first introduced under the Mysore (later Karnataka) Irrigation Act of 1965. The Act made divergence from the localisation pattern an offence. Two types of offences are distinguished: *(i)* violation of cropping pattern (VCP), that is, the cultivation of a different irrigated crop than localised, and *(ii)* unauthorised irrigation (UI), that is, the cultivation of an irrigated crop in non-localised area.

Implementation started from approximately 1970. A newspaper report from 1971 on a *New Type of "Offences" in Raichur Dt.* states that in 1970 there were only 85 VCP and UI cases, but that in 1971 there were over 2000, mostly in Gangavati and Sindhanur *taluks*.[42] The report claims that this impelled the creation of a new police station in Gangavati.[43] Penalties can be imposed for each of the two offences. For UI these can range between ten and thirty times the water rate of the crop grown and for VCP between five and ten times (see sections 28(5) and 32(4) of the Karnataka Irrigation Act, 1965).

The determination of the VCP and UI penalties is a joint responsibility of the Revenue

---

[40] In GOMYS (1962-63:46) it is mentioned that in the Tungabhadra Left Bank Canal the area localised for 'irrigated dry' crops is not yet designated for the *kharif* and *rabi* seasons, and that this needs to be done. This means that in the early years of the project there were no directions given to farmers for the season in which to grow 'irrigated dry' crops. In GOMYS (1962-3:43) it is mentioned that the demarcation will be made in the *ayacut* register. One wonders how it was thought to be made in the field.

[41] As far as I know no rules or regulations as described below were created under the Hyderabad Irrigation Act, 1948.

[42] The four most important *taluks* for the Tungabhadra Left Bank Canal command area are, from head to tail, Gangavati, Sindhanur, Manvi and Raichur (see map 1.1 for the location of the *taluk* headquarters).

[43] The source of this information is an undated newspaper report from the files of a former secretary of the distributary 24 Distributary Committee.

Department and the Irrigation Department. The Village Accountant and the Irrigation Inspector have to prepare a so called 'demand list' for each village after joint inspection of all the irrigated survey numbers. On the basis of the crop grown and the localisation pattern the water rate and eventual penalties are determined. The rates and penalties are collected by the Revenue Department as part of the collection of land revenue. (Appendix 3.2 gives a table with the water rates for different crops.)

Field observations and discussion with informants show that the 'joint inspection' is often not done jointly. The Irrigation Inspector does this work mostly on his own. He often collects information not through observation, but by talking to farmers in their houses.[44] This may lead to systematic under-reporting of the irrigated area with rice and sugarcane, because the water rates for these crops are higher than for 'irrigated dry' crops.[45]

There are enormous arrears in collection; farmers rarely pay the VCP and UI penalties.[46] There are two reasons for non-payment by farmers. The first, general reason is the phenomenon of waivers of arrears in land revenue, agricultural loans, and the like. Waivers are part of the populist framework of relationships between the state and farmers (see below). The individual farmer has little incentive to respond to requests by the government and other institutions to fulfil his financial obligations, and government officials have little incentive to pursue this fulfilment.

The second reason for the non-payment of penalties is the working of the legal system. Under the Karnataka Land Revenue Act, 1964 the Village Accountant can issue a notice to a defaulter for the payment of penal water rates. In case the defaulter does not pay within seven days, the Deputy Commissioner (the chief Revenue Department official in the district) can instruct the Village Accountant to bring to sale the defaulter's moveable property (Rule 112 of Land Revenue Rules). In one of the first court cases on the payment of penal water

---

[44] One of my research assistants witnessed an inspection of the pipe outlet *ayacut* in which we were doing research, which, considering the absence of clear marking stones of survey numbers in the field and the lack of a detailed *ayacut* map, was much too casual to qualify as precise observation. The event may have been due to our presence. Considering the area an Irrigation Inspector is supposed to cover, it is also very difficult practically to do the inspection work fully through direct observation as intended, and complete the enormous amount of paperwork connected to it.

[45] There is obviously room for corruption here. Several informants (local journalists, advocates, (former) goverment officials) reported to me that in the Tungabhadra Left Bank Canal rice farmers regularly bribe Irrigation Department officials in order to reduce the area noted down as rice land. However, the water rate is very low compared to the value of the crop. The value of an acre of paddy may be over Rs.8000 (1992 figures), while the land revenue is Rs.40 (for sugarcane the figures are Rs.15,000 and Rs.150). The penalties that can be avoided by underreporting rice and sugarcane are substantial however. Still, I have difficulty to imagine that the Irrigation Inspectors that I met are capable to extort money or other favours from the self-conscious head end rice and sugarcane farmers on a large scale. Farmers do not depend on the Irrigation Inspector for other services (such as they do on the Village Accountant: for birth and death certificates, no due certificates for loans, etcetera). I witnessed well-to-do farmers crumple notices to pay penalties in front of the Irrigation Inspector, and throw them in the canal. See chapter 7 for further discussion of the issue of corruption.

[46] The payment of water rates is better, but also not full. GOKAR/PD (1976:28) gives the collection rates for 1976: 36.3% of the water rate was collected, and 0.3% of the penalties. A recently appointed Expert Committee on the reform of irrigation policy in Karnataka gives a total figure for 1995-96 of Rs.370 million for water rates, maintenance cess and penalties together. Of this, approximately Rs.200 million were water rates. Less than Rs.100 million of the total amount was actually collected (*Interim Report*, 1996).

rates in 1974, it was decided that "it is implicit in Section 32(4) [of the Karnataka Irrigation Act] that the holder of the land against whom a demand for water rate at an enhanced rate is to be made is entitled to an opportunity to show cause against the proposed levy of penal water rate".[47] This means that farmers can contest the penalties imposed in a civil court. For the Tungabhadra Left Bank Canal alone hundreds, and probably thousands of cases have been filed against the imposition of penal water rates since the 1970s.[48] There seems to be no example of the government having won such a case.

The strict procedures as they are laid down in Laws and Rules, give many opportunities to argue that these were not strictly followed. An example is the condition that notices for payment should be signed for receipt by the individual farmer or by an adult male member of his family, or otherwise be sent by registered post. Another weakness on the government side is that it does not issue notices to all violators, and consequently farmers who have been served notices can argue that they are not treated fairly. Yet another possibility is that the government withdraws cases after intervention by members of parliament representing the concerned farmers.

In 1989-90, the Irrigation Department in the Tungabhadra Left Bank Canal stepped up its legal offensive by pursuing non-payment of penalties as a criminal case.[49] The procedure is that the Executive Engineer of the Irrigation Department lodges a complaint with the Police Department, which investigates the complaint, and files it at the court. The Irrigation Department prepared the cases by issuing notices that prohibited the cultivation of rice in *rabi*, by registering the survey numbers in which rice nurseries were raised, by blocking the field channel to these plots, by observing that this block was removed and the farmer continued to grow the nursery, and then lodging a complaint.

One of the weak points of this legal mechanism is that criminal cases require evidence of independent witnesses (other than Irrigation and Police Department officers). It is very difficult to find witnesses, and even more difficult to make them testify. This, combined with the standard tactic of advocates to delay cases as much as possible, makes proving the violation very difficult.

Criminal cases are relatively immune to political interference. In principle, once they are under way, they cannot be stopped. The only possibility is that the State Cabinet sends a request for withdrawal of the case to the Director of Prosecution indicating that in the Cabinet's view there are convincing reasons to conclude that the grounds on which the case was originally urged no longer exist.[50] This happened to a number of criminal cases in the head end region of the Tungabhadra Left Bank Canal in autumn 1991. MLAs had been successful in convincing the State Cabinet that the cases should be withdrawn.

---

[47] Writ Petition 3139 of 1973 at the Bangalore High Court, decided on 19.2.74 (reported in *Karnatak Law Journal* 1974(2)). I thank Mr. B.S. Raikote for discussing this matter with me and pointing me to the relevant cases.

[48] The cases seem to come in batches: around 1977, around 1981-82, and around 1988-89. These must have been years that the Irrigation Department and Revenue Department made special efforts to collect penalties. For 1988-89 this may have been a response to the serious water crisis in that year (see chapter 9).

[49] The following is based on interviews with advocates, government officials and farmers involved in (criminal) cases on penal water rates, and the study of a number of these cases. The effort was a response to the severe water crisis in 1988-89 and 1989-90. It was intended to curb rice cultivation in the *rabi* season (see also chapter 9).

[50] I thank Mr. K. Pavan Kumar for the explanation of this procedure.

To conclude this discussion of the monitoring of localisation it can be stated that the legal and institutional mechanisms to control the cropping pattern, and thereby water distribution, are paralysed. This paralysis does not mean that localisation has fully lost its importance. Its efficacy as a water control mechanism is very limited, but it remains important for two reasons.

The first reason follows from the discussion of the implementation of localisation. There it was shown that even if farmers do not keep to the localisation pattern, the exact way it was designed has implications for water distribution practices.

The second reason is that localisation has created legal entitlements to water. Farmers with localised land who receive no water or less than they are entitled to, have a formal claim to receiving irrigation water. Formal water rights are a precondition for the pursuit of a more equitable distribution of water. The abolishment of localisation, which is sometimes proposed, could take away the entitlement to water of tailenders and make their predicament even worse, except when localisation would be replaced by a stronger system of water rights (see chapter 10 for more discussion of this issue). [51)]

3.3 THE PERSISTENCE OF AN UNREALISTIC MODEL

Notwithstanding the wide gap between the theory and the practice of protective irrigation, and the full acknowledgement of this gap (see for example GOI/PC/PEO, 1965; CADA/TBP, 1979; *Interim Report*, 1996), the model of protective irrigation has remained a central element of Karnataka's and India's irrigation policy (see section 3.1). The logic of this continued existence of the model of protective irrigation lies in the populism of post-Independence Indian politics.

To explain the meaning of populism in this context, I quote from Ramamurthy's work, on which I draw heavily in this section.[52)]

> Populism, in India, as elsewhere, usually refers to 'disingenuous slogan-mongering' by political parties to manipulate the electorate for votes. Gupta (1987:53), however, suggests that it is something more: 'a hegemonic discourse that interpellates members of dominated classes into the dominant class'. In other words, populism offers a vision, a policy logic, that neutralizes any potential antagonism between different classes in the same sector, or between different members of the dominant coalition. For example, in the recent past there have been various agitations for "farmer's rights", these have mainly represented the interests of rich peasants for subsidized electricity for irrigation pumpsets, higher agricultural support prices, and the like; demands that would lead to a larger surplus for them. Yet, the fight is presented as a fight between rural and urban areas and thus masks both class antagonisms within the agricultural sector and between

---

[51)] The definition of the present 'right' is problematic because it is indirect. No water right as such has been defined, but permission to grow an irrigated crop has been granted. To my knowledge there have been no large-scale efforts of (tail end) farmers to claim supply of water as a legal right in court. The only reference to such an attempt I came across was in the history of water distribution of subdistributary D24/11 (see chapters 6 and 7 for other aspects of water distribution in this canal).

[52)] I do not discuss the historical emergence of populist politics in independent India. For a summary discussion see Ramamurthy (1995:182-187), and for detailed political-economic debate see Frankel (1978), Gupta (1987), Rudolph and Rudolph (1987, 1988), Byres (1988, 1994), Toye (1988), Kohli (1988), Frankel and Rao (1989, 1990), and Vanaik (1990).

> the rural rich and the other groups in the dominant coalition, industrialist and bureaucrats. (Ramamurthy, 1995:183)

How populism provides a logic for the persistence of protective irrigation policy, can be clarified by looking at the role that State parliamentarians (Members of the Legislative Assemblies, MLAs for short) play for and in the constituencies from which they are elected.

MLAs are not only active in their legislative function, but also, and perhaps more so, in the implementation of government policies and programmes in their constituencies. Their role can be understood as one of 'resource brokers'. Potter, describing how MLAs were perceived in the 1950s in Orissa, states that in the eyes of many people "a successful MLA is a 'fixer' (...), someone who can get a man a job, divert development monies into the constituency, help secure a contract, find a place in a school or a hospital" (Potter, 1986:152). The logic of this behaviour lies in the need to secure votes, that is secure re-election. Manor describes MLA activities to "channel goods and services" to slum dwellers in India's cities and "work hard as their advocates in dealings with state institutions" as informed by this consideration (Manor, 1993:143-144). Elsewhere Manor speaks of 'spoils distribution' politics and the 'game of patronage politics', in which "in exchange for electoral support [groups] gained access to resources" (Manor, 1989:337, 352, 348). Frankel characterises the phenomenon as "competitive populism, with its attendant corruption in the disbursement of social development funds" (Frankel and Rao, 1989:511).[53)]

Because all MLAs have to secure resources for their constituencies there is a pressure to spread public resources thinly. In canal irrigation the translation of this pressure is the construction of vast technical systems that serve large areas.[54)] As Ramamurthy notes, "to get votes, one of the best things a politician can do is to get a government canal for his constituency." (Ramamurthy, 1995:184)[55)] Protective irrigation thus fits well into a populist discourse that professes "equal benefits for all".

Paradoxically, the populist political configuration that sustains protective irrigation at the policy level also "effectively thwarts its implementation" (Ramamurthy, 1995:176). The role of rich peasants in (rural) constituencies explains this.

Rich peasants are the main political support base for MLAs in most rural constituencies. Rich peasants act as 'resource brokers' in local situations themselves, and thereby wield considerable local political influence.[56)] Rich peasants with land in protective irrigation systems tend to appropriate more than their protective share of irrigation water. In fact this appropriation is part of the explanation of their richess (see later chapters for detailed discussion). They are unlikely to be opposed very strongly in this activity by the MLAs. The latter are likely to condone, in practice, the non-implementation of localisation and non-

---

[53)] On MLAs, also see Chopra (1996) and Vijayatilakam (1998)

[54)] It is also one of the factors that explains the preference for starting new projects rather than finishing and maintaining older ones.

[55)] The Hemavathy project in the Cauvery basin (South Karnataka) provides an example of the pressure that is usually exerted at the conception stage of irrigation systems to spread the commanded area over many *taluks*, districts and constituencies, while keeping available water constant. It was originally designed as an intensively irrigated rice scheme, but has been extended to become a genuine protectively designed system. After the completion of a system further extension may take place. In the Tungabhadra Left Bank Canal we found a case where the length of a distributary canal was doubled as the implementation of an electoral promise.

[56)] For more detailed discussion of the importance of rich peasants in local and State politics, see for example P.R. Brass (1980, 1990:particularly pp.305-310), Carter (1974), Kohli (1988), Mitra (1992) and Varshney (1993).

achievement of protective objectives, for the same reasons that they defend these principles at the policy level: the reproduction of their political support base, or more simply put, re-election.

The unequal distribution of irrigation water that results is usually represented in non-class, or more generally, non-social terms. It is commonly referred to in geographical terms as the difference between head-enders and tail-enders. Furthermore, the blame of this difference is put on the irrigation bureaucracy. The role of social differentiation as cause and consequence of unequal distribution of water is thus obscured, a common enemy is defined[57], and the homogenisation of 'farmers' that is characteristic of the populist discourse, is not fundamentally challenged.[58]

3.4 SUMMARY AND CONCLUSION

In this chapter I have given a description of protection and localisation as defining characteristics of South Indian canal irrigation. Protection in the most general sense refers to the ability of irrigation to protect crops against failure and people against famine in times of drought. In this oldest usage of the term no particular type of irrigation was implied. The term protective canal irrigation was coined in the 1870s in combination with the term productive canal irrigation. Protective canal irrigation systems were the systems that the colonial government expected to yield insufficient financial returns to be considered for construction but that were nevertheless built because they safeguarded crops against drought and people against famine, but also protected the colonial government against high famine relief costs and social unrest.

Protective irrigation developed as the particular type of canal irrigation found in the drought-prone regions of the South Asian subcontinent. It has specific technical, organisational and socio-economic characteristics. Technically the systems have vast command areas, designed to spread water thinly over large numbers of farmers for supplementary irrigation of 'dry' subsistence foodgrains. The systems are supply-oriented with, in the South Indian reservoir-fed systems, continuous and constant canal flows. There is a minimum of regulation structures. Organisationally they have a low management intensity and a hierarchical command structure, which fits the supply-orientation of the

---

[57] In later chapters, particularly chapter 7, it will become clear that the role and room to manoeuvre of the irrigation bureaucracy in the implementation of localisation is strongly shaped by the same populist 'resource broking' configuration. With regard to the role of the state bureaucracy Ramamurthy argues that "protective irrigation diffuses the conflict between two sectors of the dominant coalition: the rural rich and state bureaucrats" (Ramamurthy, 1995:185). Against the growing power of the class of rich peasants "protective irrigation and localization vest control in the bureaucracy over a scarce resource" (*ibid.*:185). I do not think this is a fully correct representation. The control was vested in the irrigation bureaucracy before rich peasants organised strongly politically, and the bureaucracy's control has eroded since. The emergence of rich peasant political power is unlikely to have played a role in the choice of localisation as a rationing strategy. In my view protective irrigation and localisation provide a basis for conflicts between the state bureaucracy and rich peasants, rather than diffusing them, exactly because the resource is scarce.

[58] As a last contribution of populism to the problematic situation in large scale irrigation Ramamurthy notes that populism has helped "to produce under-priced water" (Ramamurthy, 1995:185). The discussion of localisation monitoring and water rates in this chapter supports that analysis. See chapter 10 for more discussion on water pricing.

technical design. The main organisational problem that requires resolution is the need to ration water. Different rationing systems were conceived in different parts of India. Economically, protective canal irrigation systems aim to maximise crop production per unit water. The model implicit in the concept of protective irrigation originally was subsistence-oriented family farming, by a relatively homogeneous peasant sector, exhibiting modest economic growth. After Independence more emphasis has been given to production and productivity increase in protective irrigation systems as well, but relatively extensive farming with a low degree of commoditisation and a substantial subsistence component, remains implicit in the model. However, in the existing economic conditions farmers generally aim to maximise production per unit of land instead of water. These conflicting perspectives create a basic contradiction in the implementation of protective policy objectives.

Localisation is the institutional mechanism designed in South India to control water distribution, ration water and spread the benefits of irrigation. It is a form of agricultural land use planning prescribing which crops farmers can and cannot grow on their land. By mainly prescribing 'irrigated dry' crops, localisation, when adhered to, would spread water equitably over all land/farmers in the command area. Localisation was first implemented in the Tungabhadra valley shortly after Independence. However, instead of thinly spread water, unequal distribution can be observed in many South Indian protective irrigation systems. Head-enders appropriate excess quantities of water, depriving tail-enders. The government has not been able to turn localisation into an effective mode of water control.

To explain the paradox of the persistence of the protective irrigation model at the policy level in the face of wide acknowledgement that irrigation practices on the ground are far from protective, the populist nature of Indian politics was called upon. The role of MLAs as resource brokers for their constituencies implies a policy logic of spreading resources, including irrigation canals, widely. This ideological representation of protective irrigation and localisation as in the interest of all farmers is populist because it is accompanied by a practice in which the rich peasants corner most of the benefits by appropriating more than their protective share of water. It are these same rich peasants who are the key political support base of the legislators.

Protective irrigation and state governance

This chapter has shown that protection and localisation were conceived as instruments for governance by an assumedly 'strong state' ruling an assumedly 'weak society'. The 'strong state/weak society' model was part of the imperial approach to irrigation as well as the technocratic model of planned development that was dominant in the first decades after Independence. But in both periods the model was a projection that did not match reality. In the colonial period as well as in the first period after Independence the state was less strong and society less weak than the model assumed. In situations where water was wanted rationed distribution was difficult to implement, and in situations where water was unwanted, it was difficult to enforce irrigation. The rise of rich peasants political influence from the 1970s, related with - among other things - the expansion of irrigation, further articulated the strength of 'society' in canal irrigation. At the same time the authority of the irrigation bureaucracy weakened through increased 'political interference', as Irrigation Department engineers generally put it.

However, to characterise the situation in canal irrigation as a 'strong society/weak state' condition is also not correct. Neither the strong/weak opposition nor the state/society dichotomy effectively captures the relationship between state and farmers in canal irrigation. Society is differentiated along several lines, the state is a complex set of political, administrative and enforcing institutions (Lipton, 1991:93), and the two interact in such a way that demarcation of state and society is not always easy, or even possible.

The question that presents itself is how to interpret protective irrigation, both the policy and the practice, as an instance of state governance and state-farmers relations.[59] It is difficult to give a straightforward answer to this question, because different meanings of protective irrigation exist, and are contested both within the state and between state and farmers.

At the policy level protective irrigation is clearly the product of a concept of a 'developmental state'. Protective irrigation posits a strong regulating role of state institutions in economic development, and its objectives are defined in terms of spreading resources for the overall benefit of society.

The populist logic that sustains protective irrigation at the policy level signifies a different, political meaning. Protective irrigation policy (or ideology some would perhaps say) secures a degree of state legitimacy and helps to reproduce politicians' political support base.

At the level of practice there is a crisis of governance, constituted by *(i)* the 'political interference' of members of the political state institutions in the day-to-day business of the administrative state institutions (and of the enforcing state institutions, as will be shown in chapter 7), *(ii)* rent seeking practices of politicians and officials, and *(iii)* the social power of the rich peasants. One of the major consequences is unequal access to irrigation water for farmers, while the dominant populist discourse obscures a full understanding of this inequality.

Notwithstanding these circumstances, protective irrigation and localisation are not dead letters, but do influence irrigation practice. Unequal distribution of irrigation water is a felt problem. It is articulated through the pressure that tail enders exert on system managers, but it is also part of the professional disposition of the Irrigation Department staff. The perception of many of them is that the systems are operated 'unscientifically' at present, and that tailenders unjustifiedly 'suffer' while others enrich themselves. They feel highly frustrated in the execution of their 'duty'.[60]

The same conclusion that Mooij draws for food policy can also be drawn for protective irrigation policy: the Indian state is characterised by normative pluralism (Mooij, 1996:243). The behaviour of politicians and state officials, that is state governance in practice, with regard to protective irrigation and localisation is both informed by official law and policy, and by unofficial rules of conduct in relation to rent-seeking, the relationships between state officials and politicians, and their interaction with (rich) peasants.

It is not obvious how this empirical conclusion can be integrated into substantive theories of the Indian state and politics. These tend to favour one particular aspect of governance practices. Following Mooij's classification of schools of thought (Mooij; 1996:48-63), neo-

---

[59] The strong/weak state/society formulations already were a reference to state theory, that is to Migdal's book on *Strong societies and weak states* (Migdal, 1988). For a critical review of this book see Jessop (1990).

[60] Chapters 7 to 9 provide evidence for this interpretation. Mooij, while discussing the role of state officials in another public distribution system, that of food, observes the following about the role of state officials in that process. "Many officials do feel some sort of commitment to the job they have to perform. Their first response to a question posed by a researcher about food policy is always in terms of the official objectives and procedures. This is not just an effort to misguide the researcher. It also shows their own perception of what the state is, does, should be or should do. They partly identify with these official objectives." (Mooij, 1996:242) In my experience the same holds true for canal irrigation officials.

classical political economists analyse the Indian state as a rent-seeking state (Bhagwati, 1993), while others, mostly political scientists emphasise the erosion of the political system (Kothari, 1988; Manor, 1988). A third group sees state officials and politicians as a separate proprietary or political class (Bardhan, 1984a; Rudolph and Rudolph, 1987). Lastly, a fourth perspective has a more positive evaluation or view of development planning and the developmental state (Byres, 1994; Chakravarty, 1987; Drèze and Sen, 1995; Mundle, 1994). A theoretical synthesis is not available, and the debates have hardly been conducted with irrigation as part of the subject matter. Theoretical development is also hampered by the scarcity of detailed studies of actual governance practices, particularly in irrigation.[61)] This is therefore where my argument stops: with a call for more studies of governance practices. The policy and practice of protective irrigation with all its contradictions certainly provides an interesting case.

To conclude this chapter I observe than one factor that makes the protective irrigation discourse more than populist rhetoric, and protection and localisation concepts with real effects at field level, has not yet been mentioned. This factor is that the concept has materialised in the earth, concrete and hydraulic characteristics of canal systems. The physical existence of canal infrastructure that allows thin spread of water makes it difficult to fully ignore the stated objectives of protective irrigation and localisation. This materialisation process is the focus of the next chapter.

[61)] The major exception is Wade's work on the system of administrative and political corruption, an analysis which includes the irrigation bureaucracy (Wade, 1982a). Though focussing on rent-seeking, he does not adopt the methodological individualism of neo-classical political economy, but analyses rent-seeking/corruption as an instititutionalised set of social relationships. Wade does not explicitly engage with state-theoretical debates. Ramamurthy's analysis referred to above confirms many of Wade's findings and tends to interpret these in the perspective of the state as a separate proprietary or political class. As indicated above, in my view that perspective on its own is unable to fully capture the nature of governance practices (for more discussion of the interpretations of these two authors see chapter 7).

Appendix 3.1: Rules for localisation (1956, Hyderabad State)

PART I-C-Rules

REVENUE DEPARTMENT

NOTIFICATION

No.48/A2/350/55 *Dated* 6-9-1956

In exercise of the powers conferred by section 67(l) and 3(l) of the Hyderabad Irrigation Act, 1357 Fasli, (24 of 1357F.) the Rajpramukh hereby makes the following rules:-

1. These rules may be called the "Rules Regulating cultivation under Irrigation Projects, 1956", and shall come into force from the date of their publication in the Official Gazette (20-9-1956).

2. "*Localisation*" *means allocation of the lands proposed to be served by an irrigation project* to different types of irrigation, *viz.*, perennial, wet, garden and light.

3. For the purpose of localisation work-

(i) "Revenue Officer" means any Officer appointed by the Board of Revenue.

(ii) "Irrigation Officer" means any Officer appointed by Government as such.

(iii) "Agricultural Officer" meands any Officer appointed by the Government as such.

4. In case, localisation work is to be done on an extensive scale, Government shall appoint one or more than one Officer for expediting such work.

5. *(a)* Sufficiently before irrigation under a project is scheduled to commence, Government may constitute a Localisation party consisting of a Revenue Officer with an adequate field and clerical staff.

5. *(b)* The benefits of irrigation under a project may be extended to as large an area as possible consistent with the economic utility of water and other local considerations.

6. The Irrigation Officer shall inspect each village in the commanded ares, conduct contour surveys and take out levels on the basis of which he shall prepare a map for each village showing the area that can be easily served by the proposed irrigation system and pass it on to the Agricultural Officer.

7. The Agricultural Officer shall go into the village and inspect every field in the commanded area of the project as shown in the map furnished by the Irrigation Officer, take soil samples, analyse them, technically, both in the field and in the laboratory, and then classify the soils in each village into different categories on the basis of their suitability for different types of irrigation.

8. The Agricultural Officer shall examine carefully the following factors before allocating the soils in different types of irrigation:-

(i) Physico-analysis of the soil;

(ii) Peculiarities of the lower strata of the soil;

(iii) Drainage capacity;

(iv) Configuration of the ayacut;

(v) Such other technical details which may be prescribed by the Director of Agriculture for soil classification work.

9. The Agricultural Offiver shall, on the basis of the intensive survey and analytical work, mark on the map of each village the different soils available in the proposed ayacut give them different colours, *viz.*, red, green, black, etc. He shall also indicate in the foot note of the map the crops suited for different soils and types of irrigation.

10. After giving full details of the soils and crops, the Agricultural Officer shall send the map to the Revenue Officer.

11. *The Revnue Officer shall, with the aid of the map, inspect the village and then prepare a* tentaive scheme for fixing the extent of irrigation and allocation of different crops in the village.

12. In fixing the extent, he shall give due consideration to:-

(i) the allowance to be made for village sites, communal needs, grazing and pastures, *etc;*

(ii) the lands unsuited for crop production be reasonably made over for other appropriate uses, like pasturage, irrigated forest, *etc.;*

(iii) the extent in respect of which there is likely to be steady demand for water in ordinary years;

(iv) selection of only such land having good soil or soil capable of restoring its fertility quickly and at small cost; the governing condition being to obtain the optimum result for the expenditure on artificial supply;

(v) leaving of a dry belt of at least half a furlong around a village to avoid malaria;
(vi) extension of the benefoit of assured water supply to as many villages as possible, consistent with economic utilisation of water;
(vii) the economic condition of the people and their willingness to take to irrigation;
*(viii)*the adequacy of the existing resources in the village in agricultural cattle, population, transport facilities, *etc*;
(ix) the prospect of developing the localised lands, within a reasonable time;
(x) the nature and extent of land holdings, and the capacity of the land owners to develop their lands without much outside assistance.

13. The lands to be allotted to different types of irrigation shall be in large compact blocks and as practicable there shall be a separate distributary for each type of irrigation. Irrigation of small patches shall be avoided and in the lands coming in the dry belt of the village, only heavy irrigation shall be prohibited.

14. The Revenue Officer shall send the localisation scheme for each village together with the map to the Collector of the District or any other Officer as may be appointed by the Government in this behalf.

15. The Collector shall arrane to give due publicity to the scheme in the village and on an appointed date, call a meeting of the villagers and ascertain their views and objections, if any.

16. The Collector shall then, in consultation with the Revenue, Agricultural and Irrigation Officers, finalise the localisation scheme and affix one copy thereof in the village chavidi and the other copy to the Revenue Officer.

17. *After the sheme is thus finalised*, the Revenue *officer shall prepare* an ayacut *register* showing:-

(a) name of village, taluk *etc.*
(b) the survey number of the land;
(c) the nature of the soil;
(d) the name of the land owner and others interested;
(e) the block in which the land is to be included;
(f) the crop or crops to be grown every year;
(g) the crop rotation;
(h) the existing assessment; and
(i) remarks

18. The ayacut register shall be in triplicate one for the Tahsil Office, one for Division and the third to be retained in the Office of the District Collector.

19. *Immediately after the receipt of the* ayacut Register the Tahsildar *shall issue individual* notices to the persons whose lands are included in the localisation scheme and direct them to prepare their lands for receiving water before the prescribed date.

20. Supply of water for irrigation from a project shall be regulated, as determined in the localisation scheme.

21. It shall be incumbent on the land owners, whose lands have been proposed for irrigation, to take water for the crop and for the period as shown in the localisation scheme.

22. When a land is included in a localisation scheme, it shall be compulsory for the land owner to pay the consolidated wet assessment of water rate for the land as may be determined by the Collector, irrespective of the fact whether he takes the canal water or not.

23. Any person contravening or violating the provisions of these rules shall be punishable by the Collector with a fine not exceeding Rs.500.

24. An appeal against the orders of the Collector shall lie with the Board of Revenue whose decision shall be final.

25. Any fine imposed under the rules shall be recoverable as arrears of Land Revenue.

MOHD. ABDULLA,
Secretary.

(Source: Government of Andhra Pradesh (1982) *Report of the Commission for Irrigation Utilisation. Volume II.* Hyderabad, pp.128-130)

Appendix 3.2: Water rates in Karnataka State

The table below gives the water rates and maintenance cess as levied in canal irrigation systems in Karnataka State from 1985, and the increases proposed in 1989.

Table 3.2.1: Water rates and maintenance cess for canal irrigation in Karnataka

Crop	*Water rates from 1985 (Rs./acre)*		*Water rates as ordered from 1.1.1989 (Rs./acre)*	*Maintenance cess (Rs./acre)*
Rice	First crop	35	100	4
	Second crop	40		
Sugarcane		150	400	4
Wheat		22	60	4
Sorghum		20	35	4
Groundnut and sunflower		24	60	4
Tobacco		24	35	4
Cotton		40	60	4
Maize, *ragi*, millets, greengram, sweet potato, gingelly, onion, coriander, eucalyptus		20	35	4
Pulses		15	35	4
Manurial crops		8	15	4
Garden crops		40	60	4

Source: Government Order No. PWD 89 NPF 86 (P.II), dated 31.10.1988, and demand lists Irrigation Department Tungabhadra Left Bank Canal 1990-91 and 1991-92

The rates levied in 1991-92 (when we did our research) were set in 1985. From 1989 the government of Karnataka ordered a substantial increase, which it started to levy from 1990. The background for this increase was the desire of the government to recover the operation and maintenance costs and stimulate irrigation development by giving it a sounder financial base. More specifically, the World Bank was insisting that the Karnataka government comply to an agreement made under one of the Convenants in relation to the bank's financial support of the Upper Krishna Project. This said that the government of Karnataka would undertake to collect full operation and maintenance costs. As soon as the government tried to levy the new rates, farmers from the Tungabhadra Left Bank area filed a writ petition at the Bangalore High Court, arguing that the increase was arbitrary. On 2.2.90 a stay order was issued by the Court, stopping the government from applying the new rates to the petitioners.[62] As a result the Irrigation Department was using the old rates for drawing up the demand lists for water rates in 1991-92.

[62] These were Writ Petitions 2367/90 to 2375/90. I only checked for cases originating from the Tungabhadra Left Bank Canal and I did not try to find out whether other petitions than those mentioned were filed with the same objective.

4

TUNGABHADRA LEFT BANK CANAL

The social shaping of an irrigation system: 1859-1976

In this chapter I introduce the Tungabhadra Left Bank Canal, the protective irrigation system that is the focus of this book. The Tungabhadra Left Bank Canal has come into existence through a process of political negotiation, planning, design exercises, and data collection activities stretching over more than a century. A proposal for a large scale irrigation system in the Tungabhadra valley was first put forward by Sir Arthur Cotton[1)] as early as 1859, but it was the Indian Irrigation Commission (1901-03) that put the Tungabhadra project firmly on the political agenda. In 1944 an agreement was reached over the division of the Tungabhadra river waters between Madras Presidency, the Nizam's Dominions[2)] and Mysore Princely State. Construction of the dam started in 1948, and utilisation of the canal system in 1953. The last distributary was operational in 1968. The final decision on the extent of the canal system was taken by the Krishna Water Disputes Tribunal in 1973 and 1976.

The theoretical question that this chapter investigates is whether and in what way the planning and design of the Tungabhadra Left Bank Canal are examples of the social shaping of a technological system (MacKenzie and Wajcman, 1985; Hughes, 1987). This means (see chapter 2) that I try to determine to what extent the design characteristics of the system emerged in a process of negotiation among different actors, who brought with them their own interests, strategies and resources.

The planning phase of the project clearly exhibits social shaping characteristics. The two main issues were:

(i) the desirability and feasibility of a protective irrigation system in the Tungabhadra valley, and

(ii) the division of the river waters among the riparian States.

[1)] Sir Arthur Cotton, Chief Engineer in Madras Presidency at the end of his career, is sometimes referred to as the 'irrigation wizard of the South' (Tungabhadra Board, 1959:1). He conceived, designed and executed the first large scale British irrigation works in South India in the deltas of the rivers Cauvery, Krishna and Godavari. The improvement and expansion of the existing systems in these deltas were extremely profitable to the colonial government in financial terms, and laid the foundation for South Indian large scale irrigation engineering. In addition Cotton is famous for his public advocacy of investment in irrigation as against that in railways, and his debate with Sir Proby Cautley on the design of the Ganges Canal. On Sir Arthur Cotton, see Hope (1900).

[2)] I will also refer to the Nizam's Dominions as Hyderabad, as is common practice.

It took a long time before the position of the Nizam's Dominions government that canals should be constructed on both banks of the river and their claim of a 50% share of available water, were accepted by the Madras Presidency government. The socio-historical context in which these issues were negotiated were *(i)* a lack of emphasis on protective irrigation in irrigation policy implementation, notwithstanding formal policy statements to the contrary (see chapter 3), and *(ii)* the unequal relation between Madras Presidency and the Nizam's Dominions, determined by the system of indirect rule of this Princely State called 'paramountcy' (see Ray, 1988). An additional factor was the lack of experience with large scale irrigation construction, particularly in the Nizam's Dominions.

The design phase of the left bank canal system is much less evidently an example of a social shaping process. Some design elements, like the total quantity of water available, the size of the command area and the part of it to be irrigated, the cropping (localisation) pattern and the duties to be adopted, and the length and alignment of the main canals, were part of the negotiations of the inter-State issues mentioned above. The claims of the negotiating parties were grounded and supported by concretising these design elements. Agreement on these design elements reached by the engineers needed political approval.

Once a sufficient level of agreement on the sharing of the river water was reached in the 1940s, the phase of detailed design of the irrigation system started. This process was fully controlled by the design engineers, and neither political actors nor the future users of the canal system seem to have played a significant role in it. From a users perspective it was a conventional top-down process that emphasised physical and cost of construction criteria in design choices, and which largely ignored the socio-economic context in which the design would have to function. This is particularly clear in distributary design.

There is thus little process to be analysed in the design phase. The question that the social shaping perspective raises with regard to the design phase is under which (social) conditions designing takes place in a top-down, engineer-dominated fashion.

The chapter is structured as follows. The first section (4.1) deals with the events that led up to the actual design and construction of the system. The reasons that nothing came of the system in the 19th century are discussed, as well as the long-drawn negotiations over the division of water in the 20th century. In the following section (4.2), the general features of the design of the Left Bank Canal are discussed: the total quantity of water available for the canal, the cropping pattern and duties, the alignment of the main canal, and the design process at distributary level. I conclude with some observations on the social shaping of the Tungabhadra Left Bank Canal and the social significance of its design characteristics (4.3).

4.1 PLANNING

The planning phase of the Tungabhadra Left Bank Canal can be divided into two periods. The first runs from the formulation of the first plan for the Tungabhadra system in 1859, to the report of the Indian Irrigation Commission (1901-03). The second period starts where the first terminates, but has two end points: 1944, when the first agreement over the division of the Tungabhadra waters was reached, and 1976 when the final decision on this issue was taken by the Krishna Water Disputes Tribunal.

1859-1902: a plan remaining a plan

The first description that I have been able to find of Sir Arthur Cotton's plan for a large scale irrigation system at the spot of the present Tungabhadra project dates from 1859. The Report of the Directors to the First Ordinary Meeting of the Madras Irrigation and Canal Company[3] in October 1859, describes the project as follows.

> 1. An Irrigating and Navigable Canal proceeding from the southern side of the Toombuddra [=Tungabhadra] River, and passing through the extensive and naturally fertile districts of Bellary, Kurnool, Cuddapah and Nellore, where it will join the East Coast Canal, and thus form a continuous water communication between the central Provinces, and Madras; taking its supply from the Rivers Toombuddra and Pennar, and other streams within its range, and also from large tanks or reservoirs in their neighbourhood and:-
> 2. A like canal leading off from the opposite [=left] bank of the Toombuddra at the same point as the first, passing through the Raichoor Doab, the southern portion of the country lying between the Kistnah [=Krishna] and Toombuddra Rivers. (MICC, 1859:3)

As this quotation suggests, the canal taking off from the right bank of the Tungabhadra river was part of Cotton's masterplan for canal construction in the Indian subcontinent (see item 1. in the quotation). The plan, conceived after the financial success of the irrigation system improvements and extensions in the deltas of the Province of Madras, focused as much on navigation as on the creation of irrigation potential. The canal on the right bank of the Tungabhadra was part of a design for connecting India's east and west, north and south, by means of waterways. The second objective of the right bank canal was to protect this tract from drought and famine.

It is remarkable that in this first proposal for the Tungabhadra project a left bank canal through Raichur district is also included (see item 2. in the quotation above). From 1853 to 1860, the period in which Cotton conceived his proposal, Raichur district came under direct British rule (see Ray, 1988:7-22 for this episode). The suggestion to construct a left bank canal seems to have gone unnoticed in the Nizam's Dominions, because it is only at the very end of the 19th century that irrigation construction is considered by the Nizam's government on the left bank, but on a much smaller scale (see below). In Cotton's proposal the objective of the canal on the left, Hyderabad bank must have been irrigation mainly, because a canal running parallel to both the Tungabhadra and Krishna rivers can hardly have been considered important in terms of navigation across India. Navigation for local transport may have been considered (see below).

The execution of the plan came to lie with the Madras Irrigation and Canal Company (MICC). This company only managed to construct the Kurnool-Cuddapah Canal, and that barely.[4] The construction of the canal was more expensive and technically more

[3] The MICC was a shortlived effort at irrigation development by private enterprise. See chapter 3, section 3.1 and below.

[4] Unfortunately I have not been able to trace the map that accompanied the 1859 MICC report. It is therefore uncertain whether a separate Kurnool-Cuddapah Canal and a canal running through Bellary were conceived from the beginning, or whether there initially was a plan for one canal only. Tungabhadra Board (1959:8) states that Cotton drew up a plan in 1860 for the Tungabhadra project including a storage reservoir, the Bellary canal, the Kurnool-Cuddapah canal, and works in Nellore district in the Pennar basin, to where the KC Canal would transport water from the Tungabhadra basin. No source is given for this information. Sandes (1935-II:25) dates the formulation of the first plan earlier in the 1850s, but gives no source.

complicated than anticipated, and the company ran aground financially in the mid-1860s (Atchi Reddy, 1990).

However, there was considerable pressure from the Tungabhadra right bank area to build a canal. In July 1866 the Collector of Bellary district wrote to the Acting Secretary to the Board of Revenue "on the subject of the extreme importance of carrying out an irrigation project for the benefit of this District". He argued that such a canal would be a financially attractive proposition (Proceedings of the Madras Government, Public Works Department No.399, 20.8.1866). In a subsequent letter, the Collector further motivated his request by writing that

> [n]othing but irrigation can save this District from periodical famines; loss of valuable stock, dying for want of fodder, and distress which high prices entail on the great mass of the people. The agriculturalists are now bartering their gold ornaments, their capital made by cotton, for grain to exist upon; their cattle are dying in thousands for want of straw, which irrigation would furnish; grass has disappeared. (*ibid.*)

The need for a protective irrigation system was thus strongly advocated by the administration of the concerned district.

The Madras Presidency government was supportive of the plan, but the financial returns criterion (see chapter 3) was decisive. The Madras government stated that when the MICC would be unable to construct the system, the Presidency could consider to undertake the canal itself (Proceedings of the Madras Government, Public Works Department No.400, 20.8.1866). This seems to have led to serious consideration of the construction of the canal. Thirumalai Iyengar (1945:5) refers to a government order from 1869 on a proposal for a canal through Bellary (G.O. No.1756, dated 22.3.1869). The canal was found to be too expensive (yielding a return of 2.6% only), and it was decided not to execute it. A subsequent proposal (yielding 3.4%) was also unfavourably decided.

> Altogether it was considered that both (...) schemes for a canal from the Tungabhadra in the Bellary District were very unpromising whether cost, result of outlay, or probability of successful irrigation were considered. (Thirumalai Iyengar, 1945:5)[5]

Other considerations also complicated decision making on the project. There was the experience of 'unwanted water' gained in the Kurnool-Cuddapah Canal in the mean time (see chapter 3, section 3.2). The Famine Commission of 1878-80 reports that until the reasons for the failure of the K-C Canal are well understood, "the Government have excellent reasons for declining to undertake the Tungabhadra Canal" in the neighbouring district of Bellary (Famine Commission, 1880-II:161).

---

[5] It is unclear to which detail Cotton's plans and other early plans for the right and left bank canals were designed, but it is unlikely that they were designed in great detail. There was discussion on the extent and the type of irrigation and the cropping pattern to be adopted in the right bank canal in the years after the proposal was made. In the Proceedings of the Madras Government, Public Works Department No.398 (20.8.1866) it is stated that an area of 750,000 acres can be irrigated from the right bank canal running through Bellary district, which must - considering the extent - have been for the irrigation of 'irrigated dry' crops. In MICC (1867) a figure of 200,000 to 225,000 acres is mentioned for the Bellary section of the right bank canal, and a duty of 100 acres/cusec (at main canal level) can be calculated from the data given. This suggests a mix of rice and 'irrigated dry' crops. The Famine Commission of 1878-80 speaks of a canal irrigating 150,000 acres for rice irrigation (Famine Commission, 1880-II:161; 1881:115). This acreage is also mentioned by Thirumalai Iyengar (1945:5), who also gives the discharge at the head of the main canal (2250 cusecs), implying a duty of 66.7 acres/cusec, which is a rice duty. I do not know which of these or other proposals were the basis for the calculations of financial returns.

With regard to the dam required for the system there were questions as well. In the years 1863-1866 an investigation was done for the MICC on possible sites for reservoirs in the Tungabhadra valley.[6] Suitable sites were difficult to find. Either the dams were too long (upto 4500 meters) and therefore very expensive, or the number of villages and value of property to be submerged by the reservoir was considered too large. The dams considered were earthen dams, with depths of water at the dam up to 100 feet (30 meters). The largest reservoir considered had a capacity of 92.3 TMCft. (Thousand Million Cubic feet), which is almost 70% of the capacity of the present reservoir. In the 1860s however, this size of reservoir was unprecedented in India. Experience with building large (masonry) dams was only gained - in India - at the end of the 19th century and in the first decades of the 20th century (Sandes, 1935:32; Kulkarni, 1990). Even if it had been decided to build the project, it is doubtful that it could have been constructed.

Perhaps because of continued calls for the project from the district, the right bank canal did not fully disappear into political oblivion. In the separate Report of the Irrigation Committee of the Famine Commission of 1878-80, investigation of the possibilities for irrigation in Bellary district is recommended (Famine Commission, 1881:115). Thirumalai Iyengar mentions that the subject of canal construction was revived in 1885, 1889 and in 1897-98, though without success. In 1899 the Madras government issued an order stating that "the subject must not be dropped and investigation must be resumed to find ways and means to utilise the large quantities of water going to waste" (G.O. No.2229, dated 8.3.1899; Thirumalai Iyengar, 1945:5). A substantive change at the policy level was needed to push the project forward. This came in 1902.

1902-1944: negotiating the division of the Tungabhadra waters

In the period from 1902 to 1944 the governments of Madras Presidency and the Nizam's Dominions had difficult negotiations about the proportional use of the available water in the Tungabhadra river. Because neither of the two parties could execute their plans without agreement of the other party, the final settlement was a 50% share of the waters for each government, despite the greater political clout of Madras Presidency.

In 1902 the Madras Public Works Department (PWD) presented a proposal for a right bank Tungabhadra canal to the Indian Irrigation Commission (1901-03). The Commission attributed great importance to the project and requested further investigations directly after it had visited Madras (IIC, 1903-II:101). The proposal that the IIC recommended for investigation and construction in its final report is shown in map 4.1.[7]

It may be noted that the IIC proposal is for a canal on the right bank only. The possibility of new irrigation on the left bank, in Raichur district in the Nizam's Dominions, had taken concrete form only a few years earlier. Gopalan reports that in 1895 a Minister of the Nizam's Dominions government was on tour in Raichur District, and that the "wide spread and acute distress of the people" made him realise that the district should be protected by means of irrigation (Gopalan, 1934:2-3). A proposal was prepared, and sanctioned by the Nizam government, for rehabilitation of the Bennur irrigation system. This was one of the river diversion systems constructed during the Vijayanagar Empire, in the 13th to 16th

[6] The report of this survey can be found in Proceedings of the Madras Government, Public Works Department No.523, July 1866.

[7] In this plan the Bellary canal takes water into the Pennar basin as well, an idea that was dropped later and is not part of the present right bank design.

Map 4.1: Tungabhadra project plan as considered by the Indian Irrigation Commission (1901-03)

Source: IIC (1903)

century.[8] The Madras Government was of the opinion however, that this 10,000 acres project might affect their interests lower down the river, and that a decision could only be taken with the knowledge and consent of the Madras government. The project was stopped in 1898. This was the first occasion in the negotiations on the Tungabhadra project at which Madras showed its paramount power over the Nizam's Dominions.

Perhaps because of this incident, the Indian Irrigation Commission (1901-03) wrote in its report that

> [t]he fact (...) must not be lost sight of that it will not be possible to carry out any large storage scheme on the Tungabhadra without occupying lands belonging either to His Highness the Nizam or His Highness the Maharaja of Mysore, or perhaps to both. We are hopeful that no serious difficulties may arise if they are allowed to participate, as far as may be practicable, in the benefits of any schemes that may be devised (...). (IIC, 1903-II:101)

The hopes of the Irrigation Commission were in vain. In August 1905 a conference took place in Hyderabad between the Madras and the Hyderabad government on the compensation to be given by Madras for the submergence of territory in the Nizam's Dominions by the construction of a reservoir at Malapur, the present site. The Hyderabad government demanded a 50% share in the river waters. The Madras government submitted the plans and estimates that it had in the mean time prepared for the right bank project to the Government of India, with the suggestion that the Tungabhadra project should be deferred for 15-20 years, as it was not a productive scheme. Preference was given to the more remunerative delta schemes (Gopalan, 1934:3-4).[9]

This course of events shows two things.

1) Madras Presidency was more powerful than the Nizam's Dominions, but not so powerful that the issue of submergence could be forced. Mutual consent was necessary. The Government of India also consistently took a position regarding this issue that aimed at not too unreasonable relations between the two States.[10]
2) Productive irrigation usually got preference over protective irrigation. Madras' interests in the Tungabhadra project were ambiguous. On the one hand it favoured water use in the Tungabhadra valley for protecting that area against drought and famine, on the other hand it had to guard the water supply to the downstream and very productive delta areas.

The political deadlock over the shares of the different States in the Tungabhadra water would last till 1944. During this period Madras considered to change the site of the dam 24 miles upstream to avoid submergence of Nizam territory, but this was found to be technically unpractical, as well as to cause similar problems with the Mysore and Bombay governments. The Madras goverment was under increasing pressure from the region to construct the canal. Gopalan mentions the "incessant agitation carried on by the educated ryots of Bellary" (Gopalan, 1934:57).[11] Because of the political trump card held by Hyderabad - the need to give permission for submergence of part of its territory - and the increasing public

---

[8] For discussion of the irrigation canals constructed in this period, see Davison-Jenkins (1997).

[9] Proposals for a dam plus a right bank canal were prepared in the reports of Mackenzie. For an account of the history of the right bank canal, see Thirumalai Iyengar (1945).

[10] One example of this is the position of the Government of India in the conflict around the Bennur project referred to above (see GONOH/PWD, 1937).

[11] I have found no references to public agitation or committees of investigation on the Raichur side. The feudal nature of the Nizam State may not have allowed such forms of political representation. Whether and in what way the local *jagirdars* (feudal landlords) and other influential people engaged in the discussions and decision making on the project is unknown to me.

pressure for a canal, the Madras government finally had to accept the principle of equal drawals from the dam on the left and the right side. At government level political agreement on this issue was reached in June 1944.[12]

The political impasse gave Hyderabad time to design a scheme that could make use of its claimed share of the water. After the Indian Irrigation Commission investigation and recommendations, the Bennur project was revived. But in 1915 it was finally dropped as it was much too small for utilising Hyderabad's claimed 50% share of the water. Investigations by the Hyderabad government showed that the Malapur site selected by Madras for the dam was indeed the best site, and that a left bank canal taking off from this reservoir should be contemplated to irrigate as much area in Raichur district as possible.[13] In 1921 investigations were started for this. In 1930 discussions between Madras and Hyderabad engineers were initiated on a joint project, and detailed investigations were done and plans drawn up (Gopalan, 1934:4, Appendix G). An extensive soil survey was undertaken in Raichur district, and the first project report on the Left Bank Canal was written (Mehta, 1933; Gopalan, 1934).[14]

The June 1944 agreement of Madras and the Nizam's Dominions made start of construction of the dam and canal system possible. The agreement allowed partial utilisation of the river water for the Tungabhadra Project, to the extent of 65 TMCft. per year each. The States were free to design canals for larger amounts at their own risk, in anticipation of a final settlement that would allow greater use. On 28 February 1945 the Tungabhadra project was inaugurated and building work started.

With the agreement for partial use of the Tungabhadra waters, the negotiations over the division of the river water were by no means over. The matter was considerably complicated by the reorganisation of the States after Independence. This meant that both the originally designed left bank and right bank canal systems were divided over new States, that is Karnataka and Andhra Pradesh.[15] Conferences were held on the sharing of the water in the

[12] The sharing of the Tungabhadra waters also involved Mysore State (and to a very limited extent the Province of Bombay). Mysore claimed a share of the waters for the Bhadra project, upstream of the Tungabhadra project. An agreement on this was concluded between Madras and Mysore in July 1944. Supplemental agreements were made in December 1945 and April 1946 (the texts of all these agreements can be found in GOI/KWDT, 1973).

[13] One of the complications of a dam at the Malapur site was that the reservoir submerged a considerable part of Salar Jung's *jagir* (a feudal estate). He was *Dewan* (prime minister) of the Nizam's Dominions in the 19th century.

[14] At the beginning of the century the Nizam State was hardly in a position to do such investigations and make such plans. A Public Works Department was established in Hyderabad in 1868; a separate Irrigation Department in 1896 (Ramamurthy, 1995:190-191). The first batch of engineers graduated in Hyderabad (at the Osmania University Engineering College) in 1933 (1342 Fasli) (The Osmania Engineering Graduates Association, 1948:11). Experience was gained with the first large project in the Dominions, the Nizamsagar dam and canal system, completed in 1931. These developments were part of the general 'modernisation drive' that was taking place in the Nizam's Dominions (Leonard, 1978).

[15] At Independence in 1947 the new Madras and Hyderabad States became the parties in the Tungabhadra project (after a failed attempt of the Nizam government to stay outside the Indian Union). In 1953 Andhra State was created, and the Kannada speaking *taluks* of Bellary district went to Mysore State. This located the right side of the head works in Mysore State, and a large part of the right bank canal system in Andhra State. The Tungabhadra Board was created to be the construction and managing agency for the right bank section of the dam and the part of the main

(continued...)

Krishna basin, of which the Tungabhadra is part, in 1951 and 1960, but the matter was settled by the Krishna Water Disputes Tribunal in 1973 only (with the last details arranged in 1976).[16] Positions and decisions taken in these negotiations affected the design of the Left Bank Canal, and the cropping pattern under it. How the final shape of the Left Bank Canal came into existence is discussed in the following section.

4.2 DESIGN

When the project slowly moved from the planning phase into the design phase, political actors gradually became less dominant and the control of the process shifted to the design engineers. The planning decisions regarding the Tungabhadra system were negotiated at the highest political level, with engineers in an advisory role. The negotiations on the design characteristics that affected the inter-State issues were directly between engineers from both States, but agreements that were reached needed political sanction. The detailed design of the canal systems was fully dominated by the design engineers.

It was noted above that one of the factors that kept the Tungabhadra project on the policy agenda was the pressure exerted by local government and farmers, but these local actors seem to have played no role in the planning and design process. With regard to the design process I have found no references to local involvement in the overall design of the main system (the dam, the primary or main canal, and the rough design of the secondary or distributary canals). For the detailed design of distributaries and sub-distributaries during the construction phase there are some, but only some indications of local influence on design decisions.[17]

From the perspective of the users design thus was a top-down process. Furthermore, in their design choices engineers only considered physical and cost of construction criteria. They did not consider the socio-economic conditions within which the infrastructure would have to function.

In this section I discuss debates and design choices regarding the following four design elements: the total quantity of water available, the cropping pattern and duties, the alignment of the left bank main canal, and distributary design. They provide the background for the

---

[15](...continued)
canal system relevant for distributing water between the two States (see Lakshminarayana, 1990 on the Tungabhadra Board). In 1956 Hyderabad State and Andhra State were merged to form Andhra Pradesh. The larger part of Raichur district, except the eastern *taluks* of Alampur and Gadwal, went to Mysore State (later renamed Karnataka). As the original plan for the Left Bank Canal extended into these two *taluks*, there was a two-State situation on the left bank as well.

[16] The report of this Tribunal (GOI/KWDT, 1973, 1976a&b) contains a very detailed discussion of the conflicts over the Tungabhadra waters, and the appended volumes with the evidence contain reprints of most of the reports and of the important correspondence on the issue. This so called Bachawat Award (after the Tribunal's chairman) runs till 2000. Other sources are GOAP/PWD (1960), which was prepared for the 1960 conference on the Krishna waters, and the report of the Krishna-Godavari Commission (Krishna-Godavari Commission, n.d.).

[17] It is at the level of pipe outlet command areas that local influence is more noticeable, but here it is mainly social *re*shaping by users after the government had put the system in place. In this section I discuss the design of the system as originally constructed by the government between 1948 and 1968. The remodelling of the system that took place, particularly at the lower levels of the system is left to chapter 8.

analysis of water distribution practices in later chapters, and substantiate the evaluation of the design process as a top-down, design engineer dominated process.[18]

Total quantity of water available

The first important physical variable for designing a canal is the amount of water available for irrigation over the year. This depends on the flow of the river and the storage capacity created. In a reservoir scheme like the Tungabhadra project, the daily, weekly or monthly flow in the irrigation canals is not directly dependent on the river flow (as it is in river diversion schemes). This is because of the buffer effect of a reservoir: it allows constant outflows with variable inflows. The discussion on availability of water was thus mostly on total availability for a year.

River flows vary from year to year in relation to variation in the rainfall in the catchment area. Water availability is normally expressed in terms of 'dependable flow' or 'dependable supply'. If a canal is designed on the basis of 75% dependability for instance, this means that in three out of four years, the canal can take water as designed, and in one year there will be insufficient water available for full supply. Which figure should be chosen as dependable flow was intensely disputed by the engineers representing both sides. How much of this dependable flow would be available for irrigation of the Tungabhadra command area was another point of debate. For details I refer to Box 4.1.

The agreement of June 1944 allowed both Madras and Hyderabad to utilise 65 TMCft. Both sides however designed their canals for higher use, as the agreement allowed them to do at their own risk. The 1947 project report for the Left Bank Canal is based on a total yearly utilisation of 92.3 TMCft. (including reservoir evaporation losses of 9 TMCft.) (GOI/KWDT, 1973-I:112). The division and available supply issue was further discussed after Independence in an inter-State conference in 1951 convened by the Planning Commission. This meeting led to a written agreement, ratified by the Bombay, Madras and Hyderabad governments. The agreement allowed Hyderabad to use an extra 35 TMCft. for the Tungabhadra Left Bank Canal (*ibid.*:38). However, Mysore refused to ratify the agreement, as it felt its interests were insufficiently accommodated. Though the other three States held the agreement to be valid for a long time, the Krishna Water Disputes Tribunal decided in 1973 that it was not valid (*ibid.*:28-43). The Tribunal in 1973 settled the amount of water available for the Tungabhadra Left Bank Canal at 92 TMCft. (including reservoir evaporation losses) (*ibid.*:220). The further report of the Tribunal allowed Karnataka to use an additional 10 TMCft. from its total allowance in the Tungabhadra basin, making the total allowance for the Left Bank Canal 102 TMCft. (GOI/KWDT, 1976a:162-170, 230).[19]

---

[18] I do not discuss the design of the dam. There was extended debate on the dam profile, the mode of construction, including the type of mortar to be used for this masonry dam, the location of the spillway, and several other design elements. These discussions are an interesting episode in the history of dam building, but I will leave them aside here because the debates do not relate directly to water distribution within the Left Bank Canal system. The same is true for two other design features of the main canal than the alignment: its navigability between mile 24 and mile 100 (though there was never any navigation on the canal) and the planning of intermediate reservoirs and drops for electric power generation (see GOKAR/ID, 1981 for details).

[19] The total allowance for the Tungabhadra right bank canals is also 102 TMCft, proportionally divided over the States of Karnataka and Andhra Pradesh. The total allowance to Karnataka for the Tungabhadra basin is 295 TMCft. plus 7½% of the difference between the use of Karnataka's projects drawing more than 3 TMCft. in the Krishna basin in 1968-69 and stipulated three year

(continued...)

Box 4.1: Dependable flow in the Tungabhadra river

A dependable flow figure had been decided in a conference in Bangalore by the Madras and Mysore governments in the early 1930s. Dependable flow at the dam site was determined by calculating the discharges at this point from discharges known at the Sunkesala weir of the KC Canal further downstream. The figures of river discharge for 32 years were taken (1900-1 to 1931-32). The dependable flow was taken as the flow in the 8th worst year, being 260 TMCft. (GOMAD/PWD, 1947:2) Dependability of the river flow was thus taken at 75%. This figure sparked considerable debate in later years, as it did not include water use of existing irrigation, which, according to Hyderabad but not according to Madras, should be included in the figure to be shared on a 50/50 basis. Hyderabad thus termed it 'available supply'. The total dependable supply of the Tungabhadra basin had been calculated by Mackenzie in the first decade of the century to be approximately 350 TMCft (used and unused). The 75% dependable flow at the dam site (used and unused) agreed upon in the July 1944 Madras/Mysore agreement was 340 TMCft. That calculation was based on joint gauging of the river in the late 1930s and discussion on the interpretation of earlier discharge measurements. This is the quantity Hyderabad wanted shared among the Bombay, Mysore, Madras and Hyderabad States, with specific allotments to Mysore and Bombay, and a 50/50 sharing between Madras and Hyderabad including existing irrigation and a contribution to the lower Krishna basin/project (see GOMAD/PWD, 1947 and GOMAD, 1954 for correspondence on the matter). The determination of the part of the dependable river flow to be used for irrigation is an iterative process in which the height of the dam (determining reservoir capacity), the regime of inflows into the reservoir, and the assumed cropping pattern (determining the release schedule for the canal) are the variables. An additional factor is reservation of water for use in upstream and downstream schemes. Gopalan uses a figure of 204.01 TMCft available for irrigation in a bad year (with the reservoir level at 1630 feet above sea level) in the 1934 Left Bank Canal project report (Gopalan, 1934). How exactly he made this calculation is unclear. The Tungabhadra project in this manner would use 77% of the river flow in a bad year, and 51% in an ordinary year. The bad year design left only 60 TMCft. for other upstream and downstream claims on this water. Considering that Mysore claimed 84.6 TMCft. for its Bhadra project (Gopalan, 1934:8), the 1934 design was at the limit of possible water use. Gopalan designed the Left Bank Canal for 50% of the available flow (Gopalan, 1934:22, Appendix C, J). The Gopalan report was a maximum-possible claim of Hyderabad. However, in the second half of the 1930s Hyderabad argued for a lower dam for some time, with the objective to reserve water for future downstream projects. This position was shortlived.

This outline shows that the dependable flow at the Tungabhadra dam site and the part of it to be used in the Left Bank Canal were politically negotiated figures. Not only the final figures were debated, but also the methods for producing the relevant data for calculating them. Examples are the formula for translating rainfall into river discharge for a particular sub-catchment, and the discharge formulas for the weirs in the river (for some of these issues see GOI/KWDT, 1973-I). Because the formulas all contain locally specific empirical coefficients, and measurement data series long and accurate enough to check them thoroughly

---

[19](...continued)
periods later (1982-3 to 1984-5 for use between 1990-91 and 1997-98 for instance), with a maximum of 320 TMCft. (GOI/KWDT, 1976a:226-228) The complexity of such arrangements is indicative of the difficulties in reaching compromises on the sharing of river waters.

were not available, there was wide scope for debate and negotation. At different moments, different conclusions and compromises were reached.[20]

All States seem to have accepted the Tribunal's decisions. At the moment of the decision making, a large part of the Krishna waters was still not used for irrigation and hydro-electric power generation. Twenty-five years later the full-utilisation situation is in much closer sight. A new round of debate is due around 2000 A.D., when the Tribunal's Award will be reviewed.

Cropping pattern and duties

The second basic variable for the design of a canal system is the cropping pattern to be adopted in the command area. Together with the total quantity of water available, this determines the area that can be irrigated. The connecting variable is the duty assumed for each crop (acres to be irrigated with one cusec of discharge; for general discussion, see Jurriëns, Mollinga and Wester, 1996). I first discuss the cropping patterns and then the duties that were adopted in the Tungabhadra Left Bank Canal.

Cropping patterns

The first cropping patterns for the Left Bank Canal were drawn up in the early 1930s during the execution of the soil survey of the possible command area and the preparation of the first project report. From the start the cropping pattern has been of a protective nature, with 'irrigated dry' or light crops as the dominant category.[21] Of the total of 690,000 acres proposed to be irrigated in the 1934 project report, 480,000 were reserved for 'irrigated dry' crops, which is almost 70%. Rice was included in the cropping pattern because it was felt that "a certain proportion of this crop is necessary to make the project financially a success" (Gopalan, 1934:59).[22]

Another typical feature of protective irrigation was also present in the first plans: only part of the command area of the canal would be irrigated. The irrigation intensity proposed in the 1934 project report was 58.9%, varying from 68.0% in the head reach of the main canal to 50.2% in the tail reach (*ibid.*:42). Finally, there was hardly any double cropping (for additional details see *ibid.*:Appendix J).

After the agreement of 1944 the cropping pattern was reconsidered several times (see table 4.1). Characteristic for the (considered) changes in the localised cropping pattern after 1944 is that it became more protective. The area with rice was reduced and that with 'irrigated dry' crops increased. The Hyderabad government sanctioned a cropping pattern in 1955 that

[20] The dependable flow for the Krishna basin for example was set at 1715 TMCft. in the 1951 agreement (GOI/KWDT, 1973-I:30). It was set at 2060 TMCft. by the Krishna Water Disputes Tribunal in 1973 (*ibid.*:73-81). An example with regard to duties is given below.

[21] Mehta (1933) and Gopalan (1934) give the the different croppings patterns considered. The total planned irrigated area ranged from 466,550 to 645,000 acres, with different distribution of area over different crops in the various proposals. The ease with which one cropping pattern was replaced in the discussions by another shows the top-down nature of the design process. Nobody seems to have been worried about the question what the farmers who were supposed to grow these crops might think of the matter.

[22] The agricultural soil survey report for the Tungabhadra left bank command area had come to the conclusion that "the facts about the suitability of black-cotton soil for irrigation are over whelming" (Mehta, 1933:20). There were therefore considered to be no obstacles for the irrigation of either 'wet' or 'irrigated dry' crops.

was more protective than the pattern included in the 1934 project report (see table 4.1).[23] This sanctioned pattern has been the basis for actual localisation; the final result is visible in the most right-hand column of table 4.1.

In 1976 the Technical Committee for the Re-examination of the Cropping Pattern proposed the most protective localisation pattern ever. This shows the force of the concept of protective irrigation at policy level, but it is also the last time that localisation is proposed as an instrument of state governance without fundamental questions attached. After this Committee's report no further changes were proposed in the localisation pattern. In the 1970s the discussion on localisation shifted from the issue of the best cropping pattern and how to convince farmers to take up irrigation, to the issues of the violation of the cropping cropping pattern, unauthorised irrigation and how to curb these (see chapter 3). In 1979 a report appeared with the telling title *Report of the Tungabhadra Project ryots grievances committee* (CADA/TBP, 1979). In the 1970s the realities of day-to-day irrigation management caught up with the technocratic dreams of the planners.

Duties

Underlying the calculations of the areas of different crops to be irrigated, once the total available water supply was agreed upon, were the duties accepted for the different crops.[24] Gopalan gives an interesting look into the way duties were determined. During a conference of Hyderabad and Madras engineers, the duties proposed on Monday 6th February 1933 were: rice 66.7, sugarcane 80 (8 months) and 60 (4 months), garden 120, *kharif* and *rabi* 180 (all in acres/cusec at distributary head). On Tuesday 7th February 1933, the following duties were considered to be more suitable: rice 60, sugarcane 75 (8 months) and 50 (4 months), garden 100, and *kharif* and *rabi* 150 (acres/cusec at distributary head) (Gopalan, 1934:Appendix G). Because the change was made overnight it can be safely assumed that the basis of the change was not new experimental data on field irrigation conditions and canal losses. I must be concluded that duties were not a given, empirically determined, but a negotiable entity. This is hardly surprising considering the lack of experimental data on water use in field conditions at the time. The positive side to the adaptations was that they were made in the realistic direction. The - yet different - duties adopted in the Gopalan report are given in table 4.2.

The changes in the (proposals for) duties to be adopted are more haphazard than those in the (proposed) cropping patterns (see table 4.2). The duties adopted in 1956 (by the Mysore government) are still in force. These differ from the duties proposed in the 1934 project report, but not in a systematic manner. Because Mysore State changed the duties, the peak discharge for the Tungabhadra Left Bank main canal increased. The main canal was redesigned for a discharge at the head of 4100 cusecs instead of 3200 cusecs. The work to bring the main canal to this capacity is still going on (also see chapter 9).

---

[23] The reasons given for this change were that *(i)* the protective capacity of the project was enlarged, *(ii)* it would conform to the local agricultural practices and the inclination of the farmers, *(iii)* the development problems which usually arise in the wake of heavy ('wet') irrigation are proportionately reduced, and *(iv)* in view of the poverty and low purchasing capacity of the people, the enlargement of the acreage under commercial and cash crops should prove a boon (GOAP/PWD, 1960:84; also quoted in Rao and Sundar, 1984:3).

[24] Duty figures incorporate expected water use (in)efficiencies by using different duties for the same crop at different levels of the canal system (main canal head, distributary head, field level). See table 4.2 below.

The Technical Committee of 1976 proposed systematically lower duties than in force, because it considered the latter unrealistically high. Many engineers have also expressed their opinion to me that they find the present duties unrealistically high. To my knowledge there has been done no extensive on-field research on actual crop water requirements and duties achieved in practice (for some actual water use data see Jurriëns and Landstra, 1990).

Table 4.2: Duties used and proposed for Tungabhadra Left Bank Canal (acres/cusec)

Crop	*Project report 1934* (a)	*Recommended in 1945* (b)	*Adopted December 1956* (c)	*Technical Committee 1973-1976* (d)	*Statement Irrigation Department 1991* (e)
Rice	Kharif Distributary 62.5 Summer Distributary 40	Kharif Distributary 66.6 Summer Distributary 60	Kharif Field 80 Distributary 65 Main Canal 55 Summer Field 55 Distributary 45 Main Canal 40	Kharif Main Canal 38	Kharif Distributary 65 Main Canal 55
Sugarcane	July-Dec 100 Jan-Feb 50 Mar-June 75	Distributary 62	Field 110 Distributary 90 Main Canal 75	Main Canal 60	Distributary 90 Main Canal 75
Garden	Distributary 120	Distributary 115	Field 150 Distributary 115 Main Canal 100	Main Canal 90	Distributary 115 Main Canal 100
Cotton		Distributary 180		Main Canal 96	
Kharif (light)	Distributary 160	Distributary 180	Field 220 Distributary 175 Main Canal 150	Main Canal 135	Distributary 175 Main Canal 150
Rabi (light)	Distributary 160	Distributary 180	Field 175 Distributary 140 Main Canal 120	Main Canal 84	Distributary 140 Main Canal 120

(a) Gopalan (1934:38-40)
(b) Rao and Sundar (1984:3), probably taken from GOKAR/ID (1981:35)
(c) GOKAR/ID (1981:35) referring to letter of Chief Engineer No.W/948/48/TS dated 22.12.1956; also in Rao and Sundar (1984:3)
(d) GOKAR/PD (1976:Annexure VI)
(e) Data from Chief Engineer's office, Munirabad (March 1991)

The alignment of the main canal

The alignment of the main canal is the third design element that was subject to debate. The main canal is a lined earthen canal, which for most of its length is a contour canal. The debated issue was its alignment. There were two main determinants for the alignment of the Left Bank Canal.

1) The cost and facility of construction.[25]

[25] This was the main factor in the first 15 miles of the Left Bank Canal, where it goes through very rocky and hilly country. Many alternatives were considered there, mainly evaluated on the cost of their construction, and the possibility to use drops for electric power generation. The latter is a financial factor as well, because it raises the benefits derived from the project.

2) How much area was to be irrigated, and how that area was to be distributed over Raichur district.[26]

According to Kosnam four different alignments for the main canal were considered between 1929 and 1949 (Kosnam, 1952-3:315-316) .

The first alignment was made in 1929 by C.C. Dalal (see map 4.2). This is the alignment used in the 1934 project report. This alignment gives the largest extent of the Left Bank Canal that has been considered. It was the result of the Hyderabad's government instruction "to align the most economical canal to command and irrigate as large an area as possible in the Doab" (Gopalan, 1934:4). In this way Hyderabad could justify its claim of a 50% share in the Tungabhadra waters. Dalal's line consists of a main canal 139½ miles long upto Rampur, two miles west of Raichur town.[27] The main canal bifurcates at this point into two branch canals, the North and South Gadwal branches, which rejoin after circling a group of rocky hills, to become the Alampur branch. This branch takes the water to the very east corner of the district, where the Tungabhadra and Krishna rivers join. The total length of the branches is 115½ miles (Gopalan, 1934:13).

The water for irrigation of this vast command was not all planned to come from the Tungabhadra reservoir. At Mile 110 the Right Bank Canal of the future Upper Krishna Project was planned to join the Tungabhadra Left Bank Canal, and supply extra water for the tail end section of the command area. Therefore, only part of the commandable area beyond Mile 110 was attributed to the Tungabhadra Project, and the remainder to the Upper Krishna Project. The 1934 Tungabhadra Project encompassed the main canal upto Rampur plus the part of the North Gadwal branch upto the frontier of Gadwal *taluk* (26 miles) (Gopalan, 1934:17).

The second alignment was surveyed by Khaja Azeemuddin in 1946 (Kosnam, 1952-3:316-317). This alignment is located at a much lower level, commanding a smaller area between the main canal and the river, thus reducing the command area with 335,000 acres (see map 4.2). This alignment was probably the result of the view that irrigation from the Tungabhadra reservoir should be limited in favour of projects downstream on the Krishna river (see above). It also concentrates more of the irrigation in the Gadwal and Alampur *taluks*, where the soils were considered to be excellently suited for rice cultivation.[28]

The third alignment was prepared by Jaffer Ali in 1947 and the fourth alignment was surveyed in 1949 (Kosnam, 1952-3:317-320). These were adaptations of the C.C. Dalal alignment. They reduced the length and the costs of that canal. These alignments were a return to a large command area for protective irrigation. In 1950 the proposal was made to construct the main canal upto Mile 127 and in addition, the South Gadwal branch upto Mile

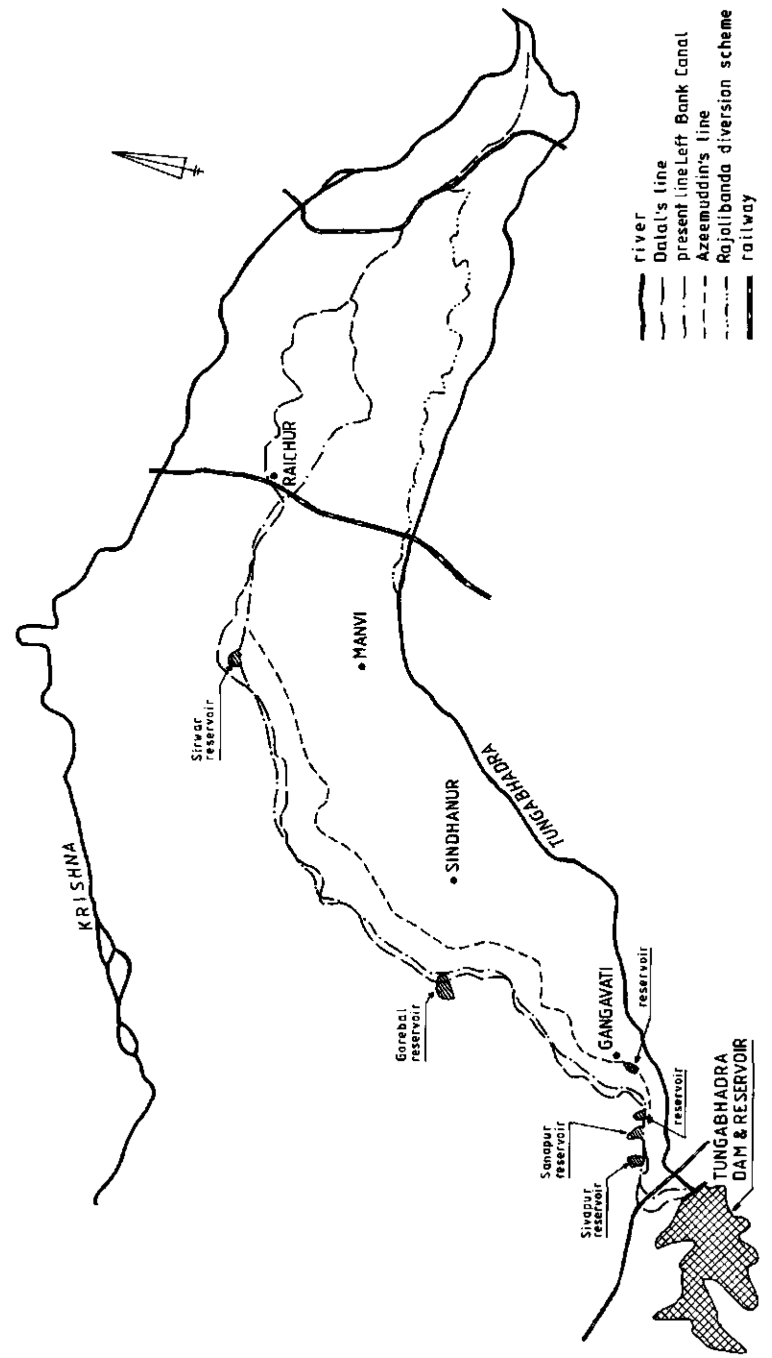
---

[26] *One factor that normally affects the alignment of a main canal strongly is the bed level at the* offtake point at the dam. This determines the area that the canal will be able to command. In the case of the Tungabhadra dam, there has been extended debate on the offtake levels of the different canals. This did however not affect the alignment of the left bank canal very much because in the first 20 miles of this canal there are drops exceeding the depth of the reservoir. The alignment for the major part of the 141 miles long canal is not affected by the offtake level at the dam. I therefore do not discuss the details of the debate on offtake levels.

[27] Apart from the last 20 miles this canal is a contour canal, which implies that irrigation is only possible on its right side, towards the Tungabhadra river. The last section lying on the ridge, allows irrigation on both sides.

[28] *One engineer who worked in the design of the main canal in the 1950s suggested to me that* Azeemuddin wanted to have more balancing reservoirs in the main canal, and therefore chose a lower alignment. I have been unable to find evidence for this statement.

Map 4.2: Alignments of the Tungabhadra Left Bank main canal



Source: based on map in GOAP/PWD (1960)

14, and estimates were prepared for this. This variant of the Tungabhadra Project was sanctioned in 1951 by the Hyderabad government (see GOKAR/ID, 1981:166-186; GOAP/PWD, 1960).

Discussion on the alignment of the main canal continued during the construction period. In 1956 Gadwal and Alampur *taluks* went to the new state of Andhra Pradesh. The Andhra Pradesh government argued that Mysore/Karnataka had an obligation to extend the Left Bank Canal into these *taluks* as this was part of the original project plan. The Krishna Water Disputes Tribunal finally rejected this in 1973, on the ground that Mysore/Karnataka was only held to construct the part of the canal that was sanctioned at the time of the reorganisation of the States (GOI/KWDT, 1973-I:58-60).

The design of the last section of the main canal was reconsidered during construction. In 1956, right after Raichur district came to Mysore State, there were different opinions on the length and alignment beyond Mile 103, where the contour canal reaches the ridge between the Tungabhadra and Krishna rivers. According to an engineer who worked on the design of the main canal in this period, there was fear that there wouldn't be sufficient water to supply a canal beyond Mile 127, and that it was better to wait and see. Others argued that postponement of the construction of the last section would risk that it would never be constructed, and that this might also endanger Mysore's claim to the water. For some time the Mysore government held the opinion that the canal should stop at Mile 127, and that in the ridge canal section between Mile 103 and 127 the Left Bank Canal should irrigate 50,000 acres on its left side (GOMYS, 1957-58:74-75).[29] There was however, also the view that water from the Tungabhadra basin should not be used to irrigate lands in the Krishna basin. Some therefore argued for a contour canal. This would avoid the problem of irrigating lands in the Krishna basin. But the contour canal was an 'unhappy' canal technically. It was finally decided to construct the canal as sanctioned, upto Mile 141, with the Mile 103-124 section as a ridge canal, and Mile 124-127 as a contour canal, irrigating land on its right side only.[30]

The alignment of the left bank main canal thus was subject to debate and negotiation, but the process and its meaning are difficult to reconstruct for want of detailed information.

Distributary design

On the design of the distributaries much less debate took place. These were only roughly designed in the planning phase. The main purpose was to estimate the approximate cost of their construction. Detailed design took place 'ongoing' in the construction phase.[31] Distributaries run on the ridges, except when this involves heavy cutting. They branch out into subdistributaries, that run on ridges as well.

Distributary design seems to have been fully done by the Irrigation Department with very little involvement, or even consultation of the local population. The clearest illustration of this I got from an engineer who had worked on the design of the Left Bank Canal

[29] It may be assumed that there has been public discussion and public action on this issue, but I have not found any documentation on this.

[30] This is according to an engineer I interviewed who worked in the design of this section. Official documents mention a ridge canal from Mile 103-127. According to the same engineer Hyderabad State had already started the excavation of the lower contour canal in a few places by mechanised cutting.

[31] This procedure explains why the distributaries are numbered to 106, but only 87 actually exist. Some were unnecessary or joined when designs were made.

distributaries. He informed me that the Tungabhadra Left Bank Canal was the first canal system in India where aerial photographs were used to make the topographic maps. This according to him had the advantage that no or very few field visits were necessary, and that the design could be done fully at the drawing table. Distributary design thus was quite literally a top-down process.

It is difficult to get a good impression of the design process of the distributary even as a technical exercise. The design (calculations and drawings) of each distributary were documented in a series of 'covers'. These are volumes on different elements of the design. Most of these documents are lost or untraceable in the Irrigation Department (sub)division offices where they should be kept. In Sirvar division office some engineers with a sense of history has searched for the covers still present, and restored to usable condition those they had found. They did not find many. For distributary 93, which I had selected for research, only one remained (on the design of the standing wave flume at the head of the distributary).[32] Because it has been so poorly documented in the literature, I summarise and discuss part of the technical procedure in Appendix 4.1. The design procedure contains elements relevant for actually existing water distribution practices, to which I will return in later chapters.

4.3 CONCLUSION: SOCIAL SHAPING AND DESIGN CHARACTERISTICS

This chapter has given a descriptive account of the negotiated birth of the Tungabhadra Left Bank Canal. At the same time it has presented some of its major design features, focusing on those relevant for water distribution as it takes place presently. In this section I discuss whether and in what way the planning and design of the canal system as it is now found in Raichur district has been a process of social shaping. After that I summarise the technical design characteristics of the system that have particular relevance for water distribution practices.

Social shaping

The structuring influence of social factors on the technical features of the Tungabhadra system are particularly clear in the planning phase. The decision to build an irrigation system in the Tungabhadra valley, whether there should be a canal system on one side or on two sides of the river, and how much water was to be allocated to the canals were highly contentious political issues. The long-drawn negotiations on this are an interesting case for studying the relationships between Princely States and the regions directly governed by the British in colonial India, and between different States in independent India. In-depth analysis of the process of these political negotiations I have not undertaken. It is a research project by itself.[33]

---

[32] I also tried to find the design covers for the other distributary selected for research, distributary 24, which came under a different division office, but the covers were untraceable.

[33] For the period 1898-1950, there are over 900 pages printed correspondence between the governments of Madras and Hyderabad on the sharing of the waters of Tungabhadra river and the design of the dam (GOMAD/PWD, 1947; GOMAD, 1954; GONOH/PWD, 1935, 1936, 1937, 1945). The Krishna Water Disputes Tribunal reports and appendices are a rich source as well (continued...)

When the general parameters for the technical design had been agreed upon in the 1930s and 1940s, the specific technical design of the Left Bank Canal system seems to have undergone little social shaping. Some design choices like the overall cropping pattern, the duties and the main canal alignment were debated not only among engineers, but were also subject to decision-making at policy level because they affected the way in which claims on a a share of the river waters could be made. But the detailed design, which gave the system its concrete shape, seems to have been the exclusive domain of the design engineers. They used physical design criteria, and the economic factor of cost of construction to make their design choices. There are only a few isolated examples of (local) political and other social influence on main canal and distributary design and construction.[34]

This course of events could be interpreted as counter evidence for the central notion of the social shaping perspective that design and construction processes are social processes in which different stakeholders, with different interest, strategies and resources negotiate about the simultaneous creation of new technical and social orders. It could be read to confirm the very common view, at least among engineers, that politics and all things social are and should be reserved for the pre-design phase, and that designing does and should not involve political and other social choices once the terms of reference are clear, and should be left to technical experts alone.

But a different interpretation, which makes use of the social shaping perspective, does not undermine it but perhaps even extends it, is possible also. This alternative interpretation argues that the absence of social shaping in the design and construction of the left bank canal system could occur under a specific set of social conditions only. There were two, mutually reinforcing, forces at work.

The first factor that explains the absence of social shaping activities around main canal and distributary design is the mode of operation of the Irrigation Department. The period immediately after Independence was one of great belief in planned intervention and planned development (see chapter 3). It was also a period in which irrigation and other engineers were highly respected nation builders. The living example of this was irrigation engineer and statesman M.V. Visvesvaraya. He started his career as a district engineer in Bombay Presidency in the late 19th century, became Chief Engineer in Mysore State, *Dewan* (prime minister) of the same state, and from this went on to develop a concept of India as a planned economy (Visvesvaraya, 1934, 1951).[35] The role of engineers in nation building was also

---

[33](...continued)
(GOI/KWDT, 1973). Material on some periods and episodes is less easily available. The relevant parts of Hyderabad/Andhra Pradesh State Archives for the period 1948-1956 when some important decisions were made and localisation saw the light of day, are unfortunately not (yet) accessible. The collection of additional information on the canal design and cropping pattern debates would require painstaking archival work in the records of the Madras and Hyderabad Public Works and Revenue Departments.

[34] Also see the example given in footnote 55 chapter 3 of the doubling of a distributary's length as a result of an electoral promise.

[35] Visvesvaraya's main achievements as irrigation engineer were the design and introduction of the block system of water allocation and distribution in Bombay Presidency (see Bolding, Mollinga and van Straaten, 1995) and the design and construction of the Krishnarajasagar (KRS) irrigation project in Mysore State. He played a small role in the Tungabhadra project as the mediator of the conflict between Hyderabad and Madras engineers on the type of mortar to be used in dam construction (Visvesvaraya, 1951:99). On Visvesvaraya and planned development also see Vyasulu (1997).
(continued...)

strong immediately after Independence. Nehru's description of dams as the new temples of India has become famous (Varma and Saxena, 1989) and gives engineers the aura of priesthood.

The second factor that explains absence of social shaping activities around main canal and distributaries design is the corollary of this social position and self-image of the irrigation engineer and the Irrigation Department. There was no developed system of representative politics or citizen participation in development planning. This was certainly true for the pre-Independence period, but also for the first period after Independence when the Left Bank Canal was built. The common idea was that this elite of experts was going to explain to farmers how they should use the system constructed for them. Several joint officials-farmers committees were set up to help the smooth putting into operation of the Tungabhadra system.[36)] To question the design choices of the engineers would probably have been been considered heresy. The Irrigation Department till today has no institutional provisions for the involvement of (future) water users in design and construction of irrigation systems (also see chapter 8).

The theoretical conclusion that can be drawn from this is that it is not sufficient to critique existing irrigation design practices by telling the engineers concerned that they may believe that they work within a planning cycle in which the technical design activity is isolated, and political decisions precede it, but that in reality their design activity is a social shaping process of interacting stakeholders. The problem[37)] with many irrigation design processes is that they actually are quite 'unconnected'. In some irrigation contexts it may be more to the point to analyse why and how other stakeholders than engineers are excluded from the design process, then to search for how these other stakeholders are engaged in the design process in formal and informal ways.

Design characteristics relevant for water distribution practices

To conclude this chapter I list the technical design characteristics of the Tungabhadra Left Bank Canal that have particular relevance for water distribution practices.

The first socially significant design characteristic is the fully supply-oriented nature of the canal system. Once canal water has been released from the dam very little can be done to regulate its availability in time. There is no intermediate storage which could act as a buffer for lower-level releases of water.[38)] There are no possibilities for regulation in the main canal and distributaries other than the distributary and sub-distributary offtakes. This means that canal water level control, which can be important for reliable water supply, is very difficult.[39)] The supply-orientation and the size of the system also imply that adaptation to

---

[35)](...continued)
Gopalan, the engineer who wrote the first project report for the Left Bank Canal, also published on the agricultural development of Hyderabad State (see Gopalan, 1948).

[36)] In the 1960s for example Distributary Irrigation Committees were established, in which the Block Development Officers played a role. The still existing committee at the system level is called the Irrigation Consultative Committee (ICC). It is now a platform for political negotiation (rather than consultation) on irrigation management by the technocratic elite (the engineers) and the political elite (the MLAs). Also see chapter 9.

[37)] The desirability to involve other stakeholders in the design process is discussed in chapter 8.

[38)] But for recent developments in this see chapter 9.

[39)] The 'regulators' that have been built in the Tungabhadra left bank main canal are not devices for water level control, but safety devices in case of canal breaches, to avoid that the full canal upstream of the breach empties itself through the breach.

changing water demands, resulting from rainfall in the command area for example, is very slow. Changed releases take days to travel through the system, and it is difficult to regulate them in a location-specific manner. Such flexibility is not intended in the design of protective irrigation systems. Their design is geared to low intensity management of stable supplies to which farmers adapt.

The second design characteristic relevant for water distribution practices is the predominance of 'irrigated dry' crops in the localised cropping pattern (and therefore high duties) and the low design irrigation intensity of 100%. The latter means that each piece of land is supposed to be irrigated for one season only, except for the limited part of the command area reserved for perennial and two-seasonal crops. These design characteristics imply that water is scarce by design.

The third design characteristic, which is briefly discussed in the appendix to this chapter and treated in more detail in chapter 8, is the choice to install pipe outlets as the structures connecting the (sub)distributary canals and the outlet command areas. Regulation of the discharge through this structure is very difficult, particularly when water level control in the supply canal is impossible. More important perhaps even is the systematic over-dimensioning of pipe outlet structures in the Tungabhadra Left Bank Canal, which makes over-appropriation of water technically very easy.

These design characteristics constitute some of the conditions of possibility of the geography of social differentiation that is the subject of the next chapter.

Appendix 4.1: Design procedure distributary canals Tungabhadra Left Bank Canal

To write this appendix I used the most complete set of 'design covers' preserved by the Sirvar Division engineers, that of Distributary 85 (real number). They were able to recover 13 of the original 16 covers. The set of 'design covers' is the series of bound volumes that gives all information on the design characteristics of a distributary and their calculation.

After determining the location of the distributary and subdistributaries, the capacity of the distributaries was designed from the tail up, on the basis of the localisation pattern in the pipe outlet command areas. On the basis of the localisation pattern a demand table for a pipe outlet command area was drawn up as in table 4.1.1.

Table 4.1.1: Pipe outlet demand table for distributary design (PO at chain 72 Right Side of Distributary 85) (duty in acres/cusec; Q=discharge in cusecs)

	Rice		*Kharif* light 102.65 acres		*Rabi* light 49.73 acres		Cotton 23.00 acres		Garden crops		
	duty	Q	duty	Q	duty	Q	duty	Q	duty	Q	Total Q
May			220	0.47							0.47
June			220	0.47							0.47
July			220	0.47							0.47
August			220	0.47			175	0.13			0.60
September					175	0.28	175	0.13			0.41
October					175	0.28	175	0.13			0.41
November					175	0.28	175	0.13			0.41
December					175	0.28	175	0.13			0.41
January					175	0.28	175	0.13			0.41
February											
March											
April											

To the peak discharge of 0.60 cusecs, 25% was added for 'fluctuation' (engineers in interviews talked about 'rush irrigation'). The more likely interpretation is however that this 25% is the difference between field level and distributary level duties, but this is not what is written in the document. If this would not be so, the distributaries would have been designed on the basis of field level duties.

More confusing is a later, undated, correction of this calculation. The corrected calculation crosses out the demand table, takes the whole area localised together and calculates discharge on the basis of the *rabi* duty of 175, and adds 25%, giving 1.25 cusecs. For other pipe outlet commands where rice is grown, the discharge for rice is added to that of the 'irrigated dry' crops. The status and meaning of the correction cannot be derived from the document. With the corrected figures, the total distributary discharge would far exceed the design discharge as now found in Irrigation Department statements. Perhaps the correction is an anticipation of actual cultivation practices, and the canal capacity needed to irrigate the thus cropped distributary command area simultaneously or in rotation.

A further surprise is that that a standard pipe size is adopted for the pipe outlet structures that connect the distributaries with the local irrigation units (the pipe outlet command areas or tertiary units) The standard pipes have a 12 inches (1 foot) diameter with 1½x1½ feet steel gates in front of them). At the same time different discharges are calculated for the different pipe outlet command areas. In some of the forms for calculation of the construction costs of the pipe outlet structures, the pipe size is pre-printed, which shows that there was indeed a standard procedure (as was also stated by several engineers interviewed on the matter). This standardisation undermines the idea of water distribution in accordance with the localisation pattern, unless regulation of discharge with the gate was envisaged. However, there is no indication that this was so, and indications to the contrary do exist (see chapter 8 for further discussion). A standard 12 inch pipe implies general over-dimensioning of the pipe outlet structure orifices.

The design of the distributaries remains somewhat of a mystery. The procedure for one distributary is insufficient ground for general conclusions. To find more evidence a lot of dust would have to be moved in the Irrigation Department offices. One can only hope that some of the original design material will be preserved.

5

WATER, SPACE AND SOCIAL DIFFERENTIATION

Agrarian change in the Tungabhadra Left Bank Canal command area

"I have seen agrarian capitalism in full swing", is what I wrote home after one of my first field visits to the Tungabhadra Left Bank Canal command area. What I had observed and heard about was intensive and highly productive rice, sugarcane and cotton farming, more than one hundred ricemills, a sugarcane factory, one of the largest cotton markets in India, scores of tractors, gangs of migrant labourers, and satellite TV dishes on the roofs of farm houses. This picture of bustle and boom is obviously only part of the story of agrarian change following the introduction of canal irrigation in Raichur district. However, notwithstanding the problems and inequalities that are part of this pattern of agrarian development, one cannot but be impressed by the impact of irrigation on the economic dynamism of the region.

In this chapter I discuss the process of agrarian change that occurred in the command area of the Tungabhadra Left Bank Canal. The central theme is social differentiation in the context of a booming canal irrigation-based economy.

The concept of social differentiation includes the following two meanings. The first meaning is that of categorisation or classification, the identification of types, of in this case farming households-enterprises. The second meaning is that of the process of the emergence and development of social difference, that is, of the categories or types identified.

In the sense of categorisation, social differentiation in the Tungabhadra Left Bank Canal command area contains few surprises. The classification of farming households-enterprises in rich, middle, small and poor peasants that is common to the debate on agrarian change in India, fits the Tungabhadra Left Bank Canal situation well. The specific features of the Tungabhadra Left Bank Canal case are the role of migrant farmers in the process of social differentiation and its spatial characteristics.[1] Social differentiation took place on the grid

---

[1] I do not take position in the debate between different schools of thought on agrarian change (such as articulated in the 'mode of production' debate and the debate on the green revolution for example; see Patnaik, 1990; Byres, 1981). That is, I don't use the research material to interpret the overall nature of the agrarian change process as a particular variety of agrarian capitalism, from the perspective of the agrarian question, or any other angle. There are several reasons for this. Firstly, the group of households-enterprises in the three selected pipe outlet command areas is not representative for the agrarian economy of the region (landless labourers and rainfed farmers are excluded for example, and the selection was on the basis of hydraulic units chosen with other objectives). Secondly, I focussed on the characteristics of the households-enterprises in the study
(continued...)

of a canal system that was planted in a socio-agricultural landscape based on rainfed farming, and into which migrated large numbers of resourceful farmers to realise the potential benefits of irrigation. What has emerged in the Tungabhadra Left Bank Canal command area is a class-related spatial pattern of land distribution and access to water. Underlying the geography of social differentiation are the imperatives of location in water distribution, the settlement of migrant farmers in locations with favourable access to water, and mechanisms that allowed the concentration of the land of rich farmers, both migrants and locals, in head end reaches. I argue that the relation of location, space, access to water and socio-economic status are not just correlations, or the unintended outcome of the sum of all individuals' behaviour, but connections that are strategically pursued by farmers. The spatial relations constituted by the canal infrastructure need to be understood as a defining part of the agrarian structure, and their evolution a central element of the analysis of agrarian change in canal irrigated areas.

The structure of the chapter is as follows. Section 5.1 gives some of the quantitative dimensions of the economic boom that was induced by the introduction of canal irrigation in Raichur district. Intensification and commoditisation were the main features of the agricultural development process that occurred in the Tungabhadra Left Bank Canal command area.

Section 5.2 discusses the pivotal role that migrant farmers played in this process. The settlers came from the agriculturally intensified and commoditised coastal areas of Andhra Pradesh. They brought the capital and the new agricultural practices that were the basis of the irrigation boom. The section describes why they migrated, why local farmers were willing to sell their land, and attempts to indicate the magnitude of the land transfers.

In section 5.3 the main topic of the chapter is discussed: the spatial dimensions of social differentiation in the Tungabhadra Left Bank Canal command area. For this purpose a typology of farming households-enterprises is first developed. The characteristics of rich, middle, small and poor peasants are discussed. At the pipe outlet command area level a correlation is found between category of farming household-enterprise and location in the pipe outlet command area. At the distributary level the relation between settlement and the emergence of head-end and tail-end areas is investigated. It is shown that there is an overall correlation between geographical location, access to water and intensity of farming, but that there is also considerable diversity among distributaries.

In section 5.4 I summarise the main points of the chapter.

5.1 THE IRRIGATION BOOM IN FACTS AND FIGURES

In the early 1950s less than 1% of the cultivated area in Raichur district was irrigated. In 1991-92 this was 30%. The Tungabhadra Left Bank Canal made the largest contribution to

---

[1](...continued)
year, 1991-92. My data on their evolution is not complete. Given also the fact that there is no abundance of usable secondary socio-economic data on agrarian change in Raichur district, a sketch of the main features of the agrarian structure in the Tungabhadra Left Bank Canal command area is possible with the available data, but not a detailed evaluation of its historical evolution. My concern with regard to agrarian change was a different one: what are the features of the agrarian structure and the process of agrarian change that are specifically relevant for the analysis of water distribution practices? This is the question that I address in this chapter.

the irrigated area. It accounted for 77% of it, and the system thus irrigated 23% of the cultivated area in the district.[2]

The economic changes associated with this increase of irrigated area can be appreciated by looking at the differences between the rainfed farming system and the irrigated farming system. Kallur has documented this difference in his impact study of irrigation in Raichur district (Kallur, 1988). He selected 10 villages with irrigation (in the Tungabhadra Left Bank Canal command area) and 10 villages without irrigation, and in each village equal numbers of marginal, small, medium and large farmers (in total 240 households).[3]

The general conclusion that can be drawn from Kallur's study is that irrigated farming is more productive, more commoditised and more profitable than rainfed farming. Kallur found that all farmers used high-yielding or hybrid varieties for all crops under irrigated conditions. Under rainfed conditions mostly local varieties were used except for groundnut and sunflower (*ibid.*:163-164).[4] Kallur also found that irrigation lead to a shift in the cropping pattern to high input, high-output and high-value crops. Rice, sugarcane and hybrid cotton occupied 31, 12.5 and 15.1% of the irrigated cultivated area in Kallur's sample while the traditional food crops (sorghum and millet) occupied only 10.5%. In contrast, under rainfed conditions sorghum and millet occupied 58.1% of the cropped area. Similarly, 0.3% of pulses were grown under irrigated conditions, while these occupied 5.8% under rainfed conditions (*ibid.*:131-137). Notwithstanding the relative decline of the area under food crops under irrigation with roughly 50%, more food is produced under irrigated conditions. This is because the yield of rice and irrigated sorghum is several times that of rainfed coarse grains.[5]

---

[2] Data on area irrigated can be derived from different sources. I used GOI/PC/PEO (1965), GOKAR/ID (1981), statistics available at the Principal Agricultural Officer's office in Raichur, and the GOKAR/DES *Annual Season and Crop Reports*. There are many inconsistencies and unclarities in these data. Figures on crops grown and area irrigated given in this chapter should thus be treated with some care. For general discussion of the reliability of socio-economic statistics see Hill (1984).

[3] Kallur collected the data for his impact study in 1982-83. He selected villages (and households) with irrigation in the 'heavy irrigation' zone of the command area (in Koppal, Gangavati, Sindhanur and Manvi *taluks*). By leaving out Deodurg and Raichur *taluk* and the less well provided parts of the other *taluks* he leaves out the parts of the command area where many farmers have less than optimal access to water. In other words, Kallur abstracts from the unequal distribution of water and focusses on the areas that do receive sufficient water for the cultivation of 'wet' crops (Kallur, 1988:17-19). The comparison of extreme cases is useful for the purpose of illustration in this section, but does not give a representative view of irrigated agriculture in the command area. Other economic impact data on the Tungabhadra Left Bank Canal can be found in Venkata Reddy (1979), Bisalaiah and Taylor (1973) and Meti (1972). The latter I have been unable to consult. For the right bank there are also several studies (Devarajulu Naidu, 1987; Sen and Das, 1986). To my knowledge no specifically executed 'bench-mark survey' exists of the agro-economic situation in the left bank command area just before the start of the project. Iyengar (1951) could be used as such. For the right bank there is such a study (GOAP, 1959). For farm economics data of householdsin distributary 36 of the Left Bank Canal, see Noij (1992).

[4] It is not clear what Kallur exactly means by local varieties. Government support for the improvement of varieties used in rainfed agriculture started before Independence (GONOH/DOA, 1944). There is also the - unknown - factor of selection by farmers themselves. The point is that under irrigated conditions varieties with a higher yield potential can be used.

[5] For example, in the agricultural years 1979-80 to 1981-82 the average sorghum yield in Raichur district was 667 kg/ha (mostly rainfed cultivation), while that of rice (all irrigated) was 2444 kg/ha (GOKAR/DES, *ASCR* 1979-80 to 1981-82). The average yield of (irrigated hybrid) sorghum in the

(continued...)

The importance of external inputs in the irrigated farming system and the high degree of commoditisation of irrigated farming can be seen in table 5.1.

Table 5.1: Commoditisation of irrigated farming compared to rainfed farming in 1982-83, Raichur district

	Irrigated farming	*Rainfed farming*
Value of seed per acre	Rs.156	Rs.47
Percentage seed purchased	90%	15%
Fertiliser expenditure per acre	Rs.643	Rs.11
Pesticides expenditure per acre	Rs.333	Rs.0
Value human labour per acre	Rs.180	Rs.97
Percentage labour hired	53%	26%
Machinery expenditure per acre	Rs.122	Rs.0
Transport costs per acre	Rs.188	Rs.11
Percentage transport hired	57%	1%
Total variable cost per acre	Rs.2003	Rs.312
Total variable and fixed costs	Rs.2983	Rs.490

Source: Kallur (1988:179-187, 194) (for all crops and sample households)

Among the external inputs used in irrigated farming chemical fertiliser is a very important one, covering almost one-third of the variable costs. The difference in fertiliser use between irrigated and rainfed farming can also be illustrated by means of *taluk* level fertiliser consumption data. The four *taluks* of Raichur district with very little irrigation (Devadurga, Lingsugur, Yelburga, Kusthagi) had an average use of 12.1 kg/ha in the 1980-81 to 1987-88 period. The average use in the three main *taluks* of the Tungabhadra Left Bank Canal (Gangavati, Sindhanur, Manvi) was 90.1 kg/ha in this period. In Gangavati *taluk*, which is the most intensively irrigated, it was 119.0 kg/ha (data from the Principal Agricultural Officer's office Raichur; Taluka Plan Statistics file).

Under irrigation the use of some 'traditional' resources was also higher, despite their smaller proportional relevance. In rainfed farming the average use of farm yard manure was 7.12 quintals per acre. In irrigated agriculture it was 10.46 quintals (Kallur, 1988:173). This is because irrigated agriculture can sustain more cattle through higher fodder production. The use of bullock power was higher in irrigated than in dryland farming for farmers with holdings smaller than 5 acres (8.2 *versus* 6.6 days/acre). For bigger farmers the reverse was the case (4.0 *versus* 7.0 days/acre) (*ibid.*:171, 178). Larger farmers met the increased land preparation intensity under irrigation by using tractors.

Irrigated farming was more labour intensive than rainfed farming, and relied more on hired labour. In irrigated farming total labour input per acre ranged between 78 mandays for marginal farmers and 47 mandays for large farmers. In rainfed farming these figures were 50 and 37 mandays. The proportion of family labour in this was 63% to 35% for irrigated farming and 100% to 68% for rainfed farming. Rainfed farming is mainly based on family labour; irrigated farming has about 50% of hired labour (*ibid.*:176).

---

[5](...continued)
summer seasons of 1980-81 and 1981-82 was 2418 kg/ha. The average yield in the *kharif* seasons (mostly rainfed sorghum) was 761 kg/ha (GOKAR/DES, *ASCR* 1980-81 and 1981-82).

Irrigated agriculture was also more profitable than rainfed farming. Kallur calculated the average income per acre for different crops and for different size classes of farms. He found that the income per acre per crop in irrigated farming was between 5 and 16 times as high as that in rainfed farming (calculated from *ibid.*:table 7.4).[6] As an indicator of the profitability of farming Kallur calculated the benefit/cost ratio (taking total costs). Table 5.2 shows that irrigated farms are generally more profitable than rainfed farms. With all inputs priced most rainfed farms worked at a loss, while most irrigated farms worked at a profit.

Table 5.2: Distribution of the benefit-cost ratio over total costs in irrigated and rainfed farming, Raichur district, 1982-83

Size class of farms (acres)	*Rainfed farming*		*Irrigated farming*	
	Benefit-cost ratio = 0-1 (% of farms)	Benefit-cost ratio = 1-2 (% of farms)	Benefit-cost ratio = 0-1 (% of farms)	Benefit-cost ratio = 1-2 (% of farms)
0-2.5	71.8	23.1	7.7	63.5
2.6-5	72.7	23.6	0.0	81.4
5-10	54.1	27.9	3.5	71.9
10-	50.3	30.3	3.7	66.6

Source: Kallur (1988:218, 220)

The Raichur district economy is often described as rice-based, but this image is not fully correct. The image of a rice-dominated economy is related to the strong growth of the rice sector in the district since the Tungabhadra Left Bank Canal came into operation, and the economic and political power of rice growers, rice processors and rice traders. Since the early 1990s Raichur is the district of Karnataka's 19 districts with the largest percentage of its area cultivated with rice. The area planted with rice amounted to one-sixth of the State total (GOKAR/DES, 1995). By the end of 1989 there were 113 rice mills in Raichur district, while in the 1960s there were less than 20, and probably smaller ones.[7] However, in 1981-82 Raichur district contributed 25% to the State's cotton production and 15% to the State's oilseeds production, while the comparable figure for rice in that year was only 8%.[8] It

[6] A major difference between rainfed farming and irrigated farming is that in irrigated farming double cropping is possible. Therefore the income per acre per crop in irrigated farming is not only higher, but the income gap for equally sized farms is further increased by the cultivation of two crops on the same land under irrigated conditions.

[7] Data from District Industries Centre, Raichur and the *Mysore State Gazetteer* 1970.

[8] Rice production in Raichur district increased from 7416 tons in 1956-57 (0.7% of the State total) to 189439 tons in 1981-82 (8% of the State total). The cotton and oilseeds sectors exhibited substantial production growth in the same period that rice cultivation expanded, but their share in the total State production remained stable. Cotton production increased from 19,632 tons in 1956-57 to 31,052 tons in 1981-82 (24.4 and 25.4 % of the State total). Oilseeds production (excluding coconut) increased from 86,164 tons to 123,496 tons (13.1 and 14.8% of the state total). In the same period coarse grains production increased from 6.3 to 7.5% of the State production (119,961 and 324,760 tons) and pulses form 4.6 to 7.9% of State production (5461 and 47,649 tons). 1956-57 and 1981-82 were chosen as reference years because they were the earliest and the (continued...)

would therefore be more correct to say that Raichur district is an important producer of agricultural raw materials for the Karnataka economy.[9]

The material presented above suggests a positive picture of irrigation, but this is a partial picture. Irrigation is associated with productive and profitable high external input farming. This has been the basis of economic growth and the development of input, output and labour markets in the Tungabhadra Left Bank Canal region. However, a full economic analysis of the changes in the farming system and regional economy as a result of irrigation would also have to value the environmental costs of irrigation.[10] Some environmental problems that threaten the sustainability of irrigated agriculture are the much quicker than expected siltation of the Tungabhadra reservoir and the extent of waterlogged and salinised/alkalinised soils. On both recent and reliable figures are lacking.[11] Other environmental impacts on which data are not available are the effects of irrigation and high external input farming on soil fertility[12], the occurrence of diseases like malaria[13], the drinking water situation and the health impact of pesticide use.[14] A sensible discussion of all these effects requires further research.

5.2 SETTLEMENT

The settlement of migrant farmers in the command area is an important feature of the process of agrarian change in the Tungabhadra Left Bank Canal. The investment capital and agricultural and entrepreneurial skills that this group brought with them were the basis of an expansive and intensive rice and sugarcane-based farming system that triggered the process

---

[8](...continued)
latest year for which I had an officially published set of data (GOKAR/DES, *Annual Season and Crop Reports*).

[9] Raichur district has a low level of industrialisation, with an emphasis on agro-processing. Of the (only) 20 large and medium industries in operation in 1989-90, 15 were directly related to agricultural production. The five exceptions were the Hutti Gold Mines, the Raichur Thermal Power Station, and three chemical industries. (Data from the District Statistical Office, Raichur).

[10] It can also be noted that in terms of social development the situation in Raichur district as a whole is far from positive. Vyasulu and Vani (1997) calculated the Human Development Index for all districts in Karnataka (with 1981 Census data), in which literacy rate, infant mortality rate, life expectancy and income were included. They calculated the index in 12 different ways, and in 10 of these Raichur district scored the lowest of all 19 districts. In the other two calculations it was the one but lowest district.

[11] For some discussion of waterlogging and salinisation in the Tungabhadra Left Bank Canal, see Jurriëns and Landstra (1990-I:20-22). See CADA (1997) for waterlogging and salinisation figures.

[12] The NGO AME has found a worrying decline in soil fertility under intensive rice irrigation (see also footnote 19 in chapter 10).

[13] Malaria was much discussed in the planning phase of the project, and the localisation rules specified that no irrigation should take place close to villages. The spacing rule is disregarded by the local population, for example in the construction of private lift irrigation schemes.

[14] In both research locations a young male labourer died during our fieldwork period through over-exposure to pesticides while spraying. Labourers hardly wear protective clothing while doing this work. On one hand the drinking water situation in the region has enormously improved through the construction of the canal system, but on the other hand there is acute shortage in canal closure periods and there are severe problems with the quality of canal water for drinking purposes (TIPP-II, 1996).

of agricultural growth. I discuss the motivation for the settlers to migrate and the reasons of local farmers to sell land to them. I conclude with a brief sketch of the magnitude of land transfers.

Reasons for migration

The settler farmers in the Left Bank Canal mainly came from the coastal districts of Andhra Pradesh (see Anjaneya Swamy, 1988:65; Nagaraju, 1989:31 for district-wise information). This region witnessed expansion and intensification of irrigated agriculture since the mid-19th century, as a result of the enlargement and rehabilitation of canal irrigation, tenurial reforms in Madras Presidency and other factors (for historical accounts see Rao, 1985; Satyanarayana, 1990; Upadhya, 1988; Wallach, 1985). Intensive commercial rice cultivation was the dominant agricultural activity and the base of an expanding rural economy.

The farmers who migrated were mostly small and medium sized farmers in their home areas. In Anjaneya Swamy's sample 80% of the Tungabhadra migrants held between 0 and 5 acres (0-2 ha) (N=150). Only 3% held more than 10 acres (4 ha) (Anjaneya Swamy, 1988:86, table 3.9).[15]

Most migrants were in their twenties and thirties. 37% of the migrants were between 20 and 30 years of age at the time of migration and 43% between 30 and 40 (*ibid.*:82, table 3.7). 71% of the farmers were members of joint households before migration, while 88% were independent households after migration (*ibid.*:85). This fact plus the age of the migrants suggests that migration took place as a solution for the further division of holdings through division of property when a joint family was split. Many of the farmers in my own sample came to the Left Bank Canal as young families with no or few, young children.

The pressure on land in coastal Andhra Pradesh was high. This resulted in low land availability for expansion of farms and in high land prices. Selling prices in coastal Andhra Pradesh and purchase prices in Raichur district are given in table 5.3.

It follows from the table that for migrant farmers there was at least a factor 7-8, and often more than 10 difference between land purchase and land sale prices.[16] Assuming that the cost of land preparation doubled the purchase price, migrant farmers could increase their landholding by a factor 3.5-4 at least, not counting other sources of money for investment than land sales.[17] The combination of small holdings and a high land price difference was the major reason for farmers to migrate (Anjaneya Swamy, 1988:chapter 4; Nagaraju, 1989:32, table 3.2). The push to migrate was further strengthened by 'no scope to enter non-

---

[15] In Nagaraju's sample (N=41) the predominance of small farmers was even stronger. 80% held less than 3 acres (1.2 ha), and no farmer held more than 7 acres (2.8 ha). Nagaraju further notes that the landless migrants "were essentially labourers sponsored by the few rich farmer-migrants who wished to have some skilled labourers in wet cultivation" (Nagaraju, 1989:34-35).

[16] Iyengar (1951:178) in a seven village survey conducted in 1950 found land prices for dry land in Raichur district ranging between Rs.197 and Rs.607 (average prices for highest and lowest grade). These are higher prices than Nagaraju found for later years. Nagaraju's prices may be on the low side when taken as representative for land sales in the command more generally. There may have been local differences, and the registered sale price may have been lower than the actual sale price to reduce administrative transaction costs.

[17] Anjaneya Swamy (1988:117, table 4.6) found much smaller differences. He found that the factor between average land value in place of origin and the place of destination was 4, 1.4, 1.2 and 0.95 in 1955, 1965, 1974 and 1984 respectively. My own data support the order of magnitude found by Nagaraju rather than Anjaneya Swamy's findings.

agricultural professions', which was mentioned by 54% of Nagaraju's respondents as the third most important factor for migration after small landholding and high land prices.

Table 5.3: Land prices at which migrants sold and bought land in different years

Period	*Price of land sold at place of origin (Rs./acre) (a)*	*Average prices, number of transactions and average acreage of land transactions in a head end distributary village (b)*				*Year*
		Price (Rs./acre)	No.	Total (acres)	Average (acres)	
1955-60	2500-7000	113	4	81	20	1957-58
		203	7	119	17	1958-59
		299	18	231	13	1959-60
1960-65	7000-15000	375	16	196	12	1960-61
		392	38	425	11	1961-62
		609	26	293	11	1962-63
		916	29	284	10	1963-64
1965-70	15000-25000	1503	63	221	3.5	1966-67
1970-		7621	39	92	2.4	1975-76
		10222	17	25	1.4	1980-81
		27503	14	16	1.1	1985-86

Sources: (a) Nagaraju (1989:33, footnote 1). Prices as quoted by migrant farmers who were interviewed in the village survey.
(b) Nagaraju (1989:47, table 4.1). Data from Sub-Registrar's Office of Land Transactions, Gangavati. Figures are rounded.

It is not difficult to understand that these small and medium sized farmers with experience in irrigated farming decided to settle in new irrigation schemes to expand their holdings.[18] More difficult to grasp is the easiness with which Andhra Pradesh migrant farmers were able to acquire vast areas of agricultural land in the head reaches of the Tungabhadra canal system.

Reasons for land sales

In informal discussions on land sales by the local population to migrant farmers, the phenomenon is often 'explained' by the ignorance, inexperience, laziness and lack of education of the local population. This representation of inferiority can be heard from local as well as migrant farmers, and is also not uncommon among government officials and, it must be said, academics. It does express the strength of the impact of settlement, but it is not an adequate account of the settlement/sales process.

---

[18] The Tungabhadra Left Bank Canal was not the first irrigation system to which farmers of coastal Andhra Pradesh migrated (see Anjaneya Swamy, 1988). The Kamma caste group, who formed the majority of the migrants, further was a relatively well organised, well educated and economically and politically astute community (see Upadhya, 1988).

The explanation of land sales by local farmers offered below consists of two elements. The first reason for land sales was the force of money in conditions of poverty. Many farmers found it difficult to ignore the purchasing power of the migrant farmers. The second reason for land sales was the strategy of particularly larger local farmers to sell part of their land to generate resources to invest in the development of the remaining land for irrigation.

The force of money

The financial solvency of the migrants that came to Raichur district in search for land was enormous compared to that of the local population. Nagaraju calculated that the migrants in his survey carried on average Rs.24,140 when they came to settle. 46% carried Rs.25,000 or more, 12% more than Rs.100,000 (Nagaraju, 1989:35). The migrants mostly came in the 1950s and 1960s.[19] The very different financial situation of the local population can be derived from Iyengar's detailed survey of the socio-economic conditions in Raichur district around 1950, a few years before the Tungabhadra Left Bank Canal was opened for irrigation (Iyengar, 1951). Iyengar found that only 29% of the 1881 families he interviewed had savings, and that the average savings of these families amounted to Rs.299 (Iyengar, 1951:450-451, table 185; figures for 1947-48). Because of these poverty conditions, it must have been very difficult for the smaller local farmers to resist the temptation to generate ready cash by the sale of land, particularly because the migrant farmers were willing to pay prices higher than current land prices. With the money these farmers could address immediate needs like paying off or relieving debts, and supporting household and other non-agricultural expenditures. Larger farmers could sell the parts of their landholding that they considered of little value, and generate considerable amounts of money. This could be used for their immediate needs, or invested in agriculture (see below).

How this temptation was transformed into actual sales is not very well known. It is not unlikely for example that land sales by indebted farmers were partly enforced by the local village elite moneylenders, but sufficient evidence for this conclusion is lacking. On the other hand small farmers may also have used land sales to clear debts and reduce the control of moneylenders on their livelihoods. What is clear from different sources (Nagaraju, 1989; Verhoeven, 1992; own field data) is that migrant farmers systematically gave loans to local farmers, big and small, in order to be able to acquire their land at some point in the future.

The poor documentation of the land transfer process leaves space for the perpetuation of superficial explanations as referred to above.[20]

Investment capacity

The very limited means of local farmers also implied that they had very little capacity to invest in the development of their land for irrigation. Investments to make land suitable for irrigation ran into several hundreds of Rupees per hectare, and a pair of oxen for ploughing

[19] Nagaraju does not give a breakdown by year or period.

[20] Some aspects of the process of land transfers were documented. For the right bank side of the Tungabhadra system the occurrence of land speculation before the canal system was opened, by local landlords as well as outsiders, is discussed in Sivaswamy (1947). Whether the same occurred on the Left Bank side is unknown to me. My interviews give evidence of some early settlers buying large tracts of land in order to resell to other, later migrants.

cost around Rs.2000 (Verhoeven 1992:73)[21] in the early years of the Tungabhadra system. With the level of savings indicated above, the lack of investment capacity of local farmers can easily be fathomed.[22]

The problem was recognised at policy level, but not solved. Well into the 1960s the policy debate on the Tungabhadra Left Bank Canal area focused on the slow rate of development of land for irrigation (see for example Anagol, 1969; GOMYS/DOA, 1968; Nair, 1961). Particularly land development for the irrigation of 'irrigated dry' crops ran behind schedule. The most important reason mentioned in documents from that period was the high cost to make land suitable for irrigation (levelling, construction of field bunds, adaptation/construction of field channels) combined with the lack of resources of local farmers to undertake these activities. Despite the recognition of the problem, institutional credit for land development was available to a very limited extent in the early phase of the Left Bank Canal project. To make things worse, the Census of India (1961b) notes that the problem with institutional credit was that it tended to benefit larger producers only.

There also hardly was a local credit market in Raichur district for agricultural loans. Raichur district farmers were not used to take loans for agricultural purposes because rainfed agriculture was very capital extensive. In 1948 only 22% of farmers had debts, while, by comparison, this was around three-quarters of the farmers in Madras Presidency (in 1945). Of the loans of this 22% of farmers 95% had a different collateral than land. 52% of these loans were smaller than Rs.300, and none was bigger than Rs.1000. The loans were mainly used for household expenditures and marriages (Iyengar's data discussed in Verhoeven, 1992:67-70).[23]

As a result, one of the few avenues open to generate investment resources was the sale of land. Particularly larger farmers used land sales to generate money for agricultural investments. This often was the purchase of cattle or oxen for ploughing because manure and draught power were a greater constraint in rainfed production than land availability. Farmers who had sufficient land, might sell part of it to gather enough money to develop the remainder of their land for irrigation and generate more income on a smaller holding (see above). A similar strategy followed by local farmers was to lease out part of their land to migrants for periods of 5-7 years for very low lease sums, but under the condition that the migrant farmer would bear the cost of land development, and return it to the owner fully leveled and bunded. In the Bhatta pipe outlet command area in distributary 93 this practice

---

[21] It seems to me that this figure of Rs.2000 is on the high side, but I have been unable to trace other sources with prices of draught animals in that period. There was great scarcity of draught animals in the early period of the Tungabhadra Left Bank Canal, which may have driven up the prices. The scarcity negatively affected the pace of land development for irrigation.

[22] An indirect indicator for the lack of investment capacity is the percentage of farmers who had a holding larger than what was considered a viable family holding in the land reform process in Hyderabad State in the early 1950s. The criterion for an 'economic' or 'family holding' was a net yearly income of Rs.800. A rainfed farm in the black cotton soil area of Raichur district would have to measure between 8.5 and 14.5 hectares to attain viability. Verhoeven calculated that 65% of the holdings in Raichur district were smaller than this and therefore were unlikely to be able to generate sufficient surplus to pay for the investments needed to start irrigated agriculture (Verhoeven, 1992:42, 60-61).

[23] However, the data on indebtedness are contradictory. The village census of Sirvar in Manvi *taluk* shows that 64% of the households were in debt, which an average debt per indebted household of Rs.482, mostly used for household expenditures and marriages (Census of India, 1961b:43).

was in use in 1991-92. Two local farmers had leased out their land to migrant farmers on these conditions.

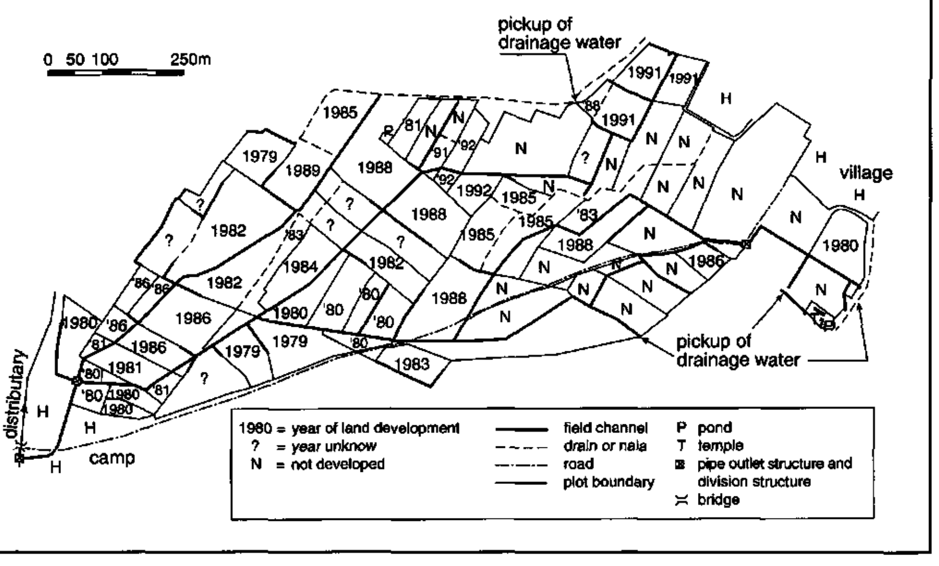
An indication of the magnitude of land transfers

To my knowledge no statistics exist on the number of settler farmers who migrated into the Tungabhadra Left Bank Canal command area and the extent of their landholdings. Evidence on the importance of settler farmers in irrigation is thus necessarily impressionistic.

For distributary 24 Nagaraju's study of land transfers in a middle-reach village can serve as an example (Nagaraju, 1989). In this village most land sales took place in the first 10 years after the canal was opened for irrigation. After 20 years the land market had become rather quiet again (see table 5.3). In the period 1957-58 to 1966-67 the net accrual of land to migrants was around 1430 acres.[24] The total area of the village was 4373 acres, including all cultivated and non-cultivated land (Census of India 1961a:280). This means that in a period of ten years approximately one-third of the village land was sold to settler farmers.

Another indication of the magnitude of the transfers is offered by the situation in the subdistributary that was studied in distributary 24 in 1991-92. On the left side of this subdistributary not a single local farmer owned land in the upstream half. On the right side of the subdistributary the situation seemed to be similar, though my data is less extensive. Most local farmers were concentrated in the downstream four, out of a total of 18 pipe outlet command areas (plus the tail end watercourse) taking water from the subdistributary.

Map 5.1: Land development in Bhatta outlet, D93



[24] Based on figures given in Nagaraju (1989:48) assuming that 1964-65 and 1965-66 had the average accrual of 1963-64 and 1966-67.

In Bhatta outlet in distributary 93, 41% of the 164 acres acres command area was owned by settler farmers in 1991-92, and another 4% leased by settler farmers from local farmers.[25] This land was concentrated in the head reach of the outlet command area. This shift in landholding took place between 1978 and 1992, and was ongoing. On map 5.1 (see previous page) the dates of the leveling of particular plots are indicated as far as we could recover these.[26] It can be seen that land development evolved from head to tail, starting with the activities of the settler farmers. Following the typical pattern, the migrant farmers settled along the distributary canal, acquired land in the head end of the outlet command area, and gradually moved downstream. Local farmers followed suit in developing their land for rice cultivation.

This scattered and limited evidence suggests that in relatively short periods after the start of settlement substantive, and sometimes massive, redistribution of land took place from local to migrant farmers.

5.3 THE GEOGRAPHY OF SOCIAL DIFFERENTIATION

The reader might perhaps expect, after the discussion above, that there is a systematic and regular pattern of migrant farmers with large landholdings occupying the geographical head ends (and using most water), and local farmers with small landholdings occupying the geographical tails (and having poor access to water). However, the geography of water distribution and social differentiation is more complex than this. In this section I argue that there is a general correlation of class, access to water and size and location of landholding. However I also argue that there is considerable diversity within this general pattern, which derives from different histories of settlement and irrigation development in different localities.

Before I can make this analysis I present a typology of households-enterprises. This socio-economic classification allows me to unpack the generalised notions of 'farmers' and 'water users' used so far. It also serves to transcend the dichotomous classification of migrant farmers *versus* local farmers, within which the former are the rich and successful farmers with large holdings, and the latter the poor ones with small holdings. I present a categorisation of rich, middle, small and poor peasant households-enterprises which allows a more refined analysis of the spatial pattern of water distribution in relation to the characteristics of the agrarian structure.[27]

After the presentation of the typology the discussion of the class-related distribution of land and access to water moves at two levels: the pipe outlet command area and the distributary level.[28] At the level of the pipe outlet command area a strong correlation between location, access to water and socio-economic position is found. This is graphically presented by drawing the categories of households-enterprises on the outlet command area maps. I discuss how this correlation has emerged as a result of settlement and other land-transfer mechanisms.

---

[25] See footnote 17 in chapter 6 on the size of this pipe outlet command area.

[26] The year of leveling was mostly also the year of purchase.

[27] For discussion of the possible role of caste, ethnicity and religion in social differentiation see footnote 46 in chapter 6, where the social relations of water distribution are discussed in detail.

[28] A similar analysis is in principle possible at main canal level, but the number of distributaries that were studied is too small to allow firm statements (but see chapter 9 for some information).

At the distributary level I discuss the relation between settlement and head-tail divisions for distributaries 24, 93 and 97. The discussion shows the importance of looking at the way the head-tail pattern evolved over time, and identifies some other factors than proximity to the water source that influence the spatial pattern of water use.

A typology of farming households-enterprises

In this part of the section I present a typology of farming households-enterprises. It provides the basis for relating water distribution to social differentiation.

The typology of farming households-enterprises presented below is based on the following data. For the 1991 *kharif* season we collected detailed information on the agricultural practices of the cultivators of the plots in the three selected pipe outlet command areas, as well as farm economics data. In a household survey of the same group at the end of the agricultural year we collected summary data on the second cropping season, *rabi* 1992, and on plots cultivated outside the selected pipe outlets, for both seasons. Through the household survey also general data on household composition, other economic activities, household assets and some other relevant items were collected. This data was complemented and partly checked with the daily observations and discussions registered in the research assistants' and my own field notes.

The typology takes the household as the classification unit. Household is defined as a group that eats from the same pot. For the purpose of analysing water distribution practices

Box 5.1: Households-enterprises as the unit of analysis

The farming systems of irrigating farmers in the Tungabhadra Left Bank Canal can be described as 'male farming systems' (Safilios-Rothschild, 1988). Male farming systems are defined as those farming systems where male household heads/members dominate agricultural decision making. With very few exceptions the farming enterprises in my sample were controlled by the male heads of the households (or the family leader, an expression used in Wood, 1995; for further general discussion of male dominance in Indian farming households see Agarwal, 1994). Men controlled the use of the family land, the acquisition of inputs (and credit for that) and the marketing of the produce. They also managed the farm labour activities (though women, wives, daughters and daughters-in-law might perform most of this labour). The exceptions among a total of 82 farms were two cases of female controlled farms (one case where the husband had left/was sent packing, and one where the husband had recently died leaving his wife with young children), and one, maybe two cases of dual control (in one of these cases the wife took credit without the husband knowing where it came from). In all these cases there was the prospect of sons (or sons-in-law) taking over the management of the farm in due course. In what way farming decisions are negotiated within the household I do not know. Most households depended on agricultural cultivation and directly related activities alone. These directly related activities were mainly agricultural wage labour and the selling of milk produced by own cows and buffaloes. Both were to an important extent a female activity. The income gained from these activities was if not pooled at least spent for household purposes. Smits (1993) reports several cases where women had to give the income earned through wage labour to their husbands. In one case the husband even collected his wife's wages from the employer. When women kept their money income it was fully spent for household purposes. I therefore conclude that the households I studied are certainly not homogeneous units, but that they can be considered as single enterprises.

in the Tungabhadra Left Bank Canal it makes sense to regard farming households as single agricultural enterprises, even when internal divisions of labour and interests exist (see box 5.1 on the previous page for discussion).

The typology

The main variable I used in the classification of the farming households-enterprises investigated is a qualitative version of Utsa Patnaik's labour exploitation ratio. This ratio is the balance between net labour hired in (labour hired in minus labour hired out) and family labour in self employment (Patnaik 1987:chapter 3).[29)]

This led to the identification of the following four categories in the population of 80 households-enterprises on which sufficient data was available. A short description of the different types of labour and employment relations that are involved is given in box 5.2.

I: Households-enterprises who employ one or more permanent/bonded labourers for agricultural production, apart from large numbers of daily wage labourers. Family labour is not hired out. Field labour is not done by female family members.

II: Households-enterprises who employ large numbers of daily wage labourers, but no permanent/bonded labourers. Family labour is not hired out. Field labour is hardly or not done by female family members.

III: Households-enterprises whose main source of income is own agricultural production (mainly based on family labour, with some hiring in of wage labour), but who hire out family labour as wage labour for small to larger number of days. Female family members work on own fields as well as wage labourers.

IV: Households-enterprises who derive their income mainly from hiring out family labour as wage labour. Cultivation of own land mainly by family labour with some wage labour hired in. Female family members work on own fields and as wage labourers.

The labels commonly attached to these four categories in the (marxist) Indian debate on agrarian change are rich peasants, middle peasants, small peasants and poor peasants, a terminology that I will also employ (see Patnaik, 1987).[30)]

The next step was to combine this classification based on labour characteristics[31)] with other characteristics of the household-enterprises. The classification correlated with the size of irrigated landholding, and there was also correlation of the classification with the terms on which credit was acquired.

---

29) I disregarded the surplus appropriated through land leased out and loan interest (and the reverse) that is part of Patnaik's model, because these were minor factors in this case.

30) The categories of landlords and landless labourers are not part of my typology. The first because they were not part of the sample, the second because without land a person cannnot be a water user (in this case). I personally find the labels 'poor peasants' and 'semi-proletarians' more fitting for the last two categories. More important than the labels however are the characteristics of each category.

31) Because of the partly quantitative and partly qualitative data on labour and employment, it is impossible to give a condensed presentation of the original data.

Box 5.2: Different types of agricultural labour and employment relations

Agricultural labour working for daily wages

* Hired individually (ploughing, tilling, pesticide spraying, fertiliser application, cleaning field channels) or in groups (harvesting, weeding).
* When employer and labourers live in the same village or camp direct employment of groups; otherwise employment through *meestris* (females for female groups, males for mixed groups). Payment through *meestri*, who is group member. *Meestri* some extra payment at end of the season.
* Sometimes semi-permanent arrangements with individuals and groups: 'first employment guarantee' arrangements against fixed or current rates, excluding the sugarcane harvesting period.
* Common daily wage rates in 1991-92: Rs. 12 for males, Rs.10 for females. Some activities were paid better (for example Rs.20 for pesticide spraying).

Group/gang labour on contract basis

* For activities that need to be done quickly in times of peak labour demand, like rice harvesting and sugarcane cutting.
* Local groups/gangs, but also seasonal migration from outside the command area.
* *Meestris* act as group representatives, not as exploiting middle(wo)men. Work with the group and find new contracts. Get some extra payment.
* Sometimes price arrangements linked to pre-season advances.

Attached or bonded labourers

* Old terminology of bonded labour is used (*jiitada aalu*), but (life)long attachment is rare. Better described as permanent labourers on 1-3 year contracts. *Sambalada aalu* (salaried worker) is also used.
* Involves advance (loan) before contract starts.
* All young men in the case of field labour.
* In 1991-92 payment was Rs.3000-3500 per year, usually plus two bags of rice and a set of clothes, and sometimes meals at the farmer's house.
* Unpopular employment relation that labourers preferably avoided.

Wage labourers on a monthly wage

* Small group of tractor drivers and their apprentices.
* Monthly payment in 1991-92 Rs.400 per month (driver) and Rs.200 (apprentice), plus 'tips' when tractor is hired by other farmers (Rs.5-10 per acre).

Exchange labour

* Involves exhange of labour days between two farmers (*muuyi aalu*).
* Mainly found among small farmers relying heavily on family labour, and almost exclusively among local farmers. Not prominent in irrigated agriculture.
* Only exchange of male labour was observed.

Family labour

* Found in all categories of the typology. A lot of pride and prestige is derived from building up a farm by own labour, particularly among settlers. Local elite also invests more family labour in agriculture than in the past.
* Female participation is high in poor households, and absent in rich households.

The average irrigated landholding for the different categories is given in table 5.4. It can be seen that from poor to rich peasants the size of irrigated landholding increased.[32] More details on landholding are given in appendix 5.1.

Table 5.4: Landholding and origin of rich, middle, small and poor peasants in three outlet command areas in the Tungabhadra Left Bank Canal command area (kharif 1991)

	Rich peasants	*Middle peasants*	*Small peasants*	*Poor peasants*	*Total*
Number of migrant farmers	20	13	7	1	41
Number of local farmers	0	11	18	10	39
Total	20	24	25	11	80
Average cultivated irrigated landholding (acres)[a]	13.2	7.6	3.4	2.2	
Average rainfed landholding (acres)[b]	0	1.1	2.4	0.6	
Average total landholding (acres)	13.2	8.7	5.6	2.8	

a) All cultivated land was counted, both owned and leased; uncultivated and leased out land was not counted.
b) All rainfed land was counted, cultivated or not.

Table 5.5: Sources of credit for rich, middle, small and poor peasants in three pipe outlet command areas (1991-92)

Source of credit	Rich peasants	Middle peasants	Small peasants	Poor peasants
No loans, moneylender himself	2	0	0	0
Bank loans only	***4***	2	0	0
Bank loans and input traders	***4***	***6***	5	0
Input traders only	3	***8***	5	1
Input traders and other farmers	2	3	***3***	1
Other farmers only	0	2	***10***	***5***
No credit, unable to get	0	1	0	***4***
Unknown	5	2	2	0
Total	20	24	25	11

The distribution of the types of credit over rich, middle, small and poor peasants is given in table 5.5. The terms of the credit become more unfavourable from top to bottom (for

[32] Rich and middle peasants have very little rainfed land because they are mainly migrant farmers, who only invest in irrigated land. Small peasants are mainly local farmers and do own and cultivate rainfed land. Poor peasants generally didn't own rainfed land. In this category many farmers leased small pieces of irrigated land.

explanation, see appendix 5.1). The table shows that the terms of credit worsen from rich to poor peasants. This is visualised by highlighting for each category of farmers the two combined credit categories that contain the highest number of households-enterprises. However, the situation with regard to credit is rather specific per outlet command area. Table 5.5 shows a general trend, but it doesn't fully convey the differentiated access to credit. Forms of credit and outlet-wise access of different categories of farming households-enterprises to credit are described in detail in appendix 5.1.

The cluster of the labour/employment characteristics, landholding and credit relations was used to make the final classification of individual households-enterprises into the four categories.[33] Because the typology is based on the clustered occurrence of different types of relations, it can be considered as a relational typology (see Whatmore *et al.*, 1987).[34]

Livelihood strategies

The clustering of characteristics into four categories of farming households-enterprises is not just a statistical exercise. The four categories are associated with four different livelihood and accumulation strategies, which I will now describe.

Rich peasants are the affluent farmers, who not only focus on expanding their agricultural operations (in canal and lift irrigation), but also undertake other activities. The main one of these is local input trading *cum* moneylending. Another one is hiring out their tractor when they own one. These farmers employ permanent labourers because they have large, intensive farms, but also to devote some of their time to their other business. Nevertheless, rich peasants farmers are still found in the field doing manual labour very frequently.[35] These farmers invest strongly in the education of their children to start businesses or to take up employment outside direct agricultural production. Options open for these farmers and/or their children are to formally establish themselves as traders *cum* commission agents in a regional market centre (or become partners in such firms), or even start a ricemill. In my

---

[33] Five households-enterprises changed category when the landholding and credit characteristics were combined with the labour/employment characteristics. Three were shifted from the middle peasant category to the small peasant category, and one the other way. The fifth shift was from small peasant to poor peasant. This low number of changes shows the close fit of the labour, landholding and credit factors. The choice to take these three relationships as the basis of the typology is partly based on other research on agrarian change in India which shows that land, labour and credit are central differentiating factors, and partly on the analysis of the field data that was collected. There was also a close fit of the categorisation with possession of tractors, ownership of motorbikes and other assets, and quality of housing. Very few household-enterprises undertook productive economic activities other than agriculture (also see above).

[34] In the original design of this chapter a presentation of the farm economics data that we collected was also envisaged. However, its presentation takes a lot of space, and it is not essential for the argument of the chapter. Furthermore, as noted above, the sample of the households-enterprises in the three pipe outlet command areas is not representative for the situation in the command area. It can support a qualitative analysis of types and mechanisms, but does not provide basis for generalisation of quantitative findings. For those interested, quantitative data on the input intensity of irrigated farming, yields, the gross value of output (total and per acre), and the profitability of farming (total and per acre) for the four categories of households-enterprises are available from the author.

[35] Farms where farmers only supervise labour by others (part of Patnaik's definition of landlords) are very rare. Examples that I came across outside my sample were large landholders from the local elite, or business people and politicians who own land. These sometimes had appointed managers for their farms, or leased out land, but in other cases their sons undertook the farm work.

sample there were only very few examples of farmers setting up such official businesses. This had to do with the point of the demographic (and accumulation) cycle in which the most affluent farmers in my sample found themselves: recently married with young children. Some of them however were clearly on this trajectory. Farmers in this category are locally referred to as being 'economically and politically sound', or *sowcars*, which means rich and influential farmers who are also moneylenders.

Middle peasants are farmers with a reasonably secure existence (though not necessarily at a high level of income). They make profits (in most years) that allow them to consider the expansion of their holdings by leasing or buying land. They focus on agricultural expansion and intensification. Activities outside agricultural production lie outside their ambit. Middle as well as rich peasants are employers of the members of the families of small and poor peasants households who go out for wage labour.

Small peasant producers consider themselves and are considered primarily as farmers, but their position is a difficult one. At the next property division or through dowries for daughters their landholding may be fragmented or reduced. They hardly have the resources to solve this problem - by acquisition of land, investment in the education of their children, or setting up a small business - though this is sometimes attempted with great hardship. Because of their difficult socio-economic status, they run the risk to lose land when they have to take loans with local farmers. Family members also go out to be employed as wage labourers to earn additional income. Good agricultural results are crucial to this category, and failures may be disastrous. One of the few avenues for improvement in this category is the conversion of rainfed land held by the farmer into irrigated land by the installation of lift irrigation (by other, more wealthy farmers or the government).

For poor peasant households the main concern is survival (maintaining minimal food entitlements for reproduction of the family). This category generally considers itself to belong to the labour class, and is often referred to by others as such. Own land cultivation gives a more secure basis to their existence than totally landless people. For this reason they actively try to hold on to, lease and sometimes buy small pieces of land.

Water distribution and the typology of farming households-enterprises at pipe outlet command area level

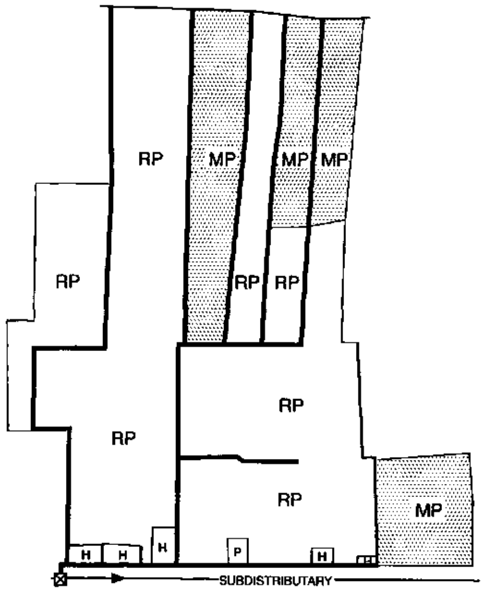
In this sub-section I discuss how at pipe outlet command area level the categorisation of farming households-enterprises is related with their location in the command area, and associated to that, their access to water and the crops grown. After the presentation of the situation in the three pipe outlet command areas studied, I summarise the mechanisms that explain the class-location correlation.

In Kabbu outlet in distributary 24 the differentiation was that between rich peasants and middle peasants. The outlet as a whole had excellent access to water, which allowed close to 100% rice and sugarcane cultivation. Three out of eleven cultivators were middle peasants; the rest were rich peasants. The three middle peasants had their land towards the tail end of the outlet (though not all the tail end land was cultivated by middle peasants) (see map 5.2).

In Hatti outlet in distributary 24 all categories of farming households-enterprises were represented. This outlet is located on the same subdistributary as Kabbu outlet, but had a much more problematic overall access to water as a result of its tail end location. Map 5.3 gives the spread of the four categories of farmers over the outlet. Also here a head-tail correlation existed, but it is less easily visible because of the layout of the outlet. The relative distances to the pipe outlet gate for rich, middle, small and poor peasants were 100, 109, 156 and 164. Rich and middle peasants were thus closer to the water source than small and poor peasants.

Lastly, the spread of farmer categories in Bhatta outlet in distributary 93 is given in map 5.4. Here the pattern is also clear, particularly when the categories rich and middle peasants (mostly in the head end) and small and poor peasants (mostly in the tail end) are taken together, The correlation is remarkable considering the relatively short history of agricultural intensification in this outlet command area (1978-79 to 1991-92).

Map 5.2: Categories of farmers in Kabbu outlet, D24



RP = rich peasant
MP = middle peasant

From table 5.4 it could already be concluded that migrant farmers dominate the categories of rich and middle peasants, and local farmers the categories of small and poor peasants. Therefore, the head-tail pattern in terms of rich and middle *versus* small and poor peasants is also to a large extent a migrants-local farmers division. This suggests the great impact that migrant farmers have had on the agrarian structure, but the correlation is also the product of the choice of these three particular outlets, and of the focus on canal irrigation without including the lift irrigation associated with it. In general, the association between head end and migrants, and tail end and local farmers is not as strong as suggested by the situation in these three pipe outlet command areas. This is elaborated below when the relation between settlement and water distribution at the distributary level is discussed.

More significant is the correlation of size of holding with location. The difference between the Kabbu and Hatti pipe outlet command areas in the subdistributary in distributary 24, illustrates this most clearly. In the head end Kabbu outlet command area the landholding of the 10 owner-cultivators ranged between 7 and 31 acres of irrigated land; the average was 12.3 acres. In the tail end outlet in distributary 24 (Hatti outlet) there were three rich peasants with 24, 22 and 11 acres of irrigated land; the average was 19 acres.[36] In Hatti outlet the 21 middle, small and poor peasants on which we had sufficient data owned between 0.75 and 10 acres of irrigated land. Ten owned less than 4 acres; the average was 4.6 acres.

[36] Their holdings in the tail were only part of their total holdings, which were mainly located in the head reach of the subdistributary.

parents. The objective may be to bring extra land into the family, or to keep land within the family as much as possible. The latter occurs when cousins marry.

3) Larger farmers extend loans to smaller farmers to acquire land when these small farmers default on the loan. Larger farmers did - obviously - not explicitly state that this was the objective of the loans. However, we documented a number of cases where this had happened. The fact that in Bhatta outlet in distributary 93 some farmers extended loans to smaller head end farmers while being short of resources themselves further supports this analysis.

The mechanisms discussed above are well known in the literature on agrarian change in India and as such unsurprising.[41] What I find striking is how quickly these mechanisms have led to substantial shifts in the distribution of landholding, both in size and location. An interesting addition to the analysis presented would be the landholding history of a pipe outlet command area with no or few migrant farmers. This would give a better idea of the strategies of local farmers to capture the benefits of irrigation.

Settlement and head-tail patterns at distributary level

The extreme predominance of migrant farmers in the socio-economic structure and pattern of water distribution that was decribed above, is partly the result of the choice of outlet command areas. The role of migrant farmers in the places where they settled has been clarified by that description, but they didn't, and could not, settle everywhere where water was available. The discussion below on the spatial pattern of water distribution at distributary level, and its evolution over time, can put the role of migrant farmers in a better perspective.

I discuss the relation between settlement of migrant farmers and the head-tail pattern in water distribution for distributaries 24, 93 and 97 (for the approximate location of these distributaries see map 1.1, chapter 1).

Distributary 24

The intensification of agriculture in distributary 24 started in the middle and tail end area of the canal (for a map, see figure 7.1). In the 1950s, the early years of the irrigation system, migrants made sure that the land they bought was localised for rice and sugarcane. They visited the Irrigation Department offices to study localisation maps and find out the survey numbers where rice and sugarcane could be grown. This meant that many of the early settlements, including those in distributary 24, were in tail end and middle reach areas, because that is where rice and sugarcane were localised (see chapter 3).

A relocation of water use in the distributary took place because in the course of time rice and sugarcane cultivation expanded into the areas localised for light crops. This meant that water use in the upstream reaches of the distributary increased, and scarcity emerged in the tail end reach of the distributary. Upstream development started to affect tail end water supply in distributary 24 in the second half of the 1960s. Table 7.2 in chapter 7 shows that between 1966-67 and 1986-87 the total area irrigated in distributary 24 varied around a stable level. But a relocation of crops within the distributary command area did take place. In 1991-92 rice cultivation had increased in the head reach compared to 1966-67 (see table 5.6).[42]

---

[41] However, the discussion generally focuses on size of landholding rather than location.

[42] Table 5.6 divides the distributary 24 command area in three parts, head, middle and tail, by clustering villages. This is because villages are the units in the collection of the cropping data. For (continued...)

When the rice cultivation under lift irrigation (from natural drains and the river) is subtracted from the total tail end rice cultivation, the shift is clear.[43]

Table 5.6: Rice cultivation in the head, middle and tail of distributary 24, 1966-67 and 1991-92

		Rice cultivation in 1966-67 (acres and share of total)		*Rice cultivation in 1991-92 (acres and share of total)*			
		Kharif	Rabi	Kharif		Rabi	
				Lift irrigation included	Lift irrigation excluded	Lift irrigation included	Lift irrigation excluded
HEAD							
6 villages							
Localisation (acres):							
rice	232	2819	2683	6008	6008	4844	4844
sugarcane	1877						
total	6483	(39%)	(44%)	(48%)	(52%)	(59%)	(67%)
MIDDLE							
3 villages							
Localisation (acres):							
rice	556	2995	2300	3752	3752	1311	1311
sugarcane	3723						
total	5765	(41%)	(37%)	(30%)	(32%)	(16%)	(18%)
TAIL							
3 villages							
Localisation (acres):							
rice	1742	1441	1178	2831	1831	2051	1051
sugarcane	1791						
total	5092	(20%)	(19%)	(22%)	(16%)	(25%)	(15%)

Source: Demand lists distributary 24 (Irrigation Department)

The figures in table 5.6 show that the emergence of private lift irrigation in the tail end of distributary 24 was a significant response to increasing water scarcity. It seems to have been a much more common approach than relocation of the full landholding to a more upstream part of the distributary.[44] 47% of the pumpsets for lift irrigation in the two tail end villages in distributary 24 were owned by settler farmers. The capital required for these

---

[42](...continued)
the 1960s, 1966-67 was the only year for which village wise cropping data was available in the distributary 24 subdivision office. The village-wise clustering is crude as a head-tail division, and almost fully misses the shifts in the subdistributaries.

[43] My estimate of 950-1000 acres lift irrigation (all rice) in the distributary 24 tail end area is based on data for two of the three villages concerned. There is - thus - an underestimation of the total rice under lift irrigation in the tail end region. However, there is also some rice cultivation under lift irrigation in the middle and head reach. The *kharif* data for the two years can only be used for comparing the relative distribution within the distributary command. For comparison of the absolute areas cropped *kharif* data are less suitable because of the unknown factor of rainfall and its timing. The *rabi* figures can be used for both purposes because there is hardly any or no rainfall in this season. The table shows that in *rabi* 1991-92 the area cropped with rice in the tail and middle reach (excluding lift irrigation) was less than that cultivated in *rabi* 1966-67.

[44] The total investment for a 10 HP pumpset (which can irrigate tens of acres, depending on topography) roughly equalled the purchasing price for 2 acres of head reach land in 1991-92.

investments was generated in canal irrigation. However, another important group of pumpset owners were the village elite.[45] For them lift irrigation has been an important instrument for the improvement of their economic status. They invested in pumpsets to supply their own lands, but to a large extent also to sell water to smaller, mainly village, farmers. This is an extremely profitable business. My calculations for one case suggest that the total investment can be earned back in two to three years.

Despite the relocation of water to the head end reach of the distributary, the tail reach farmers of distributary 24 managed to consolidate their access to a share of the canal water, and a considerable area of rice (and sugarcane) is still cultivated in this part on canal water. The reason behind this is the political weight of middle and tail reach farmers, built up in the early period of the canal's operation. Details of this are discussed in chapter 7. Here it can be noted that the specific spatial history of settlement and agricultural intensification in this distributary has shaped the present geographical distribution of water use in the canal's command area.

Distributary 93

The first ten years after distributary 93 came into operation in 1968 the extent of irrigation was limited, even less than the localised area. Rice constituted a very small part of the crops grown. Farmers and officials reported in interviews that there was no scarcity of water in this period. 1978-79 is the year that settlement of migrant farmers started, and since then the irrigated area and rice cultivation have sharply increased (see table 5.7).

The oldest and biggest migrant camp in distributary 93 was established by farmers who had settled in a neighbouring distributary in the 1960s. In that distributary they had chosen land localised for rice for initial settlement. In distributary 93 there is no rice localisation, but in 1978-79 this no longer deterred the settlers. Settlement in distributary 93 took place in the geographical middle reach (see figure 8.9, chapter 8). The sharp increase in rice cultivation in the middle reach caused acute scarcity of water in the tail end reach.[46]

The land in the geographical head of distributary 93 is mainly owned by a number of local landlords, reportedly owning hundreds of acres. In 1978-80 they were unwilling to sell, maybe because they were well aware of the potential value of their land. Around 1990 head reach local farmers started to develop their land for irrigation. In this distributary a shift of rice cultivation towards the geographical head may therefore be expected in the years to come, and water supply to the middle and tail reach will be negatively affected (for more discussion of this case, see chapter 8).

Distributary 97

Settlement in distributary 97 started in the late 1970s. All camps are located along roads and/or canals in the upper half of the distributary command. First the camps were built along subdistributaries and distributaries. In the 1980s farmers mainly settled along the distributary, closer to the water.

---

[45] 50% of the pumpsets in the mentioned area was owned by local farmers (3% was unknown or mixed group ownership). Most of these pumpsets were owned by the village elite, but some were also obtained by Harijans (former untouchables) through government schemes.

[46] The village boundaries cross-cut the distributary 93 command in such a way that it is impossible to show this concentration in the middle reach on the basis of village-wise cropping data.

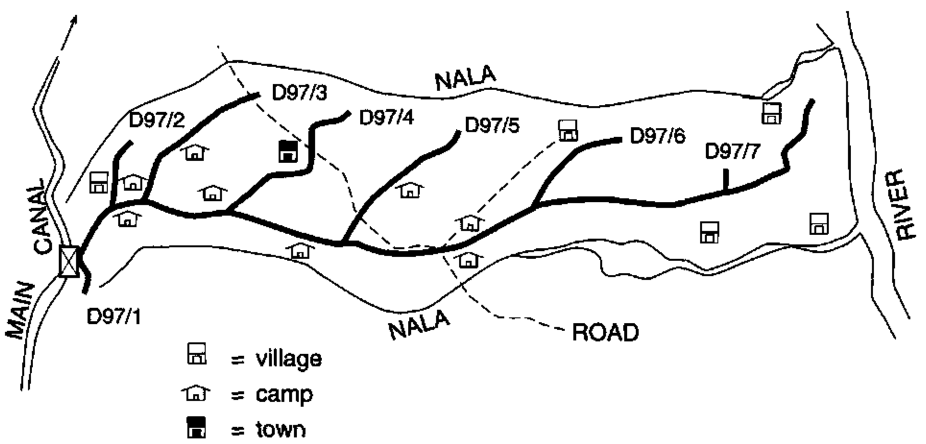
Table 5.7: Total area irrigated and rice cultivation in distributary 93 from 1976-77 to 1991-92

Year	Rice (acres)[a]	Total (acres)[a]	Rice (acres)[b]	Total (acres)[b]
1976-77	114	4117	-	-
1977-78	160	4424	-	-
1978-79	243	3386	-	-
1979-80	423	2493	562	3221
1980-81	1168	4178	1503	4738
1981-82	1401	5363	1621	5696
1982-83	1750	5558	2121	6282
1983-84	-	-	2549	5476
1984-85	-	-	1771	6390
1985-86	1793	7236	2812	9031
1986-87	4124	8347	6530	12433
1987-88	-	-	3505	9877
1988-89	-	-	5267	9552
1980-90	-	-	3468	8714
1990-91	3540	9858	4435	10929
1991-92	4525	11782	5123	12138

a) Based on weekly standing crops file (Irrigation Department)
b) Based on demand lists (Irrigation Department); there are many uncertainties, double counting problems and adding-up errors in these figures, particularly in 1985-86, 1986-87 and 1987-88

In distributary 97 the largest local town also happens to be located in the head reach of the distributary (see map 5.5). This means that the head end area was no scarcely used 'jungle' far away from the villages, as in distributary 24, but a core area of rainfed agriculture. There were therefore strong local landed interests in the head end of the

Map 5.5: Villages and camps in the command area of distributary 97



distributary. The strength of these local interests may partly explain the dispersed settlement pattern. The history of land acquisition that was reported to us is that rich settler farmers bought pieces of land from different large local landowners, after which the land was sold or leased to smaller migrant farmers, leading to small camps in different places.

With the intensification of irrigated agriculture, also by the local population, the demand for water in the head reach of the distributary strongly increased. The start of the tail end, defined as the area that receives less than three irrigations per season, is steadily moving upstream. In 1992 this had reached the point that some of the most downstream camps started to experience serious water shortage. Many villages in the tail end of the distributary have been out of irrigation for many years (see chapter 8 for more detailed discussion of this distributary).

Conclusion

The descriptions of the spatial patterns of water use at distributary level, and their evolution over time, shows that the categories of 'head' and 'tail' need to be treated with some care. Location is important, but there is no simple correlation with intensity of water use. Neither can migrant farmers only be associated with the category of 'headenders' and local farmers only with that of 'tailenders', notwithstanding the pivotal role that migrant farmers played in the process of agrarian transformation. By implication, migrant farmers are not as predominant among rich and middle peasants as suggested in the discussion of the typology and the situation at the pipe outlet level above. And, local farmers are not as predominant among small and poor peasants as suggested there.[47)] The following two processes explain this.

1. Migrant farmers have not always settled in the geographical head end (because of the localisation pattern) and have not been able to acquire all land in head end areas (because of unwillingness to sell by local farmers). The local farmers who had or could acquire the financial means, and had land in the right place also joined or are joining the process of agricultural intensification through irrigation. Also, what once were favourable locations sometimes became tail end reaches at a later stage, because ongoing land development for irrigation implied relocation of water use in the command area.[48)]
2. In some tail reaches lift irrigation has strongly developed, both along the Tungabhadra river and along the *nalas* (natural drains) that separate the distributary command areas. This development is directly associated with canal irrigation. The water in the *nalas* to a large extent has its source, apart from rainfall, in the inefficiencies of canal irrigation. The financial investments in lift irrigation are to a large extent based on the earnings form

[47)] However, the former is truer than the latter. Many settlers that do not manage to build up a successful farm remigrate to their home area, as mentioned above, or resettle in other, new irrigation systems when access to water deteriorates. This implies that migrants are likely to be poorly represented in the categories small and poor peasants. A much larger sample of farmers, and documentation of departures, would be required to test this hypothesis.

[48)] It may be true that in the Tungabhadra Left Bank Canal there is a gradual long term relocation of water use towards geographical head end areas. This can be observed in several distributaries and also seems to happen at main canal level. This statement is based on recent fieldwork, done by R. Doraiswamy and the author. However, the chapters on water distribution practices show that this is not a 'natural' and unavoidable process, but the outcome of struggles over water distribution, in which location is an important strategic factor.

canal irrigated agriculture (either the income from cultivation or the income from land sales).[49] Local farmers seem to participate in this process on par with migrant farmers.

5.4 CONCLUSION

Canal irrigation induced a dynamic process of agricultural intensification and commoditisation. The farmers from the coastal areas of Andhra Pradesh who migrated to the Tungabhadra Left Bank Canal command area played a central role in this process. They brought the capital and the skills to establish a new farming system, based on intensive irrigation of rice, sugarcane and other cash crops. Because of the protective nature of the canal system's design, this intensification process resulted in unequal water distribution. This chapter has investigated the relationship between water distribution and social differentiation, and focused on the spatial dimensions of that relationship.

At the start of canal irrigation the following observation in all likelihood also applied to the Tungabhadra Left Bank Canal.

> "There is no obvious reason to suppose that all advantageous locations are systematically preempted by large landholders. Large farmers are found in all reaches of the canal network (...)" (Vaidyanathan, 1991:22-23)[50]

However, the distribution of landholding is not a given, static factor, but is influenced by the introduction and development of canal irrigation. There has been a redistribution of land in the Tungabhadra Left Bank Canal, which tends towards concentration of larger holdings in head end reaches, and smaller holdings in tail end reaches. The most important process to cause this tendency were the land transfers associated with the settlement of migrant farmers. But, land transfer continued after the initial settlement, by purchase of land, by dowries and by strategic loan-giving.

The picture of the relation between water distribution and social differentiation that results from this is more complex than a simple correlation of location with size of landholding, socio-economic status, region of origin, and access to water. At pipe outlet command area level a correlation could be observed between large holdings, rich and middle peasants, migrant farmers, and good access to water. At distributary level considerable diversity existed within an overall pattern of class-related access to land and water. Particularly the

---

[49] Also shopkeepers, input traders and other businessmen sometimes invest in lift irrigation. In the examples we came across this was often to sell water to farmers, and not for own cultivation.

[50] The truth of this statement depends on the level at which landholding is considered. At the level of the main canal and distributary it is certainly true. In all villages spread along these canals there will be larger and smaller landholders. At lower levels, within the boundaries of a village or subdistributary and outlet command area, the statement may not hold. Also under rainfed conditions there may be a spatial pattern in the distribution of landholdings. In one case we studied in the Malaprabha Right Bank Canal command area, the larger holdings of the richer farmers were close to the village, and those of the smaller, poorer farmers further away from it. Because the village was located on the bank of a *nala*, the holdings of the larger farmers were in the tail end when the canal was constructed, and those of small farmers in the head end. This locational pattern was one of the factors that led to effective water users organisation for water management (see van Ommen, 1997). In the Tungabhadra Left Bank Canal area we have come across examples where small plots of both larger and smaller farmers were located close to the village, and the larger farmers also had big plots further away from the village which were more extensively used. It can be imagined that the combination of physical geography and social history has produced diverse patterns.

dichotomy of migrant *versus* local farmers breaks down at distributary level (and probably also would break down at outlet level when a larger number of outlet commands areas would be investigated). In distributary 24 migrant farmers had first settled in the middle and tail reaches and were confronted with upstream land development that relocated water use away from them. In distributary 93 head reach local farmers refused to sell land, and the migrants who settled in the middle reach will face pressure on water availability when these farmers start to develop their land for irrigation. In distributary 97 settlers had to share the head end location with local farmers from the town located in this part of the command area.

In addition, the expansion of lift irrigation needs to be taken into consideration. Canal irrigation has provided both the water and the financial means to develop this type of irrigation along *nalas* and along the river. Both local and migrant farmers have invested in this, and for local elites it has been an important means to reproduce or strengthen their socio-economic status.

A theoretical conclusion is that in the analysis of agrarian change in canal irrigated areas, the classification of agricultural producers can not only be based on socio-economic indicators like size of landholding, access to credit and labour/employment conditions. The relationships among these factors are not just correlations, or the unintended outcome of aggregate individual behaviours, but they are connections that are strategically pursued by the different producers.[51)] Spatial relations are a defining part of the agrarian structure. Typologies of agrarian producers and analyses of agrarian change in canal irrigation situations therefore need to incorporate the way the canal infrastructure shapes the physical and social landscape.

The analysis above has a broad-brush character. How the different configurations of water, space and social differentiation are reproduced in day-to-day water distribution practices is still unclear. This is the subject of the four following chapters, which discuss water distribution practices at outlet, distributary and main canal level.

[51)] In terms of critical realism, the factors are not externally but internally related (see Sayer, 1984).

Appendix 5.1: Landholding and credit in Raichur district and the three selected pipe outlet command areas

In this appendix more background information is given on landholding and credit relations in Raichur district and the three selected pipe outlet command area, as these emerged with the expansion of canal irrigated agriculture.

Landholding

Land distribution in Raichur district was skewed in the past and is skewed in the present. Table 5.1.1 gives land distribution in the district in 1958 and 1977.

Table 5.1.1: Land distribution in Raichur district in 1958 and 1977

1958			1977		
Size class	*% of holdings*	*% of land*	*Size class*	*% of holdings*	*% of land*
0-15 acres	66.8	30	0-12.5 acres	69.8	33.0
15-30 acres	21.9	30	12.5-25 acres	20.0	29.9
> 30 acres	11.3	40	> 25 acres	10.2	37.1

Source: Mysore Tenancy and Agricultural Land Laws Committee (1958) and Agricultural Census (1977) as reported in Census of India (1981)

The table shows that both in 1958 and 1977 the two-thirds of the households with the smallest holdings owned about one-third of the land, and the 10-11% of the households with the largest holdings owned 40% of the land. The structure of inequality did not change, but there was a downward shift in average landholding size. The average landholding in Raichur district in 1958 was 15.5 acres. In 1977 it was 11.5 acres. In all likelihood this downward shift reflects increasing pressure on the land as a result of the growth of the farming population.[52] This was partially the result of 'natural' population growth and partly the result of settlement by outsiders attracted to the irrigation. However, the conversion of rainfed land to irrigated land increased the productivity of the land. With a favourable water supply this more than compensated the reduced size of the holding (see the productivity differences discussed above).

In my own non-random sample of farming households the distribution of landholding among the owner cultivators was a given in table 5.1.2. The table shows that the overall structure of unequal distribution is similar to the Raichur pattern discussed above. The average landholding is lower than in 1958 and 1977, but no meaning can be attached to this because of the unrepresentative sample.

[52] As a result of land reform legislation, including land ceiling provisions, many farmers have distributed land titles over different family members. In the 'demand lists' for revenue and water fee collection that we studied in 1991-92, this spreading of landholding titles was clearly visible. To what extent this has affected past and present landholding statistics is difficult to ascertain.

Table 5.1.2: Land distribution among owner-cultivators in three pipe outlet commands[a]

Size class	*% of holdings*	*% of land*	*Average area per holding (acres)*
0-5 acres	33	10.1	2.8
5-10 acres	33	25.6	7.0
10-15 acres	18	22.1	11.2
> 15 acres	16	42.2	23.2
Total			9.0

a) Landholding data of tenants and non-cultivating owners was not complete and therefore excluded.

Credit

Credit is the cornerstone of commercial irrigated agriculture in the Tungabhadra Left Bank Canal. 92% of the cultivators in the two pipe outlet commands in distributary 24 took some form of credit to make their cultivation possible. In the outlet command area in distributary 93 the figure was probably as high, but for reasons discussed below this is not fully certain. Those who did not take credit were either too affluent to need it (because they were moneylenders as well for example), too poor to be able to get it, or tail enders practising extensive practically rainfed types of cultivation that require much less investment.

Credit was used mainly for acquiring the external inputs for agricultural production. Similar to Kallur's findings nine years earlier, chemical fertilisers were the largest input cost, but seeds and pesticides are often also bought on credit. Credit is used for paying the labourers employed during the season as well.

There were four sources of credit for agricultural production: banks, input traders and commission agents, local farmers, and specialised moneylenders. The cost of credit increased from the first to the fourth source.[53]

Banks

The first source was a crop loan from a nationalised bank. Banks have a maximum loan per acre, which depended on the crop grown. For rice for example this was around Rs.1800 in 1991-92.[54] Bank loans were in principle the cheapest loans. Depending on the amount, the official interest rate varied between 12 and 15% per year.[55] The loans were given in cash. A bank loan might carry other costs in addition to interest. Farmers systematically reported that to acquire a new bank loan (opening a new account) involved "spending at every table". The amounts quoted by farmers implied increases in the effective yearly interest rate of 5% or more. Regular customers, who renewed their loan seasonally did not seem to face this problem.

---

[53] A fifth possible source are cooperative credit societies, but these were defunct. In the sugarcane area another source of credit existed in 1991-92. The sugarcane factory recommended farmers to the bank for crop loans, and supplied inputs like the planting material on credit. In one of the larger lift irrigation schemes the factory payed the electricity bills for the pumps. All these costs are charged to farmers through their bank account at the time the payment of sugarcane was made through these accounts.

[54] The requirement was around Rs.4000 per acre. One way to get around this was to register loans as sugarcane loans, which had a higher maximum of Rs.4600.

[55] Effectively the interest is higher because the loan was compounded every 6 months. Farmers consequently quote 18% (1.5 Rs. per 100Rs per month) as the bank interest rate. In the few account books I have seen the official rates were used.

Another cost was related to the requirement of giving the title deed documents of the land to the bank as collateral (for crop loans exceeding Rs.10,000). Farmers holding ancestral property without sale deeds had to register their land at the revenue office, to get a document that they could deposit at the bank (an extract from the village land record was not accepted). This registration remained valid for 12 years, but was expensive (around 10% of the loan amount), and again required the payment of intermediaries.

It is therefore not surprising that bank loans were hardly accessible to small farmers, but mainly to the assertive affluent ones. To illustrate this I quote from one of the interviews I had with bank employees in the command area.

> *Loans for dry land, we usually discourage. Big farmers only come to this bank, dryland farmers don't come.*
>
> *With many small loans, there are so many accounts to handle, and we may also neglect the supervision. Lending is very easy to those who have 1) good lands and 2) are relatively affluent. With landless, tailenders and dryland farmers it is difficult; there is a tendency to send them off with one word.*
>
> *The camp people know how to deal with us, they are worldly-wise. They know the bank's requirements and act according to our regulations. They know how to approach and convince us. Those who do not know how to talk to us, they don't get the loans. We put hurdles for those we don't want to finance, and we scale down our requirements for accepted parties. With such people the documentation we ask is minimal.*
>
> *Even the public sector banks cater to the higher class in practice. There is not a real sympathy for the lower class. Having to give 20% of the loans to the lower class, it's all eyewash.*

Input traders and commission agents

The second source of credit were traders in agricultural inputs (fertilisers, pesticides and seeds). These traders were often also commission agents for agricultural produce, particularly rice and cotton. Farmers bought fertiliser and other inputs on credit in these shops on the condition that they would sell their produce through this shop. The interest rate was mostly 24% per year (2 Rs. per 100 Rs. per month), but we came across cases of 36% as well.

There were other sources of profit in this arrangement than interest. Fertiliser on credit was Rs.5-10 per bag more expensive than fertiliser bought in cash.[56] This amounted to a price increase of 2½-6%. For pesticides and seeds such price increases also existed. Furthermore, the farmer was charged a commission of around Rs.2 per bag of rice (price per bag around Rs.200-300 depending on variety and moment of sale) for the sale of his crop, and was also charged part of the weighing and handling charges (usually Rs.0.80 per bag). Legally these costs should be charged to the buyer of the produce. There might also be a difference between the price quoted to the farmer and the buyer of the produce. Finally, farmers were often not paid immediately, but had to wait several weeks. This was because the buyer also took some time to pay. When the farmer wanted to be paid immediately, as he legally should be, he was charged an extra month interest.

Local farmers

The third source of credit were rich peasants who acted as moneylenders and input dealers. Many of them were smaller, unregistered versions of the traders *cum* commission agents. The niche in the market for local moneylenders is the proximity to their clients. Transport time and cost for these clients are minimal compared to that with the traders *cum* commission agents located in local market centres. Another aspect of the relationship is the local knowledge on the creditworthiness of the clients. To get inputs on credit from a trader *cum* commission agent required a personal recommendation by a trusted person. Access to the local provider was more direct.

When the local moneylenders *cum* input dealers were new in the market, they made their conditions somewhat more favourable than those of the official traders *cum* commission agents.

---

[56] The price for a bag of urea was around Rs.157, for a bag of 'complex' (NPK fertiliser of different composition) between Rs.190 and Rs.240.

When established their conditions were very similar. However, I suspect that farmers had less control over the price they were paid for their produce in credit arrangements with local farmers. In chapter 6 I discuss the multiple dependencies of farmers on these local credit providers, which may reduce farmers' bargaining power with regard to conditions and prices.

Specialised moneylenders
The fourth source of credit were the specialised moneylenders, either local informal ones, or formally registered ones, or pawn shops. The first category seems to be the most important for agricultural loans. The providers were mostly the traditional village elite (see for example Census of India, 1961b). These loans were the most unfavourable, charging 3% interest per month or more.[57] Many people in this category were also taking up trade in rice, and were merging with the third category.

Credit sources in the three outlet command areas
In the three outlet command areas investigated the distribution of credit sources was as given in table 5.1.3.

Table 5.1.3: Sources of credit in three pipe outlet command areas, 1991-92

Source of credit	Kabbu outlet, distributary 24 No. and % of cultivators		Hatti outlet, distributary 24 No. and % of cultivators		Bhatta outlet, distributary 93 No. and % of cultivators	
No loans, moneylender himself	1	9%	1	3½%	0	0%
Bank loans only	3	27½%	1	3½%	2	5%
Bank loans and input traders	2	18%	11	40½%	2	5%
Input traders only	4	36½%	5	18½%	7	16½%
Input traders and other farmers	1	9%	3	11%	6	14½%
Other farmers only	0	0%	4	15%	13	31%
No credit, unable to get	0	0%	2	7½%	3	7%
Unknown					9	21%
Total	11	100%	27	99½%	42	100½%

The correlation of credit source and category of farmer was outlet specific. In Kabbu outlet, the head end pipe outlet command in the subdistributary in distributary 24, the 11 cultivators predominantly used bank loans and took credit with input traders. Four farmers were affluent enough not to have to rely on the credit of input traders. These farmers were able to wholly or partly pay their inputs in cash, and sell their produce on favourable conditions (for example by storing rice till prices were higher than at harvest time). Of the four farmers who had taken credit with input traders only, three had taken a bank loan in recent years but not yet repaid, and one took a bank loan at the start of the 1992-93 season. Nine out of eleven cultivators (82%) can thus

[57] We were quoted rates upto 6%. This is high, but still an improvement on the loans in kind given by this group in the past. In the system called *laagi* a person who borrowed a bag of *jowar* (sorghum) had to repay 1.5 bags after 6 months. When not repaid this became the principal, for which another 50% was charged in the next half year. This were however not loans for productive purposes. I have no information on present local rates of interest for consumptive money loans.

be regarded as regular users of bank loans. Only one farmer depended (partially) on money borrowed from another farmer/local moneylender. This was the only tenant cultivator in the outlet.

Hatti outlet, the tail end outlet in distributary 24, exhibited a greater spread over the different sources of credit. In this pipe outlet command a lower percentage of farmers were regular users of bank loans than in Kabbu outlet command: 44% against 82%.[58] Eleven out of twelve farmers who had bank loans also took inputs on credit from input traders. In Hatti outlet nine farmers (33⅓%) had to take credit with other local farmers or were unable to get credit. In other words, they had to rely on unfavourable credit arrangements or no credit at all. The level of affluence was generally lower in this tail end command than in the head end Kabbu command area as a result of smaller holdings and a less reliable water supply.

In Bhatta outlet in distributary 93, my information on sources of credit is incomplete. Nine farmers I have listed as 'unknown', all of whom were migrant rice farmers. They claimed to have bought their fertiliser and other inputs in cash. Because none of them sold his rice through the trader from which he purchased inputs, this claim is likely to be true. At the same time, it is highly unlikely that they had made these purchases from their own financial resources (considering size of holding and other factors). My guess is that all these farmers had taken either bank loans or, more likely, loans from other local farmers.

Even without knowing the source of credit of 21% of the cultivators, it is remarkable how many cultivators (partly) depended on local farmers for credit in Bhatta outlet: seventeen out of 42 (40½%). Fifteen of this group were local farmers. Most of them took loans with local *gowdas* (the village elite) who had been (money)lenders for a long time, and were now expanding their activities to include rice trading. Only one local farmer used bank loans, and seven took credit from input traders. In Bhatta outlet the history of intensive, credit-based irrigated farming was not longer than 10-12 years. It may be hypothesised that this period had been too short for most local farmers to develop less personalised credit relations with less unfavourable conditions attached. In Hatti outlet, with a history of 30-35 years, this was much more the case.

[58] There were no cases in Hatti outlet of cultivators without bank loans who did have such loans very recently.

6

THE WEAK AND THE STRONG

The reproduction of unequal water distribution at pipe outlet level

Preamble to chapters 6 to 9

No visitor to the Tungabhadra Left Bank Canal can fail to notice the skewed distribution of water in the command area. Luxuriously green patches are found close to scorched yellow areas, and both may be served by the same canal. The infamous head-tail differences occur at all levels of the system: outlet, distributary and main canal. In chapters 6 to 9 I discuss the water distribution practices at these different levels as examples of politically contested resource use. The objective is to understand the mechanisms through which the skewed pattern of distribution comes about from day to day, and year after year, and what different people have done and do to reproduce or change it. Chapter 6 discusses the pipe outlet level, chapters 7 and 8 the distributary level, and chapter 9 engages with the events at the level of the main canal.

At each of these levels the interaction between water, people and technology takes a different form. The story begins at the outlet command area level, where farmers distribute water among themselves. The chapter shows that the nature of the agrarian relations in the command area, particularly credit and employment relations, structure unequal access to irrigation water.

I then trace the water and follow its users upstream to see which diversions and encounters take place in the domain of the Irrigation Department between the outlet and the Tungabhadra reservoir. At distributary level the main theme is how the relationships between farmers and the irrigation bureaucracy, mediated by politicians, translate into rotation schedules (chapter 7) and adaptations to the outlet structures (chapter 8). These institutions and technologies are analysed as the expression of the balance of power between the actors concerned, and in their turn shape the interactions that take place.

At the main canal level (chapter 9) the focus is on institutional transformation within the Irrigation Department. It is shown how, against all odds almost, management procedures for main canal operation that were introduced during a severe water crisis, made water supply at this level more stable and reliable.

The practical relevance of this analysis is the following. That water is unequally distributed in protective large scale canal irrigation systems is not a new finding. However, there are very few accounts of how this unequal distribution occurs on a day-to-day basis.[1] This lack of documentation of actually existing water distribution is one factor that supports the perpetuation of a number of doubtful assumptions about irrigation water management that have dominated policy making in this field in the past decades. Three of these assumptions are *(i)* that farmers generally are uneducated wasteful users of water, *(ii)* that there is anarchy and chaos on the canals, and *(iii)* that farmers are unorganised.

This trifold picture has had unfortunate consequences for irrigation intervention. The image of uneducated wasteful farmers has supported a top-down, extension-driven mode of intervention in irrigation management, which I will describe as the 'policy as prescription' model in chapter 9.[2] The anarchy and chaos characterisation creates an excuse for not looking at the existing situation in depth: where there is no order, it has to be imported from outside.[3] The assumption of unorganised water users has created the illusion that Water Users Associations can be established on a *tabula rasa*.[4]

Together these assumptions have, for a long time, put the blame of the problems in large scale canal irrigation primarily on farmers. Recently however, rent-seeking analysis has brought the irrigation bureaucracy in the purview of wastefulness, chaos and anarchy and poor organisation as well (Repetto, 1986; Burns, 1993; Wade, 1982a). Such analyses underpin many of the policy initiatives for financial reform in the irrigation sector (see chapter 10 for detailed discussion).

The elaborate discussion of water distribution practices in the following four chapters aims to put assumptions as outlined above in perspective by confronting them with canal-level, and office-level, realities. In this way realistic starting points for change in water distribution and management practices can be identified. I hope that detailed accounts such as the one presented in this book will help to prevent wishful thinking about changes in irrigation water management, and stimulate the design of irrigation interventions on the basis of locally-specific knowledge of real irrigation situations. The threads of the policy-related argument will be drawn together in the concluding chapter 10.

6.1 INTRODUCTION

For the purpose of analysing outlet level water distribution practices three outlet command areas were selected (see chapters 2 and 5). Two small ones were selected along a tail end subdistributary of distributary 24, a head end distributary. One outlet, which I called Kabbu outlet, was located in the geographical head end of this subdistributary. One outlet, which

---

[1] Exceptions include Merrey (1983) for Pakistan, and Wade (1979, 1988a) and Ramamurthy (1995) on South India. Also see Brewer, Sakthivadivel and Raju (1997). Classics on the *warabandi* system in North India are Reidinger (1974) and Malhotra (1982) (also see Malhotra, Raheja and Seckler, 1984). Other contributions that discuss water distribution practices as understood in this book to a larger or smaller extent are Gorter (n.d.), IWRS (1982), Jairath (1985), Palanisami (1984), some of the papers in Pant (1984), Vander Velde (1980), and Venkata Reddy (1990). For discussion of water distribution practices in the Tungabhadra Left Bank Canal, also see Ramamurthy (1984) and Groenhuijzen and Noordman (1992).

[2] The major example is the Command Area Development Programme. For critical evaluations of this programme see Wade (1982b), Bottrall (1985) and Sivamohan (1986).

[3] For a 'law and order' approach to improve water distribution in the Tungabhadra Left Bank Canal, see for example CADA/TBP (1979).

[4] Reference to such efforts is made in chapters 9 and 10.

I called Hatti outlet, was located in the tail end of the subdistributary. The third outlet selected was located in the geographical middle reach of a tail end distributary, distributary 93. I called it Bhatta outlet. The approximate locations of the distributaries can be found on map 1.1. Figure 7.1 gives the location of the Kabbu and Hatti outlet command areas in distributary 24. Figure 8.9 gives the location of Bhatta outlet command area in distributary 93.[5]

The hypothesis that informed the choice of outlets was that organisation for water distribution by water users was induced, if not explained, by the occurrence of water scarcity (Wade, 1988a; Uphoff, Wickramasinghe and Wijayaratna, 1990). Sites were selected which experienced, according to local farmers and Irrigation Department officials, a considerable degree of water scarcity, without being totally deprived. It was assumed that these would be the places 'where the action was' and therefore good sites for uncovering the mechanisms at work.

I expected considerable conflict over water distribution at pipe outlet level.[6] This expectation was strengthened by the observation of clearly unequal distribution of water at the beginning of the fieldwork in two of the three outlets, Hatti outlet in distributary 24 and Bhatta outlet in distributary 93. Surprisingly however, there was very little, if any, open conflict about the inequality in water distribution in these two outlets. The issue became even more puzzling when in Hatti outlet (distributary 24), which was an outlet experiencing serious water scarcity, we discovered the existence of a sophisticated set of rules for internal water distribution. It was equitable in principle and was employed in the field by the water users, but had unequal outcomes.

The relations between water scarcity, the pattern of water distribution, and the rules and practices of distribution are explored below in two sections. In section 6.2 I discuss some of the general features of water distribution practices at outlet level. It will be shown that in all three outlet command areas farmers have made operational rules for water distribution. These rules are implemented, with varying degrees of strictness, in the water scarce periods of the agricultural year. The rules are resources which are called upon when needed. The two main characteristics of the operational rules for water distribution made by farmers are that they are based on the principles of zoning and sequencing, and on time/acre field irrigation.

In section 6.3 I discuss the paradox described above: the existence of unequal distribution with equitable rules and no conflicts in the Hatti outlet in distributary 24. The analysis of this case links unequal water distribution to its structural conditions of possibility: the system of agrarian relations, particularly credit and employment.

In section 6.4 I summarise the conclusions following from the analysis.

---

[5] The original plan was to select one outlet in the head end distributary and one in the tail end distributary. In the subdistributary selected in distributary 24, outlet command areas were small because of localisation for sugarcane, and two outlets were required to approximate the desired number of 40-50 cultivators. The selection of one outlet in the head and one in the tail created the opportunity to capture differences along the subdistributary as well (see chapters 7 and 8).

[6] This expectation was based on information collected before the actual fieldwork started, and consisted of interviews and discussions with researchers and other informants, the study of reports and other literature, and - a very useful source - newspaper reports on events related to water distribution in the Tungabhadra Left Bank Canal system. Particularly the latter source suggested persistent conflict on water distribution in the command area. This was partly due to the fact that my research was preceded by a few particularly eventful years (see chapter 9).

The title of this chapter is a tribute to the paper of Daniel and Alice Thorner 'The weak and the strong on the Sarda canal', written in 1957 (Thorner and Thorner, 1962). That paper discusses how people's position in the agrarian structure defines their access to canal water. Their paper is, to my knowledge, the first contribution to a political economy of canal irrigation in India.

6.2 RULES AND RULE-MAKING AT OUTLET COMMAND AREA LEVEL

In this section the various dimensions of rules and rule-making for water distribution at outlet command area level are discussed. I discuss how rules emerge in response to scarcity, which types of rules exist, how operational rules are made, what the main characteristics of the operational rules are, and how rules function as resources.

Rules as a response to increasing water scarcity

The Karnataka Irrigation Act, 1965 contains the provision that irrigation officers have powers "to inspect and regulate supply" at field channel level (Section 7). Neither before the Act came into force in 1965, nor after that, has the Irrigation Department made systematic use of the possibility to suggest or enforce distribution rules at outlet command area level in the Tungabhadra Left Bank Canal. The government constructed the field channels in the outlet commands[7], but does not seem to have given systematic training or instructions on the organisation of water distribution (and of maintenance).

In the beginning the organisation of water distribution must have been very easy, because hardly any was required. Only part of the command area was irrigated. Land development for irrigation progressed slowly, and water was abundant. When the Tungabhadra Left Bank Canal system gradually became operational between 1953 and 1968, farmers seem to have been left to their own devices as far as water distribution was concerned. Later, in the 1980s, there was a Command Area Development Authority programme for the introduction of the *warabandi* system of rotational water distribution. On paper water users associations were established in a limited number of outlet command areas as part of this effort, but they were never functional (see chapter 9 for more discussion on the role of the Command Area Development Authority and the effort to introduce *warabandi*).

In all three outlet commands investigated the emergence of more or less detailed systems of rules for water distribution was a response to increasing water scarcity. When land development for irrigation advanced water started to become scarce. First scarcity was felt in certain phases of the cropping cycle, later more generally throughout the year.

The subdistributary on which Kabbu and Hatti outlets are located started to experience scarcity in the course of the 1960s. Scarcity was caused by increasing land development,violation of the localised cropping pattern and unauthorised irrigation in the upstream parts of the distributary 24 command area. Within the subdistributary a similar process occurred. Water was increasingly appropriated by head end farmers. Hatti outlet,

---

[7] The Irrigation Department originally designed and constructed field channels along the ridges in the field, regardless of plot boundaries. These and other social factors were not taken into account in the design. The field channels have been extensively remodelled by farmers. As far as topography allows farmers have tended to realign them along plot boundaries, sometimes at the cost of considerable land leveling. In the purchase and sale of land plot boundaries have also been adjusted to the field channel system.

located in the tail end of the subdistributary, had to reduce the area cultivated with rice and sugarcane because of the decrease in water availability in the canal. Kabbu outlet is almost fully cultivated with rice till today, but securing sufficient water for this crop has become more difficult, particularly in the *rabi* season. (For more discussion of the spatial dimensions of the emergence of scarcity, see chapter 7.)

Water scarcity in distributary 93 and Bhatta outlet is of much more recent date. In this distributary rice cultivation started on a serious scale around 1978-80, when the first migrant farmers settled in the command area of the distributary (see chapter 5). The steady increase in rice cultivation since then has made water scarce, particularly in the *rabi* season. Land development for rice cultivation is however still going on, also in the Bhatta outlet command area. Neither the spatial pattern of water distribution nor the rules for and practices of water distribution have crystalised and stabilised to the same degree as in distributary 24. In Bhatta outlet rules are gradually emerging while land development continues and scarcity increases.

Types of rules

Elinor Ostrom has made a useful trifold distinction of (nested) rules in common property resource management that can also be applied to irrigation. She distinguishes:

1) operational rules;
2) collective choice rules;
3) constitutional rules (Ostrom, 1990:52)

Operational rules are the rules that regulate the day-to-day decision-making on the use of the resource, in our case water distribution. Collective choice rules are the rules that govern the process of operational rules making. Collective choice rules regulate for example how operational rules can be adapted to changing circumstances like increasing water scarcity, by the community of water users or others having authority over system operation. Constitutional choice rules are the rules that determine who is eligible to take part in collective choice and operational rules making, and the rules for the design of the collective choice rules.[8]

At the outlet command area level farmers are basically autonomous in their rule making and implementation activities.[9] The three types of rules take the following form at pipe outlet command area level.

In protective irrigation systems the constitutional issue of the inclusion and exclusion of farmers in/from the community of water users has been resolved, in a spatial sense, in the design of the system through the localisation pattern. By fixing the location of the canals, and by earmarking the irrigable land under these canals, the group of farmers who have an entitlement to irrigation water has been defined. In the Tungabhadra Left Bank Canal there is not much scope for inclusion of new land and farmers in the command area because of the full localisation of irrigable land. Exclusion does take place (see chapter 3). Farmers with

---

[8] Ostrom (1990:53) also lists the processes that belong to the different types of rules. To constitutional choice belong formulation, governance, adjudication and modification; to collective choice belong policy-making, management and adjudication; and to operational choice belong appropriation, provision, monitoring and enforcement.

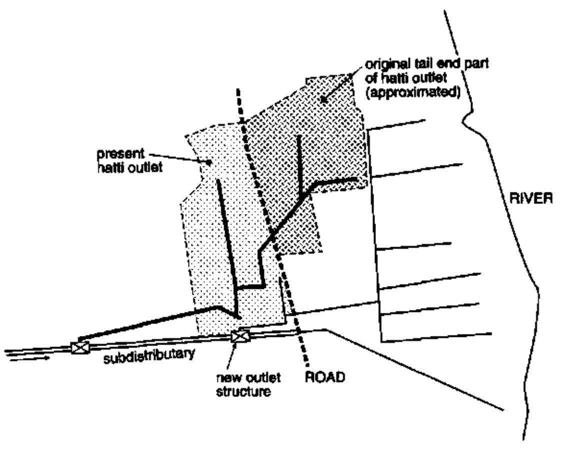
[9] In this sense the outlet command area is comparable to the farmer managed irrigation systems discussed by Ostrom. However, outlet command area farmers depend on others for regulation of the supply to their outlet. That is a major difference with many farmer managed irrigation system, where farmers may also control the water source.The lack of control over water supply strongly affects rule making and implementation at outlet command area level, as will become clear.

land in places of the command area where irrigation water no longer reaches are *de facto* excluded from the community of water users.

Farmers do have a possibility to partially redefine the division in sub-groups of the larger community of water users. In Hatti outlet there were boundary corrections of the command area, which implied the transfer of four small plots from a neighbouring pipe outlet command to the Hatti command. Outlet commands can also be sub-divided. When water became scarcer in Hatti outlet in the 1960s the outlet command area was adapted. A road divided the original outlet command area in two parts: the present 60 acres part on the downstream side of the road, and a 40 acres part on its downstream side (see figure 6.1). The 40 acre tail end portion lobbied for independent access to the subdistributary, and an extra pipe outlet structure was built downstream of that of Hatti outlet.[10] Notwithstanding the occasional occurrence of such changes the group of water users in a particular pipe outlet command area can be considered as given.

The localisation pattern not only defines farmers' formal entitlements to water in space, but also in time. Most farmers have an entitlement to receive irrigation water for one season per year (and mostly for 'irrigated dry' crops). In one particular pipe outlet command area for example the formal community of users may therefore not be the same in the *kharif* season as in *rabi* season. Or, not the same land of the users will be officially irrigable. As discussed in chapter 3, the government is unable to enforce this system of rights. In practice all farmers with irrigable land feel they have a 'right' to irrigation water in both seasons and for the crops they prefer to grow. Whether this 'right' can be effectuated is not determined by the formal system of entitlements. The inclusion and exclusion of farmers in the irrigation system in space and in time is the outcome of the struggle over water distribution, and not the subject of constitutional rule making or implementation among farmers.

Figure 6.1: Subdivision of Hatti outlet



Collective choice rules hardly exist in outlet command areas. There are very few formalised arrangements among water users for how to make operational rules and monitor

[10] The sluices under the road that connected the two parts in the past were still there. It was easy to imagine how cultivators on the upstream side of the road could deny water to the downstream side by obstruction of the pipes.

their implementation. The design of operational rules for water distribution has occurred and occurs in direct response to practical experience with the implementation of previously made arrangements and the need to solve new problems. Meetings of all water users in an outlet command area are sometimes conducted, but the design and adaptation process of operational rules has not been institutionalised. How they emerge is discussed below.

The making of operational rules

The history of the emergence of the water distribution rules in Hatti outlet in distributary 24 can serve as an example of the process of rule-making at outlet command area level (see box 6.1). In this case rules for rotational water distribution were designed in response to increasing water scarcity and difficulties that a large farmer encountered in the irrigation of his fields in the outlet command. Noticeable is the role of a local political leader in the rule-making.

Box 6.1: The emergence of operational rules in Hatti outlet

The present system of rules for rotational water distribution in Hatti outlet exists since 1974-75. It has been operational for more than 15 years, with some additions and refinements made in the course of time. All farmers in the outlet command area whom I asked about this agreed that the rules were introduced on the initiative of farmer B's father. Farmer B is one of the two big landholders in Hatti outlet command area. The accounts of how the rules emerged differ somewhat. Farmer B explained that the system was introduced by his father to avoid quarrels over water. He said that when there was insufficient water in the past "everyone quarrelled with everybody, and who was the fittest, the strongest survived, whoever is strong takes the water. Now they will blame God and keep quiet." The nature of the quarrels was the following according to the son. Farmer B's father had bought 17 acres of land in Hatti outlet command area by the end of the 1960s, which was a substantial part of the 60 acres large command area. The existing practice in the outlet command area was that everyone could irrigate according to need. When a farmer had finished the irrigation of his plots, the next person could start. This practice continued for several years after farmer B's father had bought the land. This lead to quarrels, presumably because water became scarcer through increase in upstream use, and through increase of intensive irrigation in the outlet command area itself. The 17 acres were not developed for intensive irrigation before, and were now prepared for rice and sugarcane cultivation. The problem for farmer B's father was that he did not live in or near the outlet command area, but in the camp at the head end of the subdistributary, 3 kilometers away. When he came to irrigate, he had to wait for someone to finish. When he came again another farmer had already taken the water, as farmer B's son explained. A small farmer put a reverse emphasis in the explanation of the emergence of distribution rules. He said that the small farmers came to ask farmer B's father constantly for water, but "you can't fight 10-15 farmers", and therefore farmer B's father didn't get enough water. Despite this difference in perception, both informants make the point that the rotation was in the big farmer's interest. According to farmer B his father forced the issue by once taking the water and keep it as long as he needed to irrigate all his plots. This took 15 days. Two meetings were held to come to a decision on the design of the rules for the rotation system. The first meeting was not successful. In the second meeting a third party, a political leader from the tail end camp who had no land in this outlet command, was present. Farmers explained the relevance of the political leader's presence by saying that in this way they "would be sure they would not be cheated".

To emphasise the importance of locally specific factors in rule making, the Hatti outlet can be contrasted to Kabbu outlet in the same distributary. In Kabbu outlet no rule making was possible in the period before 1984. At that moment a big and rich farmer sold his land to the father of the brothers now farming it (to finance the establishment of a rice mill). This big and rich farmer, who lived in a camp more upstream on the distributary and had his land spread along it, came and went as he pleased to irrigate his land in Kabbu outlet, or so the story goes. He had too much economic and political power for other farmers to be able to force him in the straightjacket of a rule system. Unlike in the Hatti outlet case local farmers seem to have been incapable, in the absence of accountability or dependency relationships, to negotiate more regulated water distribution.[11]

In Bhatta outlet in distributary 93 the rule making process could be directly observed because rules for water distribution were still in the making. The basic rule in water distribution in this outlet command area was that everyone could take water when he wanted it, on the basis of agreement of an order of irrigation with those who irrigated and desired to irrigate. The principle was that who first asked the present irrigator, would be next in sequence. This typically is a rule that occurs in a situation without water scarcity.

With an increasing percentage of Bhatta outlet command area under rice cultivation, water became scarce during a period of a few weeks in *kharif* 1991, notwithstanding that this rainy season was one with abundant rainfall. Day-to-day agreements became difficult, and a rotation system was implemented.[12] Some farmers claimed that the rotation had been in existence for the past 5 years, others mentioned a shorter period.

All farmers we discussed the matter with agreed on the existence of the following two rules in the rotation. The first one was the division of day and night irrigation (changing at 6 a.m. and 6 p.m.). The wet crop, that is rice, was to be irrigated during the night; the light crops, that is all other crops, were to be irrigated during the day. The second rule was that during the night irrigation would take place on a time per acre basis. The basic rule was one hour per acre. For part of the week this was changed to 1.5 hours per acre, namely when the pipe outlet gate was opened less than usual as part of the rotation schedule in the distributary. During daytime irrigation turns were to be decided on the basis of mutual agreement. Discussions with farmers regarding the order of irrigation in the hour-based, night part of the rotation did not yield clear results. Some farmers claimed that it existed in some of the field channels, but others contradicted this.[13] Rice cultivation is likely to

---

[11] As an aside it can be noted that these two contrasting examples somewhat qualify the often cited condition for successful rule making and implementation that it is enhanced by the homogeneity of the group of water users. The two cases suggest that the quality of the socio-political relationships within the group can make a big difference for the behaviour of the socio-economically dominant members of the group.

[12] Farmers reported that this took place after joint decision making of all farmers during a meeting at a central point in the command area. In reality however this meeting is more likely to have been a meeting of a limited number of leading farmers. We failed to observe a large meeting at the indicated meeting place on the day that it had supposedly taken place. One can understand the importance of claiming that all farmers were part to the decision. How the communication took place to other farmers we have not been able to find out exactly. In the Bhatta outlet case there was great secrecy about the organisation of cultivators and their representatives, for reasons discussed in chapter 7.

[13] We were unable to do field observations at night. One reason for this was the illegal extra water drawals at night (see below) at which the farmers wanted no witnesses. We were unable to reconstruct the order of irrigation the morning after the night before.

increase after 1991-92; already in *kharif* 1992 new land development (leveling) for rice irrigation was observed during a short field visit. This will necessitate adaptation of the day/night system, because it will become impossible to irrigate all rice land during the night.

In none of the three outlet commands was there an institutionalised procedure for the formulation and adaptation of operational rules. The pattern that can be discerned in their fabrication, apart from their emergence in response to scarcity, is that 'the important farmers' in the outlet command area play a central role in the process. To this point I will return below.

Main elements of operational rules in outlet command areas

The two characteristics that could be found in all rule systems we documented or heard about[14] were 1) systematic rotation of turns over users by sequencing and zoning, and 2) time/area-based irrigation.

In all three outlet commands agreements existed on the sequence of irrigation. In Bhatta outlet in distributary 93 this was, as already mentioned, a rotation in which the 'irrigated dry' crops part of the outlet command (mainly the tail end part) irrigated during the day, and the wet crops (rice) part (mainly the head end) during the night, and perhaps some sequencing during the night irrigation. Hatti outlet in distributary 24 had a very detailed rotation system that is discussed in section 6.3. Here, I discuss Kabbu outlet in distributary 24 as an example.

The 11 cultivators of Kabbu outlet in distributary 24 together cultivated 70 acres. The outlet was divided in two sections. The first section consisted of 5 cultivators, who cultivated 39 acres. These cultivators were a father, his three sons, and the father of one of his sons' wife. This group of 5 cultivators had an irrigation turn of 26 hours, three times a week on Friday, Sunday and Tuesday.[15] The turn started at 6 in the morning on these days and lasted till 8 o'clock the next morning. On Saturday, Monday and Wednesday the second group of cultivators, 6 in number who cultivated 31 acres, had their turn of 22 hours.[16] The irrigation thus alternated between the two sections during the week. The rationale of spreading the three days for one section over the week, rather than keeping them as a block, was that the discharge in the subdistributary varied systematically during the week (see chapter 7). The alternation was meant to spread water equally over the two sections.

The Kabbu outlet had another common characteristic of rotation or sequence rules: the order of irrigation was systematically varied to compensate for different availability of water during the week and for the inconvenience of irrigation at night. The first section internally compensated for the later start on Friday of irrigation, the day after the weekly canal closure. The gangman normally opened the subdistributary canal only around 9.00 a.m. on that day. This group also alternated night irrigation. These family members had a very flexible system of irrigation. Four of the five lived on the canal bank in their plots. The brothers regularly

---

[14] Apart from the three outlet command areas investigated and discussed in detail, we collected less elaborate information on many other outlet commands.

[15] The rationale of *weekly* rotation for internal distribution in outlet commands lies in the existence, in many secondary canals, of rotation at subdistributary and distributary basis also on a weekly basis, and the resulting weekly fluctuation of discharge at a particular point in the canal.

[16] The relative turns would be 26.7 and 21.3 hours when calculated proportionally to landholding. I do not know how the rounded figures of 22 and 26 hours were decided. Thursday is the subdistributary canal closure day. This closure is part of the rotation system at distributary level (see chapter 7).

took care of each other's irrigation. However, alternation of night irrigation and other flexibilities do not depend on kinship relations (see the discussion of Hatti outlet in section 6.3).

In all outlet commands investigated the irrigation time for an individual plot was based on the size of that plot. The most common rule found was an irrigation time of one hour per acre, but variations exist. The most complex time/acre based rotation schedule we found in another tail end subdistributary of distributary 24. It was devised by farmers themselves in response to a severe water crisis in the late 1980s, after which they effectively took over the management of the canal from the Irrigation Department. The details of the example can be found in Box 6.2.

Box 6.2: Time/acre irrigation in a tail end subdistributary in distributary 24

This relatively short subdistributary had six pipe outlet command areas that received, in turn, all water flowing into the subdistributary. On Friday the subdistributary was closed as part of the distributary rotation. On the first Saturday of the season the most upstream pipe outlet command started with irrigation, and in that week the six pipe outlet command areas received water going from the upstream side to the downstream side. The next week irrigation went from the downstream side to the upstream side. In the next sequence the second pipe outlet command started on Saturday, in the next the third, etcetera. In this way the differences in supply from the distributary during the week were evened out.

Farmers had decided how many acres could normally be irrigated on the different days of the week: 25 acres on Saturday, 40 acres on Sunday, 60 on Monday, 80 on Tuesday and Wednesday and 90-100 on Thursday. For each day the irrigation time per acre was calculated by the division of 24 hours or 1440 minutes by the number of acres. On Saturday for example the irrigation time was 58 minutes per acre, In the first sequence for example, only part of the first pipe outlet command could be irrigated. On Sunday another part of the first PO was irrigated at a rate of 36 minutes per acre, and on Monday the remainder of the first pipe outlet command area and most of the second outlet command at a rate of 24 minutes per acre, and so forth. Earlier, explained the farmers, they irrigated all six pipe outlet command areas simultaneously, and they could irrigate a little bit everywhere, and no water reached the tail. But "if water is concentrated in one place it can irrigate some land".

Rules as resources

An important aspect of the rules made for water distribution at outlet command level is that they function as resources in the social interaction regarding water distribution. This means two things. Firstly it means that the rules are not operational the full agricultural season or year, but are mobilised when needed. Existing rules are mobilised in periods when the demand for water is high. Secondly it means that when the rules are in operation, they not only function to determine the sequence and duration of irrigation, but also form the basis on which divergence from and violations of the rules are negotiated.

Because rotation rules were applied only in short periods in the three outlets studied in 1991-92, the evidence that could be collected on the second meaning is limited. Moreover, most of it is included in the discussion of Hatti outlet in section 6.3.[17] I therefore limit myself to the discussion of the first meaning, by giving examples from the three outlet command areas in turn.

Kabbu outlet
In Kabbu outlet in distributary 24 we did 68 observations of which plots were irrigated at a particular moment, spread over the two seasons, all during daytime. Of these 51 (or 75%) were according to the rotation over the two sections (the expected figure in case of random irrigation is 50%). This shows that the rotation was not always followed. We could identify periods in the year that farmers reported that there was 'no rotation', and indeed irrigation practice fitted the rule badly. This was the case for example in December and January. The demand for water was relatively low in this period because temperatures were low, the first crop harvested, and the second crop in the nursery phase and early crop stages. Rotation was implemented strictly, though not without exceptions, in March when the demand for water was much higher: temperatures were higher and the rice crop was in full growth.[18]

Hatti outlet
In Hatti outlet in distributary 24 there was no scarcity in the first month of the agricultural year 1991-92, because of sufficient rain. 'Irrigated dry' crops had been sown on rainfall before the canal water reached the pipe outlet on 21 June. However, towards the end of July, water scarcity came to be felt. The reason was increased water use in the outlet command area itself as well as upstream. The coincidence of full growth of light crops and rice was a period of scarcity.

The first rotation period started on 28 July, and came to an end with rain starting on 20 September, which lasted for several days. On 28 or 29 September the rotation was re-introduced for a period of two weeks. Mid-October the harvest period started, demand for water went down, and rotation was no longer required. After this there were several months

---

[17] In general adherence to the rules in the periods that rotation was implemented was rather strict in the outlet command areas in distributary 24. The less than 100% adherence to the alternation between the two sections in Kabbu outlet even in more water scarce/high demand periods that is mentioned below, should be interpreted as flexible use of the rules rather than violation. In Hatti outlet the alternation of the two 30 acres zones was kept to very strictly, but within the zones there was more flexibility in the application of the rules (see section 6.3). In distributary 93, where rotation rules were much less 'consolidated', the situation was different. How rule violation made the rotation break down in Bhatta outlet is reported below. In the small sized (60-70 acres) outlet command areas in distributary 24 interference of other farmers (within as well as outside rotation periods) in the turn of the irrigating farmer was very rare. Such interference was quickly noticed. In Bhatta outlet in distributary 93, which measured approximately 164 acres, there was more interference. For tailenders it was necessary to guard the field channels within the outlet during irrigation. (164 acres was the area actually cultivated in 1991-92, determined on the basis of information from farmers and own measurement. The survey number listed in the Irrigation Department records for Bhatta outlet command area together were 220 acres. There was no good outlet command area map that could be used to check and explain the difference.)

[18] In the *kharif* season it never came to a period of strict implementation of the rotation because of sufficient canal water supply and frequent rainfall. The rules were sometimes used in this period by farmers to claim that they could irrigate on a particular day ("today your section irrigates, therefore our section can irrigate tomorrow"). This didn't cause problems because there was sufficient water. Our observations were not frequent and detailed enough to allow more detailed analysis of this phenomenon.

without the rotation in operation because the demand for water remained relatively low. From October to January there was harvesting of rice and 'irrigated dry' crops, followed by the planting of new crops. Because less rice was planted in the *rabi* season than in *kharif*, demand for water was reduced. Also, December-February was the harvest period for sugarcane, a water demanding crop. Lastly, temperatures went down in the course of November, and only rose again substantially in the month of February. As a result of the latter, there was almost an introduction of the rotation system early February, but from that moment part of the cotton crop and the other 'irrigated dry' crops came to an end, which reduced the irrigated area in the outlet command area. In this whole period it was possible to distribute water on the basis of mutual agreement.

It was only in the second half of March that the reduced area started to feel serious scarcity. In this period there were days in the week that no water at all reached the pipe outlet through the subdistributary because of high upstream use (peak season for the second rice crop, sugarcane re-started, hot season started). From 22 March rotation was started. This period terminated on 18 April. In Hatti outlet the use of the rules for rotational water distribution was thus also restricted to the most water scarce periods of the year.

Bhatta outlet

In Bhatta outlet the rotation was implemented for one two-week period only during the 1991-92 agricultural year. Reasons for this were the not too unfavourable water supply situation of the outlet command area in general, and concerted efforts by farmers to increase supply in response to scarcity.

Canal water arrived in distributary 93 in the second half of July. It rained a lot in that month. There was no water scarcity well into August. On 24 August we had the first observation of the irrigation of a non-rice crop in Bhatta outlet.[19] The 'irrigated dry' crops needed water after it had not rained for some weeks. In the same week the Irrigation Department introduced rotation in the distributary, which implied the closure of the Bhatta pipe outlet for 2½ days per week.

The scarcity thus created led farmers in Bhatta outlet command area to introduce rotation. On 29 August it was decided that all farmers would get 1 hour per acre for the irrigation of their plots. However, the rule was not actually introduced. First farmers tried to get the supply improved. On 30 August farmers forced the gangman to open the pipe outlet gate more than normal (this was at the end of the first closure period of 2½ days).[20] On 31 August a group of 20-30 farmers went to the local Irrigation Department office, and mobilised the *Mandal Pradhan* who lived in the tail end village to join them, which he did.[21] After having waited for several hours farmers spoke to the Executive Engineer, but he did not make any promises. The representation remained without effect.

---

19) From 31 July we systematically observed which plots were irrigated during the daytime.

20) In actual fact the pipe outlet gate was not fully closed during these 2½ days. The 'almost closure' situation did allow some irrigation to continue in the outlet command.

21) The *Mandal Pradhan* is the chairman of the *Mandal Panchayat*, the elected body in between the village and *taluk* (sub-district) level, created under the decentralisation policy implemented in Karnataka during the 1980s. This *Mandal Pradhan* was the biggest landowner of the tail end village, an important local moneylender and employer, effectively the village head, and, depending on the person, feared, admired and detested. His family's, very big, house was symbolically located at the highest point of the village.

On 6 September, at the end of the second almost closure period of the pipe outlet gate, it was decided to introduce the day/night system, with time-wise irrigation during the night. Up to 14 September there was no irrigation of rice plots during the day. The agreement turned out to be very fragile. On 14 September a cultivator known for his selfish behaviour broke the rule and started irrigating his rice plots out of turn, to which other farmers respond by doing the same. The system immediately collapsed. The situation did not develop into a crisis because from 15 September there was intermittent rain till early October.

After the two weeks in August/September, the rotation system in Bhatta outlet was not reintroduced during the rest of the agricultural year. The reason for this was the following. After the day of the unsuccessful representation to the Irrigation Department the strategy to increase supply to the pipe outlet command area was changed. From then on the pipe outlet gate was systematically raised by farmers during the night by means of duplicate keys.[22]

Even after the implementation of rotation had stopped, rice continued to be irrigated predominantly at night. One reason to irrigate rice at night rather than 'irrigated dry' crops, is that it is more difficult, and more dangerous because of snakes, to irrigate fields with 'irrigated dry' crops in darkness, particularly the unleveled ones. Another reason is that under the cover of darkness the supply into the pipe outlet command area can be easily increased, to make the irrigation of the rice plots a lot quicker.

In contrast to the situation in distributary 24, scarcity was less a given factor for Bhatta outlet farmers. There was very feable control of outlet gates by the Irrigation Department at night in this distributary. This meant that Bhatta outlet farmers could easily appropriate additional water to the detriment of outlet command areas located downstream. They could thus avoid scarcity and rotation did not need to be implemented again.

Conclusion

The three examples support the statement that rules are mobilised when required. In addition it can be observed that there is some regularity and predictability in the occurrence of scarcity/high demand periods, in which rules are likely to be mobilised. Two of such periods are *(i)* the period when rice and 'irrigated dry' crops simultaneously have high demands for water in *kharif*[23], and *(ii)* the period that starts late February/early March and lasts till the canal closure in April or May, when the second rice crop requires a lot of water because of very high temperatures. This shows how the rhythms of the crop cycles and the weather structure social interaction on the canals.

It can also be observed that water scarcity at outlet command area level is not straightforwardly determined by given crop/weather interactions and given water use

[22] Farmers initially were hesitant to raise the pipe outlet gate. Even later in the year farmers sometimes asked the gangman to do it, rather than do it themselves. There was great secrecy around this practice. Only months after it had started, and after repeated observation of adjusted gate settings early-morming, farmers confirmed the existence of the practice. We were never told who exactly had duplicate keys, though it was confirmed by a number of farmers that they existed. The strategy to raise gates themselves was a change from the bribing strategy to get gates raised by the Irrigation Department personnel that was used in earlier years (see chapter 7 for more discussion of the events in preceding years).

[23] This overlap period is also visible in the table in Annex 4.1 (distributary design). There was thus some awareness of this phenomenon in the design phase. However, in the design crop water requirements are supposed to be stable for the full growing period of the crop, which in reality is not the case. The peak demand in the overlap period is likely to be higher than the design table suggests.

practices by farmers in other locations. Both can be influenced to some extent. The first by adapting crop choice to anticipated scarcity, as will be discussed in detail for Hatti outlet below; the second by active farmer intervention in distributary level water distribution. Bhatta outlet provides an example of the latter. The issue is discussed in greater detail in chapter 7.

6.3 THE REPRODUCTION OF UNEQUAL WATER DISTRIBUTION

Introduction

With regard to (in)equality in water distribution at pipe outlet command area level qualitatively different situations can occur. This section focuses on the reproduction of unequal water distribution in Hatti outlet, but it should be kept in mind that other situations can also occur. In this introduction I briefly discuss the Kabbu outlet and Bhatta outlet cases as examples of other possible situations, after which I turn to the Hatti outlet case.

In Kabbu outlet in distributary 24 no unequal distribution could be observed. In *kharif* 1991 the outlet command was almost fully cultivated with rice. There was one farmer (out of a total of 11) who cultivated cotton, and one farmer who cultivated part of his plot with sugarcane. In *rabi* 1992 three farmers cultivated part of their plot with groundnut, and the sugarcane cultivation was continued. The rest was rice.[24] All the non-rice crops were concentrated in the upstream half of the outlet command area; the downstream half was too wet for other crops than rice. The tail end problem in this outlet consisted of some waterlogging and salinity in the lowest plots along the natural drain. However, no systematic differences were found in this outlet command in rice yields and varieties going from head to tail.[25]

At first sight, the 1991-92 cropping pattern of Bhatta outlet in distributary 93 suggests highly unequal distribution of water from head to tail. In *kharif* 1991 the dominant crop in the upstream half of the outlet command area was rice (see map 6.1). Cotton was found on some of the higher spots, some of which are difficult to irrigate because of their elevated level. In the downstream half rice was found in the lower wet spots and where drainage water could be re-used. The dominant 'irrigated dry' crop in that part was sunflower, with a very limited number of plots with *jowar* (sorghum). In *rabi* 1992 there was extensive rice cultivation as well, but it was more concentrated in the upper half of the outlet command than in *kharif* 1991.

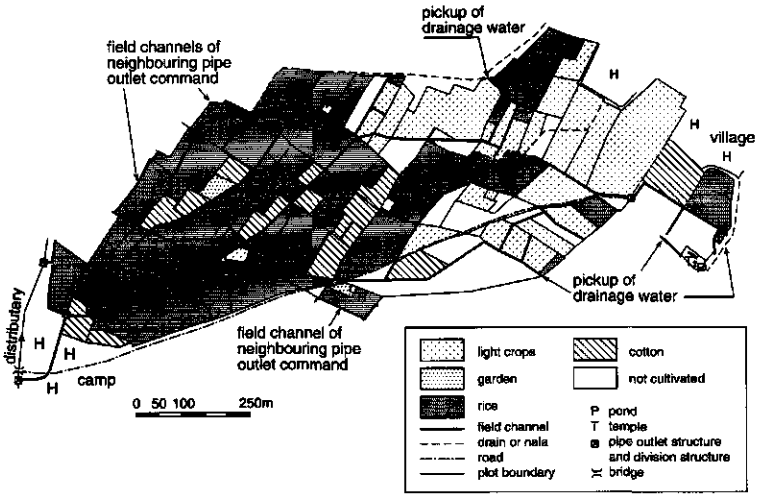
This cropping pattern suggests that in Bhatta outlet it is not easy to get water to the tail end for (lucrative) rice cultivation. However, some care is necessary with regard to this conclusion. It was already noted in chapter 5 that land development (leveling) was still ongoing in this outlet command (see map 5.1 in section 5.2). For this outlet, the water in the distributary seems not to have been used up in 1991-92. In *kharif* 1992 rice cultivation had expanded further down into the outlet command area, partly because of the development of new land for rice cultivation, and partly because some head end farmers leased in land lower down in the outlet command area. It seems very likely that when water will become scarce

---

[24] We observed the cropping pattern in *kharif* 1992 as well. Then rice cultivation was almost 100%. The only non-rice cultivation was the sugarcane.

[25] One leased out tail end plot along the drain had significantly lower yields in both seasons. This was probably due more to management problems (labour, nursery preparation) than to water availability or waterlogging and salinity problems.

Map 6.1: Cropping pattern *kharif* 1991 in Bhatta outlet, D93



in the future a head-tail pattern will occur similar to the one found now, but the 1991-92 cropping pattern can not straightforwardly be interpreted as a case of unequal water distribution. The primary inequality seems to lie in the capacity to develop land for irrigation.[26]

The only outlet command that I studied which had a 'genuine' head-tail pattern of unequal water distribution was Hatti outlet in distributary 24. 'Genuine' means that in this outlet command area all land was suitable for rice cultivation (because leveled) and all farmers would have liked to grow it. The paradoxical situation in this outlet command was that a clearly unequal pattern of water distribution co-existed with an equitable set of rules for that distribution, which was known and acknowledged by all cultivators of the outlet command area, and which was actively used. However, this seemingly contradictory situation caused no conflicts among the cultivators. It is the purpose of this section to explain this paradox.

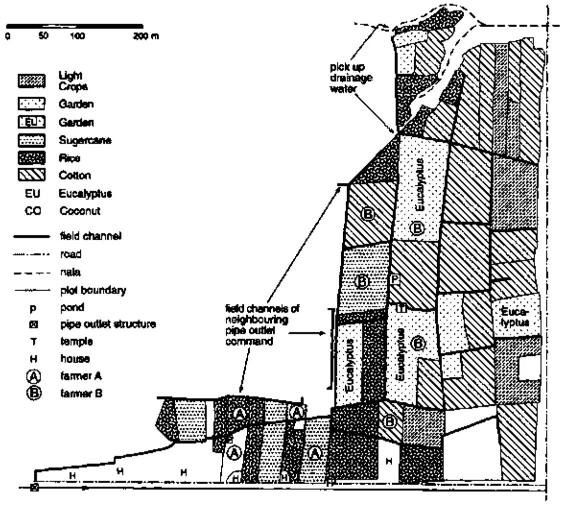
Unequal water distribution in Hatti outlet

All plots in Hatti outlet were leveled and suitable for rice cultivation. According to the farmers in the outlet, the command was fully cultivated with rice and sugarcane in the past. In 1991-92 however 'irrigated dry' crops were dominant. There even was extensification of land use in the outlet command area by the planting of tree crops. 5½ acres (out of a total of 60 acres) were planted with eucalyptus, and 3 acres with coconut. The latter was low yielding. Rice cultivation in *kharif* 1991 was concentrated in the head end, as well as sugarcane farming (see map 6.2). The small amount of rice cultivation in the tail end of the outlet command was based on re-use of drainage water (from an adjacent outlet command

[26] The use of the cropping pattern as an indicator for unequal water distribution is possible because of the general desire to grow rice, a water demanding crop. The Bhatta example shows that the indicator only 'works' when all land in an outlet command area is suitable for rice cultivation (also see chapter 5).

area and from the drain). The dominant 'irrigated dry' crop was cotton. There was very little cultivation of coarse grains. In *rabi* 1992 one plot in the head end, the one nearest to the pipe outlet structure, was cultivated with rice on canal water, and one plot in the tail end was cultivated with rice on re-use water. Sugarcane cultivation was continued in the head end of the outlet command area. Some land was left uncultivated in this season, and the remaining part was planted with 'irrigated dry' crops.[27]

Map 6.2: Cropping pattern in *kharif* 1991 in Hatti outlet, D24



This pattern of water intensive crops in the head end part of the outlet command, and 'irrigated dry' crops in the rest can be interpreted as unequal distribution. All farmers in the command area would have cultivated rice or sugarcane if they could, and the outlet command area was suitable for it.[28]

The structure of landholding was very unequal in this outlet command. There were two big farmers, farmer A and B, both settlers. They owned 24 and 22 acres, all of which was irrigated land. Of that 2 and 14 acres were located in Hatti outlet. The other cultivators were mostly small landholders, owning between 0.75 and 10 acres of irrigated land. Most fell in the 2-4 acres category (for more details, see chapter 5).

The land of the two big farmers was located in the head end of the outlet command area (see map 6.2). Half of the Eucalyptus land and all the coconut land was owned by farmer B. Here we see another paradoxical element: the big farmers appropriated the larger share of the water that reached the outlet command area. This is visible in their cultivation of rice and sugarcane. However, one of them had also extensified his land use by planting eucalyptus and coconut trees.

Water distribution rules in Hatti outlet

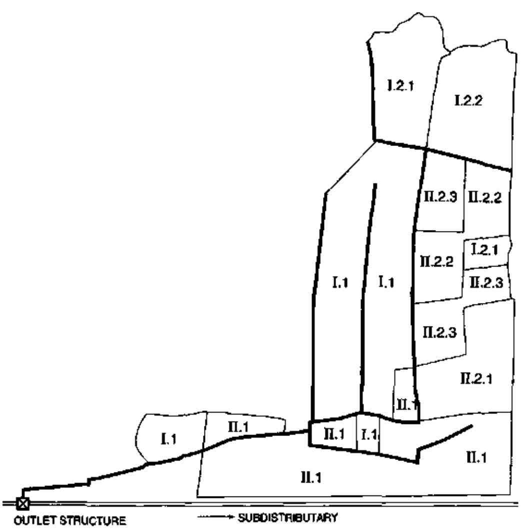
It was already mentioned above that Hatti outlet had an elaborate system of rules for water distribution. Its characteristics were as follows.

[27] In *kharif* 1992, a year that started with serious water problems and night guarding in the first week of the season, cotton was even more dominant.

[28] Apart from farmers' expression of this preference, I could observe an outlet command almost fully covered with rice and sugarcane during a short field visit in 1996. Additional water had been brought to the outlet command by means of lift irrigation, and farmers had switched to rice and sugarcane as much as possible.

The outlet command is divided into two parts, each of 30 acres.[29] These two parts receive irrigation water on alternate days. Each part thus receives water for 3 days per week. One day per week the subdistributary canal is closed as part of the rotation at distributary level (see chapter 7). Which part starts on the day after the canal closure, changes every week. In this way the variation of water availability over the week is compensated. Both parts have further internal differentiation (see map 6.3).[30]

Map 6.3: Sections for rotation in Hatti outlet, D24



The first part, which is referred to as 'Farmer B part' is divided into a segment of 20 acres and one of 10 acres. The 20 acres segment has 17 (14+3) acres of Farmer B and his brother, and 3 acres that are the plots on the left side of the approach canal from the outlet structure to the main area of the outlet command. The 20 (14+3+3) acres section receives 2 days of water, the 10 acres section one day. It is also agreed that the 1 day for the 10 acres section should not always be the same day of the week.[31] The 10 acres section is again divided into two 5 acres subsections, which each receive 12 hours of water. Here, and in all other instances, the turns change at sunrise and sunset (6 o'clock is the official agreement). The 24 hours turn changes at sunset.

[29] The rounded figure of 60 acres total command area was used by farmers themselves in their explanation of the rules. The command was actually slightly smaller. According to the localisation pattern, the survey numbers under this outlet command area measure 57.1 acres. When I added up the data furnished by individual farmers (in the datasheet on agronomic practices, the household survey, and informal talks), I arrived at exactly the same number. There is a good fit with the areas calculated on the basis of the surveying-by-pacing that I did to prepare a map of the outlet.

[30] It is remarkable that the 4 main segments of 20, 10, 15 and 15 acres discussed below closely correspond with the 4 survey numbers that make up the pipe outlet command. In the past a single survey number belonged to a single landholder. In the course of time the survey number became subdivided by inheritance and sale. In two of the 4 survey numbers this history is still very clear in the pattern of landholding. The third was sold by the single owner to a single farmer, farmer B's father. In the fourth the previous social connections could not be easily traced. Field channels also run - when topography allows - along the boundaries of the survey numbers. Spatial units have kept their social significance, even when their inhabitants have changed.

[31] When farmer B explained the rotation system to us he said he had 'to give' one day of water to the farmers in the 10 acres section. This is a significant way of phrasing it. It expresses both his dominant role in the pipe outlet command, as well as his high water demand/use (see below).

settler farmer.[35] He planted 2 acres of rice, while water was very scarce at the start of the season. Smaller farmers upstream of him in the same segment who had cultivated rice in *kharif* 1991 did not do so in *kharif* 1992.

The example suggests that location is not the only factor, and that another part of the answer is that the economically and socially powerful farmers get most of the water. It seems to be the case that 'the weak' anticipate that they would lose a battle over water with 'the strong'. Such a battle would have to take place when more farmers would decide to grow rice. The combined explanation would therefore be that power and/or location give a farmer water.[36] There is high empirical correlation between this statement and the pattern of distribution, but it begs another question: how are 'location' and 'power' set to work, through which process do they translate in more or less water and wet or 'irrigated dry' crops?

Location

For 'location' the explanation is straightforward. Being where the water comes first, or where the water has to pass to reach others, gives a strategic advantage for irrigation. Possibilities for upstream interference by others are less, and detection of interference with the supply of water to downstream plots will take time, and requires an effort of the downstream farmer to be corrected.[37] The upstream-downstream location of plots along a canal creates as it were a natural queue. In addition, upstream water users will experience smaller water losses through canal seepage and other (non-intentional) leaks than downstream water users.

Because of the small size of the Hatti outlet command, the heavy clay soil, and the relatively favourable water supply, the canal losses factor seems to have been of minor importance in the *kharif* (rainy) season.[38] In the *rabi* season the problem was more serious because the field channels dried out more when not used, developed cracks and sometimes took a long time to fill. This problem was increased by the characteristic of the rotation system that the water can be in one part of the outlet command on one day, in another the next day, and yet another on the third day. There is very little sequential irrigation of plots along a field channel. Sequencing would reduce canal water losses.

The upstream location of farmer A and B undoubtedly made their position stronger. Also the fact that the head reach lands were adjacent to the settlers camp helped in this respect. Farmer A could literally see his lands from his veranda. Such monitoring ability makes interference by others very unlikely.

However, I believe the major part of the explanation lies in the economic and political power of the two big head-end farmers. Historically power preceded location. The first step

---

[35] He was, for example, the central person in a joint lift irrigation system in the tail end of the subdistributary. He was also a farmer with some religious status. He went on an important pilgrimage during 1991-92, and he was able to invite the local MLA (Member of the Legislative Assembly) to a religious ceremony in his house, though the MLA did not show up. He had attended the marriage of this farmer, who wasn't an MLA at that point in time. He was also a farmer always on the look out and actively pursuing the purchase of new and high quality seeds.

[36] Location alone can be sufficient, as evidenced by the cultivation of rice by some small farmers in the head end of the pipe outlet.

[37] The interefernce argument does not strongly apply to Hatti outlet, but it does apply to Bhatta outlet (see above).

[38] This conclusion, as well as the following remark on the *rabi* season, are based on field observations and discussion with farmers, not on discharge measurements.

in the creation of the upstream-downstream social order was the purchasing power of particularly settler farmers to buy land in head end locations (see chapter 5). The basic question therefore is how socio-economic power is set to work in the choice of crops. I have found no evidence in Hatti outlet that the big farmers A and B directly prescribed to other farmers which crops (not) to grow. The process is a more subtle and indirect one.

Power: economic

Small tail end farmers were convinced that they would not be able to get sufficient water when they would grow a more water consuming crop. This belief was also based on practical experience. One small farmer with a plot in the tail as well as in the middle part of the outlet command reported that he had suffered a great financial loss when he had grown rice in the middle reach plot in the previous year, but was unable to get sufficient water.[39] The choice of less water consuming crops is based on the anticipation, informed by farmers' own experience or that of others, that they would run a great financial risk when they would grow more water consuming crops, because they would be unable to get sufficient water to get a good yield.

The social relationships that constituted this inability were: 1) socio-economic relations of dependency, particularly credit relations and employment relations, and 2) political relations that regulated the representation of the farmers in the outlet command at higher levels of the system.

The two big farmers in Hatti outlet supplied several agricultural inputs to other farmers on credit. Fertiliser was the major one, but one of the two large farmers also sold pesticides and cotton seeds on credit, and hired out his tractor, also on credit. The other big farmer, apart from supplying inputs on credit himself, served as a gatekeeper for credit from one of the fertiliser traders in the local commercial centre. He could recommend small farmers to the trader, who would then give them inputs on credit. For small farmers these informal, and illegal, credit relations were crucial, because they had no access to formal, bank credit (see chapter 5). The informality and illegality meant that these were local and personalised arrangements.[40] At least 6 out of the 20 small farmers in Hatti outlet had such relations with farmer A or B in 1991-92.[41]

Farmer A and B, like all good businessmen, gave substantial credit only to those they considered creditworthy. Only farmers who are able to get reasonable yields would be creditworthy. The plots of the six farmers they gave credit to were located in the head and middle reach of the outlet command area. Two of them were able to grow rice (on part of their land). 'Supporting' this group in the outlet command created the situation that tail end

---

[39] How the denial of water to this farmer took place we could not reconstruct. In 1991-92 there was no such case to observe. How the rich peasants/head end farmers show their muscle when denying water to others, I therefore do not know.

[40] The credit arrangements need not be only verbal agreements. One of the farmers in Kabbu outlet who was also a moneylender showed us the printed letters of credit of the different farmers that he had borrowed money to. The forms were filled in and signed except for the amount of the loan. This gave the moneylender the opportunity to fill in the amount he liked in case of non-repayment. Whether this system was also used in Hatti outlet I do not know.

[41] The real number may have been higher. Informal, and formally illegal, credit relations are not easy to document, because farmers are reluctant to talk about the (personal) details of their credit situation. Furthermore, the count concerns relations with regard to agricultural production in one year only. Some farmers took credit with farmer A or B in earlier years, but not in 1991-92.

farmers who would want to claim more water would not only have to fight farmer A and B, but also their business clients.[42]

In addition to credit, farmer A and B were also the employers of a number of farmers in Hatti outlet. For example, farmer B's tractor driver was the brother of one of the tail end farmers, and he employed one of the small head end farmers almost on a permanent basis to look after the irrigation of his 14 acres, including guarding activities on the subdistributary.[43] More important in quantitative terms was that farmer A and B also regularly employed the wives and daughters of the male farmers that cultivated land in Hatti outlet. I am unable to quantify the importance of farmer A and B as employers for other farmers and their family members in Hatti outlet, but that such employment took place on a regular basis can be concluded on the basis of my field data.[44]

Power: political

Farmer A and B were the representatives of the outlet command at higher levels of the system in the activities needed to secure the water supply to the outlet command. These activities are discussed in detail in chapter 7. Here it suffices to mention that farmer A was the treasurer of the organisation of five tail end outlet commands that jointly lobby for sufficient supply to the tail end of the subdistributary. Farmer A and B together with other local leaders regularly travelled to the Irrigation Department office to bring problems to the attention of the irrigation officers. Small farmers thus depended for their water supply quite directly on the big farmers, because the supply of the whole outlet command depended on the latter's performance as lobbyists.

A next logical question could be: when these two big farmers had so much economic and political leverage over others, why did they bother to participate in the design and implementation of the rotation system, and why did farmer B go as far as to extensify his land use by planting eucaluptus and coconut trees? A full answer to this question cannot be given in this chapter, because it requires discussion of processes at higher levels of the system, particularly the distributary level (chapter 7). Here it can be stated in general that the relations of economic and representational dependence are not fully one-sided. The 'strong' also depend on the 'weak' farmers in both an economic and a political sense. Business requires clients, and leadership requires followers.

The local, and formally illegal, agricultural input business of the farmer-traders requires local clients. Because of the illegality the main mechanism available to the farmer-traders to secure repayment of loans is the social control within the local community.[45] Social control

---

[42] Another factor, related to farmer A and B capacity to give credit, that is invest, is that in 1991-92 farmer A and B were discussing the possibility to invest in a pumpset to be installed on the river bank that could bring additional water to the outlet command. Investment in a pumpset lies far beyond the possibilities of almost all other farmers in the outlet. In 1996 I could observe that the lift irrigation had been installed.

[43] This gave this small farmer the advantage that sometimes water from farmer B's turn could be diverted to his own plot.

[44] Employment relations were not the primary focus of the research, and I therefore devoted a limited amount of time to it. Furthermore, such research 'following the workers' instead of the water, would have had to be village (and camp) based instead of outlet based. Another complication was that farmer A and B had most of their cultivated land outside Hatti outlet.

[45] The risk involved when such relations are absent was suggested by the relations of rich peasants with groups of migrant labourers for example. We collected several examples of these labourers

(continued...)

requires a respected position in the local community. Rich peasants act as as opinion leaders, as members of (elected) councils, and as mediators of local disputes for example. To reproduce their roles as leaders in their communities they need to accumulate social capital by showing responsible/useful behaviour *vis à vis* the people who support them, including their fellow water users. The adherence to the rotation schedule by farmer A and B in times of real scarcity, and their leading role in implementing it, can be interpreted in this way. When they would only think of their own interests, and would not want to accept yield reduction of their sugarcane by sharing in water scarcity, or decrease their demand on water by extensifying land use, their social reputation and political leadership would be negatively affected.

A paradox resolved

The argument I have developed above is that the characteristics of the agrarian structure (particularly informal credit arrangements and employment relations) and that of the organisation of political representation and leadership, constitute the structural conditions for the inability of small farmers in unfavourable locations to claim an equal share of the canal water. They are unable to substantially reduce the excessive appropriation of water by the local elite, the rich peasants, who often have land in favourable locations. Those who are 'weak' avoid conflicts over water distribution by the cultivation of less water consuming crops. Water distribution is not a practice in which the deprived choose to confront the privileged.[46)]

From the perspective of rule making and implementation, the Hatti outlet case shows that making equitable, that is location and status neutral, rules for the *supply* of water to plots within an outlet command area, and implementation of these rules in water scarce periods, may not be sufficient to achieve equity in distribution. The problem may lie in the way *demand* for water is constituted. By the choice of different crops with different water requirements inequity is accepted before distribution and rule implementation even start.

[45)](...continued)
running away with the advances given to them by their employers before the season (the advances were given to bargain lower rates). There is very little the employer can do about this.

[46)] Another factor that may be important in the dependency relation between rich and middle peasants on one hand, and small and poor peasants on the other, is the caste and community factor. In the different research locations there seemed to be a strong correlation between economic position and caste position. The outlet command areas studied however, happened to be relatively homogeneous in caste composition (distributary 24), or did not show a caste related pattern in access to water (distributary 93). Furthermore, the position of the migrant farmers, who do not fit into the local social hierarchies in a straightforward manner, complicates the analysis of such correlations. My finding is that caste (or ethnicity or religion) does not have to be introduced as a separate factor to get a satisfactory analysis of the pattern of water distribution. In the discussions with farmers on water distribution reference to economic and political power was always very explicit, but very few references were made to caste. Also the description of the migrant farmers by local farmers was mostly in terms of their farming and entrepreneurial skills and wealth (economics) and their capacity to deal with the bureaucracy and other actors (politics). Nevertheless, I feel I cannot make strong statements about the role of caste (or ethnicity or religion) in the organisation, or lack of it, of tailenders *versus* head enders. Given the correlation between caste/community and economic and political power, the caste/community factor may come to the fore when conflicts arise, and it is likely that the caste/community idiom is one of the resources used by the powerful in such conflicts. However, more explicit and open conflict than occurred in Hatti outlet in 1991-92 would be necessary to uncover this.

The system of localisation is a set of rules that intended to create an equitable demand for water. But, as we have seen, it is ineffective. Local rule making has not replaced localisation with a set of equitable demand-side rules, even when it has sometimes produced and implemented equitable supply-side rules for water distribution.

6.4 CONCLUSION

The main substantive conclusions of this chapter are the following.

In all three pipe outlet command areas that were studied sets of rules existed for internal distribution of water in the outlet. The detail and sophistication of these rules differed for the three cases. The evidence presented has suggested that more detailed rules are formulated in the face of water scarcity. All rules were the product of local rule making by water users themselves, without involvement of the Irrigation Department or other government agencies.

In all three cases the rule sets functioned as resources, mobilised when necessary.[47] Necessity occured when water became so scarce that conflicts arose over its distribution that could not be handled by mutual agreements of those who wanted to irrigate. These periods were related to the interaction of changing crop water requirements of different crops in their growth cycle, and the cropping pattern and planting dates, together with the pattern of rainfall and canal supply.

Water distribution rules organised water distribution in space and time by means of three principles.

1) Zoning of the outlet command for the systematic rotation of irrigation turns over different parts of the outlet command area.
2) A regular sequence in the irrigation of plots within zones.
3) Irrigation of individual plots on a time/acre basis.

The first principle, zoning, had been introduced in all cases we collected information on. Zoning was no simple expression of geographical convenience, though this factor was certainly important in the design of the zoning pattern. It also expressed social considerations. The distribution of the two big farmers in Hatti outlet in distributary 24 over the two main zones was no coincidence. One of the zones in Kabbu outlet was a family affair. And the crop-based zoning in Bhatta outlet in distributary 93 had to do with the practice of raising the pipe outlet gate at night.

The second and third principle, plot-sequencing and time-wise irrigation, were not always found. Their introduction seems to depend on the degree of water scarcity and the specific history and circumstances of an outlet command area. Sequencing may involve arrangements for alternating day and night irrigation, and arrangements for spreading the distributional effects of the variation of canal supply.

Time-wise irrigation expresses the link of water rights to land rights. Equity among users in access to irrigation water is defined on a per acre basis. At present, the congruence of the

---

[47] *One methodological consequence of this is that it is very important when observations of water* distribution are made. Visitors that spend only a few hours or days in the outlet have a fair chance to come outside the rotation periods, and may think they observe 'unorganised' irrigation. Furthermore, it is our experience that it is not always easy to get good information on existing rules outside the rotation periods. Short term visitors may therefore easily conclude that the rules are unclear or contradictory.

entitlements to the two resources, land and water, is considered as normal and self-evident by almost everyone.[48]

Water distribution practices sometimes diverged from water distribution rules. These divergencies should not be understood simply as 'inconsistent behaviour' or 'non-adherence'. Many differences between theory and practice were exceptions to the rule that had been negotiated on the basis of the existence of the rules. Rules were not only a resource for determining a distribution pattern in times of scarcity, but also for the negotiation of adaptations to the schedule.

The Hatti outlet case illustrated that the outcome of rule implementation may contradict its normative basis: inequality *vs.* equality. The actual implementation of equitable distribution rules may be part of the occurrence of a pattern of unequal water distribution, when the demand for water by the different farmers is structurally differentiated.

The latter point leads to the major theoretical conclusion of this chapter. Though there is no water market as such, there is a situation with regard to water use that resembles an 'interlocked transactions' or 'interlinked markets' condition. It could perhaps more appropriately be called an 'interlocked access' or 'interlinked entitlements' to resources situation.[49] For poor and small peasants access to irrigation water depends on, is interlinked with, access to other resources, notably credit for agricultural inputs, employment and access to political representation. Rich peasants are the nodal points in these networks.

---

[48] The history of the introduction of the irrigation time/acre principle in the Tungabhadra Left Bank Canal is unclear. The migrant farmers from Andhra Pradesh certainly brought it with them as part of their irrigation experience. However, it may not have a single origin, but simply may have been a 'logical' rule in the given conditions. It leaves untouched, and confirms, the distribution of landholding, which is the basic variable in the social differentiation of farmers (see chapter 5). A degree of inequity is implicit in the time/acre-wise irrigation because it does not compensate for differences in soil quality, and for transmission losses and travel time.

[49] For the concept of interlocked markets/transactions, see for example Bharadwaj (1974, 1985), Crow and Murshid (1994) and Sarap (1991).

7

MEDIATING SCARCITY

Forms of organisation in distributary water management

Distributary water management is perhaps the clearest illustration of the basic premiss of this book that water distribution is a political process of resource negotiation. In the Tungabhadra Left Bank Canal the distributary level is the main meeting ground for farmers, government officials and other actors involved in water distribution. This applies in the literal sense that these actors meet and interact on subdistributary and distributary canals on a daily basis. It also applies in the sense that many of the meetings and confrontations that are situated in other locales (like the Irrigation Department offices, the house of the local member of parliament or the site of a road block) have to do with water management at distributary level. This zone 'above the outlet' (Chambers, 1988) is a veritable arena, staging a spectacle of water distribution practices, both day and night and throughout the agricultural year.

To analyse the patterns in this eventful drama I use the term 'forms of organisation'. It refers to all institutionalised forms of human behaviour that are part of water distribution. The leading questions for my analysis of forms of organisation are: how do the different actors involved in distributary water management respond to water scarcity? What are their strategies, how do they interact, and which institutions emerge as a result?. A lot of attention is given to the strategic manoeuvring of different actors concerning water distribution, and I will emphasise the diversity and dynamic nature of distributary level institutions. At the same time I analyse how these forms of organisation are part of the larger structure of society. This embeddedness explains the stability in outcome of the day-to-day struggle over water. Notwithstanding the diversity of and change in strategies, practices and institutions, the distribution of water over space and time is relatively stable, evolves slowly, and is difficult to redirect by planned intervention. The room for manoeuvre at the distributary interface is heavily constricted.

In the introduction (section 7.1) I elaborate the questions addressed in the chapter. The following three sections discuss the main institutional responses to the emergence of scarcity and contested distribution. These are rotation at distributary and subdistributary level (section 7.2 and 7.3) and the role of politicians in distributary water management (section 7.4).[1] In section 7.5 I draw a number of conclusions.

---

[1] Because of the diversity of forms of organisation the discussion has to be limited to the main elements. I do not discuss forms of organisation in the lift irrigation schemes in the command, and give only limited attention to the styles of management of the canal-level officials of the Irrigation Department. I also do not discuss all activities of farmers 'above the outlet' in detail.

7.1 INTRODUCTION

Formally speaking there should be no need to ask the question which forms of organisation occur in distributary water management. The formal arena for rule making regarding water distribution in the Tungabhadra Left Bank Canal is the Karnataka State parliament. Through the Karnataka Irrigation Act (1965) and several other laws and regulations the Karnataka government has vested the authority for the management of the canal irrigation systems in the Irrigation Department.[2] The Irrigation Department regularly releases ordinances, schedules, and other forms of operational rules regarding water distribution at the main canal and distributary levels. This allocation of authority and definition of rules fully determines how the main canal and the distributaries should be managed. There are no institutionalised platforms for joint rule-making, implementation and monitoring by farmers/water users and the Irrigation Department.[3]

In practice the Irrigation Department is incapable of exerting its legally defined dominance and does not succeed in distributing water according to the localisation pattern (see previous chapters). Users are able to treat irrigation water in the distributary canal network as a common pool resource. The basic feature of common pool resources that "exclusion is difficult, and yield is subtractable" is badly felt (see Orstom and Gardner, 1993:93).[4] For the government management it is difficult to prevent (over)extraction of water from a system like the Tungabhadra Left Bank Canal with open earthen canals spread over 240.000 hectares. It simply provides too many opportunities for water users to interfere with main system management.

The operational rules that actually govern water distribution at distributary level are not designed in formal arenas governed by constitutional and collective choice rules. They are crafted in the confrontation of government officials who try to implement localisation, head enders who guard their privileged access, and tailenders who attempt to relieve the scarcity they experience. Existing rules and other institutions are the emergent properties of these interactions.

The analysis of this emergence below is a critical engagement with the work of Robert Wade and Priti Ramamurthy. They have done detailed work on actually existing forms of organisation in three canal irrigation systems very close to the Tungabhadra Left Bank Canal (Wade, 1975, 1979, 1980a&b, 1982a&b, 1988a&b, 1990; Ramamurthy, 1988, 1989, 1995). The focus of their analysis is the forms of organisation found among water users, the nature of the irrigation bureaucracy, and the type of linkage that exists between the two. The focus

---

[2] For discussion of the effort to make the Command Area Development Authority the paramount institution, see chapter 9.

[3] In the Tungabhadra system there is a formal platform for discussion at system level in the form of the Irrigation Consultative Committee (ICC), but its role should be understood differently (see chapter 9).

[4] The use of irrigation water for crop production implies its consumption. The water disappears from the system through evapotranspiration, percolation, seepage and drainage. The yield of the resource is thus subtractable. However, part of the canal water is re-used within the system after it has percolated and seeped into the groundwater aquifer and the natural drain. Lift irrigation and diversion by means of pick-up weirs and canals from natural drains is widespread in the Tungabhadra system. This water is partly used within the localised command, partly it extends irrigation beyond this.

of my analysis in this and the following two chapters is the same, but some of the main findings on these issues are different than Wade's and Ramamurthy's.

The nature of the relationship between the farmers/water users and the Irrigation Department officials in main system management that the two authors present is captured in the following quotation.

> The central point is that farmers' uncertainty about water supply induces patterns of 'hoarding' behaviour, which in turn induces a sense of frustration, alienation, and low morale among the irrigation staff, culminating in the 'syndrome of anarchy', a set of mutually reinforcing negative expectations on both sides of the farmer-irrigation staff relationship. (Wade, 1990:189)[5]

The situation is one of opposition and confrontation. The main mechanism that connects the two parties is that of bribe payments by farmers to officials in order to secure water supply (or, from the opposite perspective, the extortion of illegal payments from farmers by officials). Those farmers who have access to political networks can use the lobby of MLAs (Members of the Legislative Assembly) and other politicians to reduce the volume of bribe payments and exert more continuous pressure on the Irrigation Department.

In these practices the existence of village-based 'common interest corporations' of farmers is very important. These undertake activities to secure and/or increase water supply to the outlets concerned, and organise the internal distribution of water, which involves the appointment of common irrigators. These organisations of water users emerge in response to certain degree of water scarcity and risk in irrigated agriculture.[6]

In the Tungabhadra Left Bank Canal we have come across very few examples of 'common interest corporations', and none with a degree of organisation comparable to that described by Wade and Ramamurthy. The ones I did find were not village-based, but based on hydraulic units. I have found only one example of the appointment of common irrigators, and that for a few years only (see the discussion of distributary 93 in chapter 8). Incidental as well as routinised bribing is part of Tungabhadra Left Bank Canal water distribution, but it is not the main element of the farmers/officials relationship. Consequently, the political lobby through MLAs is not explicitly aimed at the reduction of bribe payments, but is mainly, as is also discussed by Wade and Ramamurthy, a proxy for an accountability relationship between farmers/water users and the Irrigation Department.

The theoretical structure of Wade's and Ramamurthy's analysis is as follows. The officials' behaviour on the canals stands in the service of the overall rent-seeking activities of the state. Rent-seeking at the local (canal) level feeds that at higher levels, and this 'system of administrative and political corruption' characterises the nature of the Indian state in general (see Wade's seminal paper on this; Wade, 1982a). Because the system also reproduces social differentiation in the farmers' communities, the economically and politically powerful members of the farming community seem to be happy, or see no other option, than to participate in the system (see Ramamurthy, 1995). There is only the occasional heroic irrigation engineer that tries to distribute water along different principles (Wade, 1980). Nothing seems to emerge from the daily struggle over water other than the reproduction of

---

[5] As Wade points out, 'syndrome of anarchy' is originally Hart's term (see Hart, 1978).

[6] The most stylised form of this ecological explanation of the occurrence of forms of collective action by water users can be found in Uphoff, Wickramasinghe and Wijayaratna (1990). Wade argues that in the cases he studied variations in risk and scarcity sufficiently explained the *occurrence* of the 'common interest corporations', but that for understanding the institutional *form* of these organisations, many other factors are relevant (Wade, 1988a:214).

this externally grounded schema of relations. It seems to be a stable configuration without history and evolution.

In the Tungabhadra Left Bank Canal the distributary level interface of water users and the Irrigation Department is not the barren battlefield that Wade and Ramamurthy sketch. Though a battlefield no doubt, the day-to-day interaction has generated other institutional forms for mediating the distribution of scarcity than the management-by-bribe-and-political-lobby approach. In this chapter I show that the interaction of water users and Irrigation Department staff has resulted in the emergence of Irrigation Department managed but jointly controlled rotation schedules at distributary and subdistributary level. The rotation schedules and the way they are implemented can be interpreted as the institutionalisation of the balance of power between head end and tail end farmers, as well as that between water users and the Irrigation Department. The political lobbying activities of farmers should not only be seen as the pursuit of particular economic interests by political means, but as a set of structured practices they are also an important factor in the consolidation and reproduction of the rotation schedules.

In the following three sections I present the evidence that supports these statements. In the concluding section I return to the main argument.

7.2 ROTATION AT DISTRIBUTARY LEVEL

For the Irrigation Department as well as the water users, the emergence of water scarcity in the distributary and subdistributaries created the need for managing the system rather than operating it.[7] Farmers started to intervene in main system management on a large scale. Chambers classified farmers activities above the outlet in the following categories: fact-finding, local negotiation, lobbying, appropriating, guarding, operating, and construction, capture and maintenance (Chambers, 1988). Farmers in the Tungabhadra Left Bank Canal undertook all of them.[8] The Irrigation Department was confronted with damage to the canals and structures, with farmers who interfered with the tasks of the canal personnel, tail end farmers who complained that they did not get their due share of the water, and head end farmers who pressed the Irrigation Department to condone their over-appropriation. In many distributaries in the Tungabhadra Left Bank Canal there seems to have been a similar institutional response to these problems: the establishment of rotational systems of water distribution at the level of the distributary, and sometimes at subdistributary level.[9]

Rotation can accomplish several things. First, it can increase the efficiency of irrigation by concentrating the flow of water. This reduces canal seepage losses, and it can make field irrigation more efficient because a plot can be irrigated quicker (also see box 6.2). When introduced in a situation of continuous flow as in the Tungabhadra Left Bank Canal, rotation can spread water over a larger area, not only by efficiency gains in the canals, but also by

---

[7] The factors that explain the emergence of scarcity were discussed in chapters 5 and 6.

[8] In addition to fact finding, I also came across the phenomenon of person-finding. It happens that Irrigation Department officials make themselves scarce when they expect problems, like being locked up in their house by a group of farmers. Farmers may then sometimes sent out patrols to nearby towns and hotels to locate the concerned officer and force him to respond to the representation by the farmers.

[9] A quick search in Irrigation Department files yielded written statements of rotation schedules for twenty mostly larger distributaries.

the reduction of the total volume of water supplied to the areas already irrigated. Lastly, rotation can make irrigation supply more predictable and reliable.

This section contains detailed description of rotation schedules at the distributary level. We studied three distributaries, numbers 24, 93 and 97.[10] Of the three distributaries, distributary 24 has the oldest and most elaborate rotation schedule. It is the main example in this section. The recent implementation of the rotation schedule in distributary 93 provides some insight in the process of the introduction of rotational water distribution. Distributary 97 is one of the few larger distributaries where there is no distributary rotation in operation. Of the three distributaries it has the lowest actual water availability per unit area. This combined with the location of settlers and a town in the head reach of the command area (see chapter 5) seems to have prevented the introduction of a rotation schedule.

The detail of the description in sections 7.2 and 7.3 illustrates the multitude and complexity of the factors that explain the emergence or non-emergence of particular forms of organisation in distributary management. The readers who prefer not to submerge themselves into these case stories are refered to the concluding paragraphs of each section, where the main findings are summarised.

Rotation in distributary 24

For distributary 24 the introduction of a distributary rotation system can be dated in the second half of the 1960s.[11] The oldest Irrigation Department document that I found in which it is described is from 1969 or 1970.[12] This document describes a rotation system which involves the closure of one or more subdistributaries plus pipe outlets directly taking water from the distributary, every day of the week. The rotation starts on Sunday at the head of the distributary, and ends with the tail end subdistributaries on Saturday (for the layout and rotation details see figure 7.1). More than twenty years later this rotation system is still in use.

The effect of the distributary rotation system is that there is some supply to tail end subdistributaries and outlets during a few days per week. In figure 7.2 the mid-day daily water levels in the *rabi* season are given for different points along the canal. The measurement points are indicated in figure 7.1. It can be observed that the discharge into the distributary is relatively stable, but that the rotation system creates increasing variation going downstream. At the start of the third, tail end section of the distributary the ratio between the maximum and minimum water depth in the canal is 1.5/1. At the tail end outlet it is 5-

---

[10] In distributary 24 three months field work was done in the *rabi* season by Kees van Straaten (van Straaten, 1992). In distributary 97 three months fieldwork was done by Alex Bolding (Bolding, 1992) in the same period. In distributary 97 no investigation of water distribution was done at the outlet command area level, and therefore this distributary was not discussed in chapter 6.

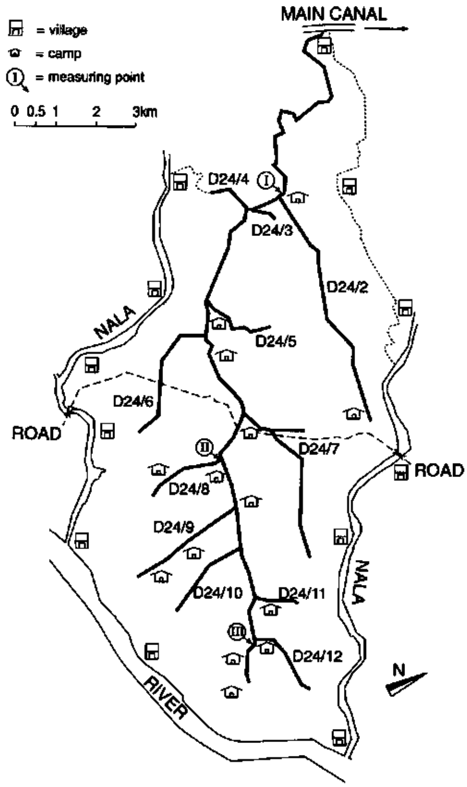
[11] This follows from references to it in the files of the Distributary Irrigation Committee from that period.

[12] One retired engineer told me that the introduction of this rotation schedule was preceded by a lot of discussion with the water users in the distributary. At one point the Irrigation Department proposed to introduce self-management of the distributary by a Distributary Committee, with the supply of a fixed discharge at the distributary head by the Irrigation Department. The Irrigation Department had also prepared a schedule for how this supply might be distributed. According to the engineer, the farmers accepted this proposal when it was discussed with them in a field meeting, but later rejected it. The engineer explained the rejection by stating that the Irrigation Department proposal was equivalent to giving a hungry man a piece of bread and asking him to share it with others.

Figure 7.1: Rotation schedule in distributary 24

CLOSURES:

Sunday:	Subdistributary D24/2 DPOs
Monday:	Subdistributaries D24/3, D24/4, D24/5 and D24/6 DPOs
Tuesday:	Subdistributary D24/7 DPOs
Wednesday:	Subdistributary D24/8 DPOs
Thursday:	Subdistributary D24/9 and D24/10 DPOs
Friday:	Subdistributary D24/11
Saturday:	Subdistributary D24/12



DPOs = Direct Pipe Outlets (outlets that take water directly from the distributary canal)

Source: File Division office 1992

In the rotation schedule published around 1970 subdistributaries D24/11 and D24/12 were closed on Friday and the tailend pipe outlets on Saturday.

10/0, that is infinite, because the supply regularly dries up completely.[13)]

There is considerable regularity in the variation of water levels during the week. At the start of the third section of the distributary (D24/III) the water level is low on Wednesday to Saturday, when the closures in the rotation schedule are downstream of this point. From Sunday to Tuesday when the rotation-closures are upstream, the water levels are higher. At the tail end the water level is zero or very low on Friday and Saturday, the days that D24/11 and D24/12 should be closed and all upstream subdistributaries are open. When one or more

[13)] The variation in discharges is even more pronounced because Q (discharge) relates to water depth$^{3/2}$ (approximately).

of the upstream subdistributaries are closed, water does reach the tail end. Wednesday and Thursday, when the subdistributries immediately upstream of D24/11 and D24/12 are closed, are the best days, though the pattern is irregular.

The variations in the water level at the head of D24/9 also show a regular pattern. The days after the weekly closure on Thursday, the inflows are low. The closures in the rotation schedule are downstream of the D24/9 offtake on Friday and Saturday. When the rotation restarts on Sunday at the head of distributary 24 the discharge into D24/9 starts to build up. The closer the closure is to D24/9, the higher the discharge into D24/9. Monday, Tuesday and Wednesday are the 'good days'. These days are crucial for irrigation in the tail end outlets of D24/9.[14)]

The distributary 24 rotation system is not a rigorously implemented schema, but a resource called upon when necessary. During the season, the strictness of its implementation depended on the acuteness of water distribution problems. During relatively calm periods, the Irrigation Department allowed a degree of tampering with outlet gates by farmers, at night (by the absence of night patrols) but also during the day. The Irrigation Department staff regularly violated the official schedule itself to solve local problems in distribution, like increased demand for transplanting and ploughing, or requests for a last irrigation before the canal closed. Because of variation in the local conditions, the schedule may be used more in one season than another. Over the years, the rotation system was reintroduced many times. In times of water crises the schedule is formally declared, by notifications, to be in operation (again), and efforts are made to implement it more rigorously than in the period before the notification.

The rotation system in use in distributary 24 can also be interpreted as the maximum that headenders will allow to accommodate tailenders. This follows from the failure to introduce more rigorous schedules. In the second half of the 1980s several efforts were made by the Irrigation Department to implement a rotation schedule that would push more water to the

---

[14)] Subdistributary D24/9, like the distributary 24 tail end outlet, benefits mostly from closure closely upstream, and less of closures further upstream, because extra discharge in the main distributary as an effect of the closure of subdistributary and pipe outlet gates, is consumed close to the point where it is generated. This is because the downstream gate settings are not adjusted downwards in order to spread the extra discharge over the full canal length proportionally. The pipes of pipe outlets and subdistributary offtakes are put on bed level, and therefore do not behave proportionally: the percentage increase in discharge through the pipe is more than the percentage increase in the canal. It would also be very difficult to implement such a practice of fine tuning of gate settings. Water levels can substantially vary within a single day, and pipe outlets are non-modular structures, which also makes them sensitive to changing water levels in the outlet canal (see chapter 8). However, a 'rough tuning' response to varying water levels does exist. For example, normally the D24/9 offtake gate is raised 11 or 12 inches. On Friday and Saturday, the days with low supply in the distributary at the D24/9 offtake point, the gangman puts the gates of the D24/9 offtake at 9 inches opening. This reduces supply into D24/9 and increases supply to the area downstream of it. On the other hand, in the peak demand period at the end of the season, late March and early April, the gangman, under farmers pressure, raised the gate to 13 inches, even 14 inches on one day, and skipped the Thursday closure on 9 April. 'Rough tuning' is thus not a strictly implemented rule. (For those who study figure 7.2 closely, the absence of Thursday closure of subdistributary D24/9 at the end of April and in May is caused by abundant supply: the rice harvest had started.)

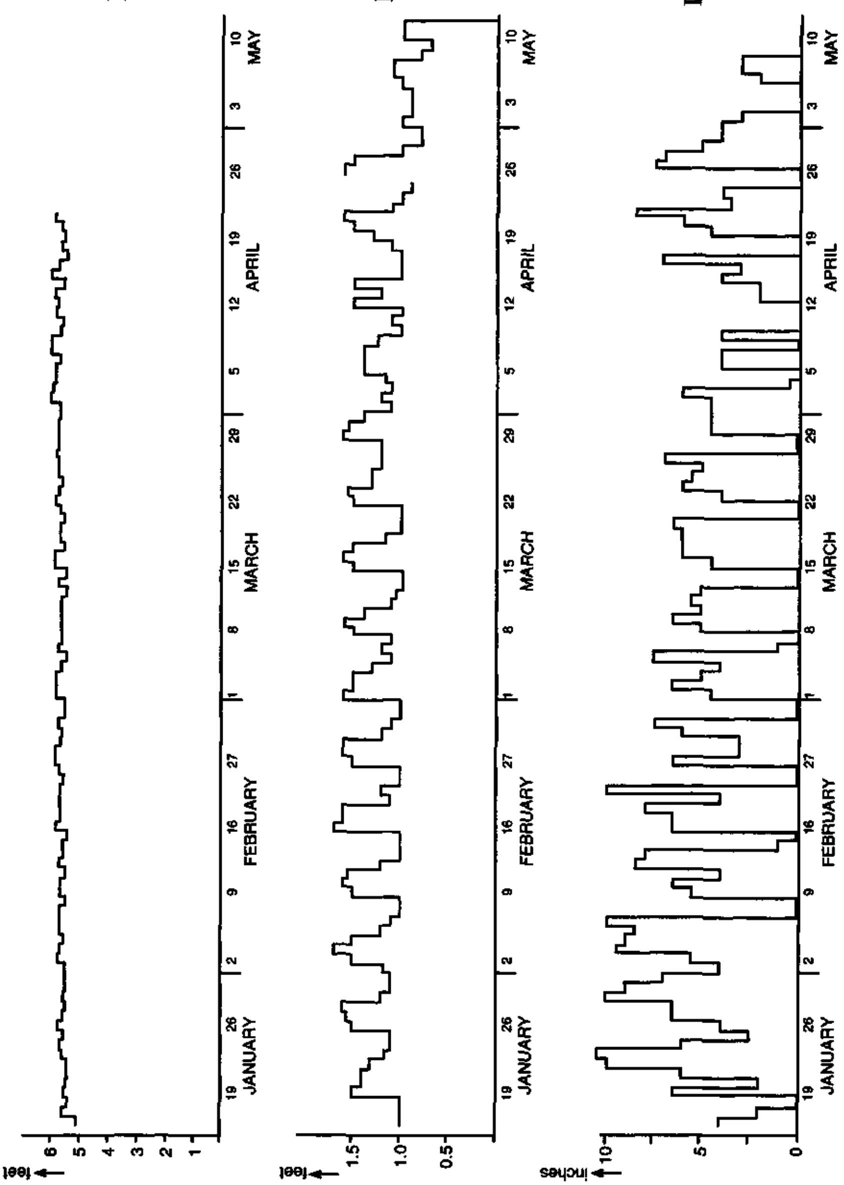


Figure 7.2: Mid-day water levels at different points along distributary 24 during rabi 1992

tail by closing subdistributaries for two days per week instead of one.[15] In March 1989, at the height of a water crisis (see chapter 9), the Irrigation Department ordered a rotation in distributary 24 that divised the distributary in two parts, each receiving water half of the week. The Irrigation Department also tried to implement this in the following 1989-90 irrigation year. In July 1989 the *Mandal Pradhan*[16] wrote a letter to the Assistant Executive Engineer in charge of distributary 24 saying that "if the POs are closed as specified in the notification, it is going to create a lot of problems to the farmers. Because of this reason, it is better to follow the old system of closing POs (...) rather than this new system. We request you to consider this matter." This consideration did not take long. Ten days later the Assiatant Executive Engineer wrote to his superior, the Executive Engineer, that "if we follow the [new] rotation system farmers will be getting water once in 8 to 10 days, as such ayacut farmers are opposing it. (...) it is not possible to introduce the new rotation system, instead of it the old rotation system will be followed". After these failed efforts to implement rotation with longer closure periods, a new Section Officer came and adopted a different strategy (see section 7.4, example 3).[17]

Rotation in distributary 93

In distributary 93 rotation at distributary level was first introduced in the early years of the canal when demand for irrigation water was so low that it was decided to supply the outlets along the main distributary for one week and along the subdistributaries the other week (see figure 8.9 for a map). When migrant farmers settled in the canal command, from 1978-79, this was one of the first things they tried to change. They represented to the Irrigation Department without success, and consequently mobilised support from a local MLA. At a cost of 8000 Rupees a ceremony was organised to which important officials from the Revenue, Agricultural and Irrigation Departments, functionaries from the banking sector, and village leaders from ten surrounding villages, were invited. The local MLA laid the foundation stone for the main camp on the distributary. During the ceremony the water facilities for this new camp were discussed, as well as the number of pipe outlets, both of which the settlers wanted improved. After 1981, the founders of the camp reported, water supply was continuous. One of them observed that "money is the only thing that matters to get the work [18]

---

[15] I found references to proposed changes in the distributary 24 rotation system starting from *kharif* 1985. In August 1985 the Irrigation Department ordered the introduction of rotation in subdistributaries in the third section of distributary 24. In January 1986 a system was notified in which each subdistributary is closed two days per week. This was repeated in August 1987 and in late 1988 and early 1989. It seems unlikely that implementation was very successful. Farmers made no reference to it in their accounts of changes in water distribution in distributary 24.

[16] The *Mandal Pradhan* is the chairman of the *Mandal Panchayat*, which is the elected body one level below the District Council (*Zilla Parishad*). The *Mandal Panchayat* covers a number of villages. These bodies were introduced under the 'Karnataka Zilla Parishads, Taluk Panchayat Samithis, Mandal Panchayats and Nyaya Panchayats Act 1983' in an effort to decentralise decision making on (rural) development.

[17] There is a difference between notifications issued by the Irrigation Department that try to resolve real crises in the field, and notifications that are issued because 'higher authorities' have given orders to do so. In December 1989 another notification was issued for the 50/50 rotation after pressure from the Command Area Development Authority, which seems to have had no impact at all.

[18] The MLA later became a cabinet minister, and was instrumental in the sanction of the construction of roads and electricity lines to the main camp on distributary 93.

Box 7.1: Water distribution and legal action in distributary 93

Just outside the main camp on distributary 93 there was a large pipe outlet of which farmers constantly raised the gate to take extra water. As nothing had helped to reduce this, the Section Officer decided on a different strategy: to bring the offenders to court and get them convicted. Knowing how difficult court cases could be won by the Irrigation Department, he made certain arrangements. One necessity was to catch the gate-raisers red-handed, and a second to have independent witnesses. Through the gangman he got word that farmers were preparing to demolish the gate. On that particular night, he went to the camp close by, socialised with farmers, and let himself be given food and drink, to avoid suspicion and mislead the offenders. He had earlier asked some farmers from a tail end village to go into hiding not far from the concerned outlet. Some time after dark, farmers came to raise the gate and 'remodel' the outlet. When the Section Officer heard noises indicating that this business was going on, he went to the spot and the witnesses came forward. The Section Officer could now book the case. However, went he went to the local Sub-Inspector of Police, this person refused to register the case. After the incident on the canal, some farmers from the camp had immediately gone to the Sub-Inspector and convinced him, by means I can only guess at, not to accept the case. The Section Officer responded by addressing his Executive Engineer and through him the Superintending Engineer. The Superintending Engineer supported his departmental staff and went to talk with the Police Inspector, who consequently instructed his subordinate to register the case after all. This all happened within 24 hours, because the law prescibes that cases have to be be registered within this period. After 2-3 years the offenders were convicted, and had to pay a Rs.200 penalty.

The increasing gap between supply and demand led to the introduction of a new rotation system in distributary 93 during the 1980s. When exactly this happened is not fully certain. The Section Officer in charge of distributary 93 in 1989-90 stated that he newly introduced rotation in that year. In order to be able to introduce a rotation schedule the management routines that had emerged since rice cultivation had started to expand, had to be undermined.

The middle reach rice farmers of distributary 93 had maintained their generous water supply throughout the 1980s by 'maintaining' the canal officials. There was a systematic practice of collecting money on a per acre basis for this purpose. A 'management committee' of trusted farmers was formed to organise this.[19] The newly appointed Section Officer for distributary 93 tried to enforce a more equitable water distribution pattern. He designed a rotation system, supervised his field staff closely, was on the canal a lot, and confronted farmers who interfered. He also mobilised the law, legal procedures and the police, to enforce water distribution. An example of one such a confrontation is given in Box 7.1. The example illustrates the perseverance and clever manoeuvring of this officer, the difficulty but possibility to change existing distribution patterns, and also it is a lesson in how to construct a winnable court case.[20]

[19] This is one of the two examples of organised bribe payments that I could identify in the areas studied. The other was situated in subdistributary D24/10 and involved the collection of money in emergency situations only. It had also been superseded by other management routines (see section 7.3).

[20] The case described is based on interviews with the concerned Section Officer, and the documents of the court case. I could not verify all details by interviews with farmers.

The Section Officer through these actions and his refusal to take bribes (he threatened to pursue those who offered them) was able to establish a rotation schedule in the distributary.[21] In this rotation the distributary was divided in two parts which received water for 3 days each. The border was located just upstream of the main camp on distributary 93 in the middle of the rice cultivation area.[22] The seventh day, Sunday, the canal was closed. Whether it was fully implemented as planned I do not know, but heroic stories are told by tail end as well as head end farmers on the efforts of this officer to implement the system. "He was not afraid of anyone" is what was said with admiration. The system must have had some effect because tailenders tried to prevent his transfer, but without success.[23]

In August 1991 a different rotation system was notified. In this rotation there were three sections instead of the earlier two. The first section stretched from the main canal till approximately the start of the middle reach rice area, the second section from this point till the end of this rice area, and the third section included the remainder of the canal (see figure 8.9 for a map). The rotation consisted of closure of the first section from Sunday evening to Wednesday morning (2½ days), and the second section from Wednesday morning to Friday evening (2½ days). From Friday evening to Saturday evening there was no closure.

The major advantage for the middle reach rice farmers of this rotation as compared to the earlier one was that on all days of the week (except of course the day that de distributary as a whole was closed) water was passing in the distributary canal past the middle reach outlets. This created the possibility to draw water at any time required, while in the earlier system part of the distributary canal in the middle reach was dry for half of the week. The change to the new three-section rotation can thus be interpreted as a concession to the middle reach rice farmers.

The implementation of this rotation schedule during 1991-92 was not very strict. This was partly due to the timely rainfall at the start of the year, and partly because the Section Officer of distributary 93 took very little interest in water management. As a result field staff got little support in implementing the rotation. Figure 7.3 shows that in the *rabi* season in 1991-92 the intake of Bhatta outlet command area, which is located in the second section, was never closed fully in the Wednesday to Friday rotation period (also see chapter 6). The same was true for other pipe outlet commands in the second section, and also the pipe outlet commands in the first section during their rotational closure. The gate opening was reduced to one or two inches on the 'closure' days, but the gates were never fully shut.

There was a day and night rhythm as well. The gate readings given in figure 7.3 are from 12 p.m.. We also took a reading early morning before the gangman arrived. On most days in February and March, the peak period, we found the gate opened 6 or 7 inches in the morning. The gangman then came and reduced it to 4 inches, at which level it was kept during the day. When we drove along the canal around 6 p.m., after the gangman had returned home, we frequently observed farmers sitting on outlets to manipulate gates.

---

[21] It is noticeable that the middle reach farmers were unable to prevent this despite their political connections. One possible explanation is that after roughly 10 years they were not yet sufficiently embedded in local politics, and that their distributary was relatively small and not a central area in a constituency (see also section 7.4).

[22] I leave aside the details of the rotation schedule in the subdistributaries.

[23] It seems that this officer's ability as a trouble shooter was also noted by his superiors and he was posted in comparable problematic situations in other distributaries in the years after his transfer from distributary 93.

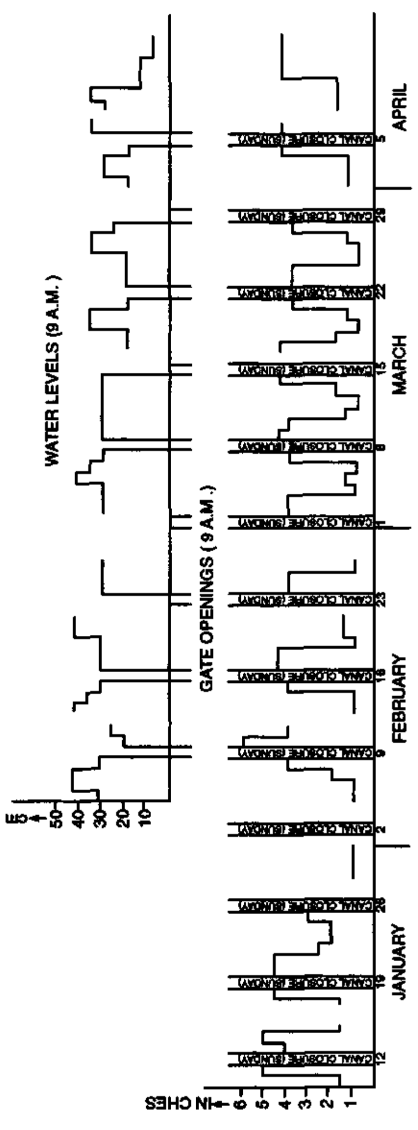


Figure 7.3: Gate openings of and water level at Bhatta outlet, distributary 93 during *rabi* 1992

Also visible in figure 7.3 is that the water level in the distributary at Bhatta outlet was generally higher in the three days before the canal closure than the three days after it. This means that the partial closure of the outlets in the second section raised the water level and increased the supply to the third, tail end section. When tailenders talked about the rotation they said that they could get water during three days a week. These were the days of the second section's partial closure. The Irrigation Department concentrated the little bit of night guarding that it did in the *rabi* 1992 season to enforce the rotation more strictly, also in these three days.

That the rotation was not very strictly implemented is also shown by the actions that a large farmer from a tail end village found necessary to undertake to get water to his lands. When this large farmer wanted to irrigate his lands he employed 6 labourers to guard the canal and he himself guarded the distributary gate at the main canal. These interventions were prepared with representations to the Irrigation Department. Reportedly, the labourers sometimes carried axes while guarding the canal.

Main findings

The main findings of this section are the following.

1) Water scarcity induces the emergence of rotation schedules. They are used in many distributaries in the Tungabhadra Left Bank Canal, from head to tail. However, very low water availability combined with other factors may make them unfeasible.

2) Rotation schedules are the outcome of local negotiation between different groups of farmers and the Irrigation Department. It seems to be the Irrigation Department that usually articulates the exact time schedule; the feasibility of this shows in its use. The

introduction of rotation and its reproduction over time is not easily achieved. It requires repeated and concerted action from farmers as well as Irrigation Department staff, and may involve the mobilisation of political influence and the law. Its monitoring involves guarding activities of both the Irrigation Department and farmers. The rotation schedules are thus jointly controlled.

3) Rotation does not accomplish equality in water distribution but does push some water to the tail end areas. Rotation schedules can be interpreted as the expression of the power balance between head enders and tail enders.

4) Rotation creates a regular variation of water availability, that is, it increases the reliability of supply.

5) The management style of the Irrigation Department officer responsible for distributary management is an important variable in the implementation of rotation schedules.

6) Rotation schedules are an institutional resource that is drawn upon when needed.

7.3 SUBDISTRIBUTARY ROTATION

In this section I discuss subdistributary rotation in distributary 24. This distributary has in total eleven subdistributaries that provide an interestingly diverse pattern of forms of organisation (see figure 7.1 for the layout of the distributary system).[24)]

In distributary 24 the subdistributary rotations are partially formalised and implemented by the Irrigation Department, and partly they are farmer controlled. Also, rotation is not practised in all subdistributary canals. The reasons for these and other differences are explored below.[25)]

Farmer controlled rotation: D24/10, D24/11 and D24/12

The most complex subdistributary rotation schedule, combined with rotation within the outlet command area, was found in D24/11. The details of this were already given in chapter 6, box 6.2.

In a neighbouring subdistributary, D24/12, with six pipe outlets like D24/11, farmers had not been able to come to an agreement on rotational water distribution. The farmers of the two head end pipe outlet command areas had refused to participate in a rotation system proposed by the tail end farmers. Because of the location of the head end pipe outlet structures, literally on the doorstep of people's houses in the middle of a camp, the tailenders could do very little about this refusal.[26)]

---

24) The two subdistributaries in distributary 93 do not add to this analysis. Distributary 97 has no rotation at all, as explained above.

25) The descriptions given below are based on interviews with farmers, and not on direct observation of rotation practices. Only in subdistributary D24/9 systematic observation was done.

26) The D24/12 tailenders stated that since 1985 they operated their own rotation. The rotation concerned 4 outlet command areas, located in pairs (one outlet on each side of the canal). The two pairs were alternately closed for 24 hours. These outlets no longer had gates. Water was led around the structure rather than through it because the pipe could not take the full subdistributary supply. Gangmen were not active on this canal in 1991-92 and the Saturday closure of this most downstream subdistributary was not effectuated. Within the pipe outlets distribution was done on a one hour per acre basis in the tail end four outlets, and one hour and three quarters per acre in the upper two. Farmers in the upstream outlets claimed that this time-based rotation in the outlets had been in operation for more than 10 years.

The major difference between D24/11 and D24/12 is the settlement pattern. In D24/11 farmers now living in a camp in the head end of the subdistributary originally settled in the tail, and moved when water became scarcer. Many farmers have their land spread along the distributary. The settlers who lived in the head end of D24/12 have always lived there and have their land concentrated in the head end of the subdistributary. The four tail end outlets were mainly cultivated by farmers from a tail end village.[27)]

Another factor that may explain the difference between D24/11 and D24/12 is the greater length and higher design duty of D24/12 (see table 7.1), and its location further downstream along the distributary. D24/12 farmers also claim that the sill level in their subdistributary offtake was too high, but the Irrigation Department denied this.

Table 7.1: Characteristics of D24 subdistributaries

Subdistributary number[a)]	*Length (meters)*	*Design discharge (cusecs)*	*Localised area (acres)*	*Overall duty (acres/cusec)*	
24/2	7656	30.36	3547	117	(high)
24/3	915	4.84	189	39	(very low)
24/4	1007	6.90	914	89	(medium)
24/5	2654	12.70	535	42	(very low)
24/6	3721	8.59	969	112	(high)
24/7	4270	25.67	2012	78	(medium)
24/8	2898	14.64	1506	103	(medium)
24/9	3965	20.46	1285	63	(low)
24/10	2989	4.16	996	240	(very high)
24/11	1525	6.44	424	66	(low)
24/12	2244	9.38	758	81	(medium)

a) Subdistributary 24/1 does not exist
Sources: data mainly some from the Section Officer's notebook, assuming that these are the figures actually worked with). Lengths of canals were checked with command area maps. Localisation and design discharges were checked with the localisation boards on the canals, and with the 1969-70 rotation schedule. There were inconsistencies.

D24/10 also had a beheaded form of rotational water distribution, but with a different history. Before 1985 the whole distributary was involved in rotation. All pipe outlet pipes were 9 inches in diameter. Downstream farmers often came to block the upstream pipes with stones. The stones were put inside the pipes and were difficult to remove. The head end farmers represented to the Irrigation Department, which decided to decrease the pipe diameters of the upper 4 pipe outlets to 6 inches and leave the downstream 4 pipe outlets at

[27)] In both the D24/11 and D24/12 cases the head end pipe outlets are cultivated by both settler and local farmers. There is no simple local/settler division in access to water. However the settlement pattern does influence the possibilities for the implementation of rotational distribution in the subdistributary.

9 inches.[28] From that moment the four upstream pipe outlets were out of the rotation. Since then rotation is practised in the downstream half only. Every pipe outlet there receives water on two consecutive days, one pipe outlet at a time. This means that three out of four pipe outlets receive water every week and that the days on which a particular pipe outlet receives water rotate in a cycle of 4 weeks. In at least one of the pipe outlets irrigation is organised on a one hour per acre basis. There is no longer a gangman active on the canal. He would hardly have any possibility to regulate gates also. Of the four pipe outlets in the upper half two had their gates removed. The lower four pipe outlets were completely demolished. The design duty found for this subdistributary (see table 7.1) is extremely high, and make the water distribution problem technically understandable. The reasons for this high duty are unknown.

Other management routines than rotation: D24/8 and D24/9

In subdistributaries D24/8 and D24/9 there is no rotation over pipe outlets. Rotation schedules for these two subdistributaries are appended to the 1969-70 document that specified the distributary 24 rotation system, but were, according to farmers, never implemented. In the second half of the 1980s several efforts were made by the Irrigation Department to introduce rotation in these subdistributaries, but without success.

Two main factors explain the absence of rotation, a technical and a socio-political one. The technical factor is that the two subdistributaries have been designed for almost 100% rice and sugarcane localisation in the case of D24/9, and roughly 50% in the case of D24/8. The tail end of the D24/8 command in 1991-92 was irrigated by a lift irrigation scheme, which relieved scarcity conditions. This implies that the subdistributary canals can carry sufficient water for irrigation of rice and sugarcane in most of their commands.

The socio-political factor is that these two subdistributaries are part of the original core area of settlement. The political weight that farmers from these subdistributaries carry was considerable, because of their numbers, and through the economic power and social and political networks built over the years.[29]

The political weight of the water users ensured that water kept reaching these subdistributaries; the design characteristics made sure that it can flow through the canal.

The management routine that did exist in D24/9 was the following.[30] In the subdistributary Irrigation Department gangmen are active and the outlet structures were in a reasonable state. For each outlet the gangman had set a 'normal' gate opening, which was acceptable to headenders and brought some water to the tail. The gate opening was expressed in threads, counted on the rod along which the gate is lowered and raised. The threads visible when the gate is fully closed were painted white. The gate opening could quickly be determined by counting the unpainted threads that were visible. The number of threads that

---

[28] In 1985 there was a pipe outlet remodelling programme in many subdistributaries.

[29] *The data on which this statement is based is quite diverse.* It includes interviews on the history of settlement and water distribution with different actors, information on the commission agents and rice traders community, information on political networks, and accounts of interactions between these farmers, the Irrigation Department and the local MLA. One example of the latter is discussed below in example 3 in section 7.4. It were the leading farmers from subdistributary D24/9 whom the Section Officer chose to mobilise when he needed support to solve a problem with head end farmers.

[30] My interview data suggest that it was the same in subdistributary D24/8.

is 'normal' for a particular outlet was not a calculated number, but based on experience.[31] The routine consisted of the gangman's judgement of the water level in the canal and his decision whether he would put the gate at normal level, or squeeze the supply into the outlet a bit. He never raised the gate above its normal position on his own initiative. In this way the gangman tried to maintain a stable, though unequal, distribution of water in the subdistributary.

This routine worked during the day, but every morning when the gangman came on duty he had to correct a number of gates back to their normal position. Farmers changed the gate openings during the night after the gangman went off duty.[32] The canal was the farmers' domain at night. Then farmers who needed to irrigate traveled up and down the canal to check the upstream gates, or to obstruct them to increase the supply to their own fields. This guarding and manipulation work was done by the farmer-irrigator himself, a family member, or in case of some rich peasants, by a labourer. Upstream farmers sometimes guarded their outlets by sleeping on it, or by employing people to do so. Most of the manipulation and guarding activities took place between sunset and midnight.[33]

The guarding and manipulation activity was mostly a matter of individual farmers or very small groups, who in water stress periods might act jointly in larger numbers. However, a more organised form was put into operation in times of high water stress. The five tail end outlets of subdistributary D24/9 since many years had an association that undertook activities to safeguard the water supply. One of these activities was the employment of night guards in difficult periods, to check upstream gates and eventually obstruct them. The money for the wages of these employees was collected on a per acre basis from the water users. A few years before we did our fieldwork the Irrigation Department had started to pay for these tail end night guards. In subdistributary D24/9 the Section Officer handed the money to the chairman of the five outlets committee, who employed and payed the workers.[34] For the

---

[31] For outlets on the main distributary of D24 calculations had been made by the Section Officer to determine the gate opening needed for the design discharge. These calculations bear little relation to the real situation because the head between main distributary and field channel was standardly assumed to be one foot, which is an arbitrary value. The meaning of these pseudo-calculations was more their strategic value in negotiations with water users on discharge into the outlet. The Section Officer could, and did, argue that a particular opening was what farmers in an outlet were allowed to get, scientifically derived from the localisation pattern, which has legal force. Farmers were unable to check the calculations.

[32] Farmers manipulated gates by means of copied keys. Some gates were in a state that lifting could be done by hand. There was gate manipulation during the day as well, but much less so than during the night. During daytime a person is quite exposed and the adjustment of other people's gates a risky matter. During the day farmers generally asked the gangman to raise the gate if they needed more water. Sometimes the gangman obliged and sometimes he didn't, depending on the situation on the canal and his relation with the concerned farmer. Gangmen sometimes received small payments for changes made in the gate settings. However, gangmen generally found it difficult to refuse requests of influential farmers even without payment. The social status of gangmen was low. Often they had worked as agricultural labourers before. Gangmen who had worked on the canal for a long time had sometimes developed good arguing skills to use against requests for favours.

[33] An amusing example of this at distributary level is that middle reach farmers in distributary 24 made sure that their gates weren't blocked just after midnight. This was the time when tailenders returned home from the cinema, on the way blocking a few gates.

[34] The five-outlets-committee had office bearers and held regular meetings where the accounts were checked and activities were planned. This is the only example of such a stable and well

(continued...)

Irrigation Department it was attractive to work through intermediaries because it was easier than direct employment. The latter created selection and control problems. For the local leader it was interesting because it created new patron-client relationships. To be an intermediary is a form of social capital accumulation. The Irrigation Department-paid night guards were not allowed to adjust gates, but had to report interference to the gangman when he came on duty in the morning. The turnover of management responsibilities to water users was thus partial.

Irrigation Department managed rotation: D24/2, D24/6 and D24/7

In three other subdistributaries with (part of) their command area in the core area of settlement and agricultural intensification, D24/2, D24/6 and D24/7, internal rotation systems implemented by Irrigation Department gangmen were in operation. There were a number of differences between these three subdistributaries and other subdistributaries.

Subdistributaries D24/2 and D24/6 were not designed for 100% sugarcane and rice, but the localised area includes a substantial part of light crops.[35] The discharge capacity per unit area of command is thus relatively small (or the duty high) compared to D24/8 and D24/9.[36] D24/7 has a bifurcation point in the head end, and in fact consists of two canals. This complicated water control. D24/2 and D24/7 are long canals with vested interests in the tail and middle reaches. That is where the original land development and settlement took place, and these powerful farmers have a strong interest in distributary rotation.

The reason that the Irrigation Department plays a role in this rotation, in contrast to D24/10, D24/11 and D24/12, may be hypothesised to lie in two factors. First, the water supply into D24/2, D24/6 and D24/7 apart from being relatively higher is also much stabler than that into D24/10 and particularly D24/11 and D24/12. This was due to the more upstream location of D24/4, D24/6 and D24/7. Secondly, the length of the subdistributaries increased the number of water users and the number of villages and camps they came from. This may make farmer controlled rotation more difficult to establish.

These factors together make the existence of subdistributary rotation managed by the Irrigation Department more likely in these three subdistributaries than in the others[37], because there is bothe the need and the possibility for (from the farmers' perspective) external management.

---

[34](...continued)
structured form of tail end organisation that I have heard about in the distributary 24 command area. There might be more however, because they are easily overlooked. Farmers do not quickly reveal their existence to outsiders, possibly because of the occasional bribing that their activities involve. The Irrigation Department officers seemed only to know (about) the leaders of the organisation.

[35] D24/7 was designed for almost 100% sugarcane. This may still give capacity problems when a lot of rice is cultivated, and canal maintenance is poor. Unlike D24/8 it had no large lift irrigation scheme in the tail end.

[36] D24/6 passes along a piece of unlocalised command, and therefore prospects for unauthorised irrigation are good. There is thus more demand (and a higher duty) than table 7.1 suggests. It should be noted that discharge capacity is a relevant factor only when the subdistributary is in a position where it can potentially draw full design discharge. This is not the case for D24/11 and D24/12.

[37] This prudent formulation is deliberate because a fully convincing explanation would require more information, to be gathered through intensive fieldwork. Straightforward correlations do not exist.

No rotation and no Irrigation Department presence: D24/3, D24/4 and D24/5
Subdistributaries D24/3, D24/4 and D24/5 had no internal rotation systems in 1991-92, and no or very low Irrigation Department management presence along the subdistributary.

Subdistributary D24/4 is in principle a similar case to D24/6 (it also has great possibilities for unauthorised irrigation). However, this was a subdistributary with severe water supply problems. The explanation for this may be the difficult location of the subdistributary outlet in a curve in the canal, and with a drop structure downstream of it that was regularly demolished by downstream farmers. Therefore supply into the canal was low, leading to severe internal distribution problems. Irrigation Department staff was chased away when it tried to enter into this subdistributary (see example No.3 in section 7.4).

Subdistributaries D24/3 and D24/5 provide yet another situation. These two canals have exceptionally low design duties, that do not correspond with the localised cropping pattern. The absence of water distribution problems (and organised rotation) is therefore not surprising.[38] In the 1969-70 rotation document lower design discharges are found than at present in the Section Officer's notebook. Influential settler farmers cultivated land in these subdistributaries, which are located very closely to a camp (D24/5 takes off in the camp). I can only assume that this influence got translated into a low design duty to legitimise higher releases into these subdistributaries.

Main findings
At first sight, the clustered presentation of the different management situations in the different subdistributaries perhaps suggests that there is a straightforward relationship between location on the distributary and management practices in the subdistributary. Except for subdistributary D24/2 the discussion moves from the tail end to the head end. The locational factor is certainly of importance, but on closer look it becomes clear that there are a large number of factors that influence and explain the existing forms of organisation.

The material presented above suggests that the following factors are important for the explanation of the nature of the water distribution routines at subdistributary level.
- The settlement pattern.
- The design capacity of the canal/overall duty for the command area.
- The social power of farmers to bring water to the subdistributary.
- The degree of water scarcity.
- The opportunities for expansion of irrigation outside the localised area.
- The length of the canal as it influences the number of farmers and villages/camps.
- The hydraulic conditions at the subdistributary offtake.
- The bifurcation pattern of the subdistributary.
- The stability of water supply into the subdistributary.

The discussion of these factors above has shown that they are not independent but interrelated, that not all factors are relevant in all cases, and that a factor may have a different meaning in different situations.

[38] Gangmen were not active on these two canals, and pipe outlets were demolished. However, the latter should in this case not be interpreted as a sign of water scarcity, but exactly the opposite. There was so little water scarcity that the structures themselves were not important.

7.4 LEGISLATORS IN DISTRIBUTARY WATER MANAGEMENT

The main actors in the responses to water scarcity described above are farmers and Irrigation Department officials. A third actor is important: the politicians. All elected members of governmental bodies come under this heading. For water distribution in the Tungabhadra Left Bank Canal the MLA, the Member of the Legislative Assembly, the State parliament, is of particular importance.

Constituencies, commands and resource broking

India has a constituency based parliamentary system. Each member of parliament thus has a clearly defined base area. Some of these are part of irrigation systems, covering head end areas, tail end areas, or parts of both. For the purpose of this analysis the basic point about Indian MLAs is that they are resource brokers (see chapter 3 for discussion and explanation).

Irrigation water is a resource provided by the state with development objectives, but it is not a development programme in the same way as for example a government housing scheme. Its benefits cannot be handed out at special occasions where the good deeds and ideas of the MLA and his/her political party can be commemorated, like for example can be done at the public distribution of sites for houses to former untouchables. The distribution of irrigation water is a continuous and spatially dispersed activity, for which a functional organisation, the Irrigation Department, bears day-to-day responsibility. MLAs can - thus - influence water distribution only by influencing the behaviour of Irrigation Department officials.

The mechanism that enables an MLA to do this, is his/her influence on the transfer of government officials. Chief Ministers and Ministers 'delegate' their legal decision making power with regard to transfers of members of the government administration to MLAs in exchange for support of these MLAs of the Cabinet in the Assembly (de Zwart, 1992). Wade summarises the importance of transfer determination by MLAs by stating that "[t]ransfer is the politician's basic weapon of control over the bureaucracy, and thus the lever of surplus extraction from the clients of the bureaucracy" (Wade, 1982a:319). De Zwart adds to this monetary objective the argument that frequent transfers are a method for politicians to avoid competition in 'resource broking' by government officials, who are also (potential) 'gatekeepers' for state resources (de Zwart, 1992:5-6). There is difference of opinion on the degree to which political determination of transfers is systemic and institutionalised, and involves monetary transactions, but there seems very little doubt that it exists in most places at least in some degree.[39)]

From the perspective of the farmer/water user, influencing water supply through the MLA or another politician is a deviation. A shorter institutional route is to exert pressure on the Irrigation Department directly. This is indeed very commonly done, and different methods are used for it, as indicated above. These methods come into existence because there are virtually no formal accountability mechanisms between water users and Irrigation Department

---

39) Wade (1985) may be read to suggest that political determination is ubiquitous and highly institutionalised. De Zwart (1992) has found, studying several departments in Gujarat, that routine transfers are very common, and political determination and the attendant system of payments for posts only found in part of the cases. De Zwart further shows that the possibilities for government servants to resist 'arbitrary' transfers are very limited. One of the few avenues open to them is legal action. As the objectives of transfer policy are very vaguely described, it is very difficult to win such cases, even when one can afford the costs of litigation.

managers. The irrigation bureaucracy is designed on a 'management by prescription' model (see also chapter 9). The absence of such accountability mechanisms makes the exertion of direct pressure a cumbersome affair. One reason for this is that it has to be repeated continuously. Farmers therefore regularly resort to an indirect method to influence Irrigation Department behaviour: lobby their MLA to secure water supply. Farmers explained to me that this method gave a bigger chance of longer lasting success, and was cheaper.[40)] There is an accountability feed back loop in political lobby in which the initiative lies on the farmers' side: the threat not to re-elect the MLA.

I do not claim that this set of relationships exists in all parts of all irrigation systems, or even in all distributaries in the Tungabhadra Left Bank Canal. Its occurrence depends on a number of factors.[41)] Firstly, as already indicated, irrigation water should be an important resource in the MLA's constituency. Many voters in the constituency must depend on canal irrigated agriculture. In the Tungabhadra Left Bank Canal rice and sugarcane farming, trading and processing were the backbone of the local economy in distributary 24. In distributaries 93 and 97 a much smaller part of the command area is irrigated, and with less remunerative crops. In those cases a politician's vote base may not be primarily related to irrigation.

Secondly, a lot depends on the geographical intersection of constituencies and command areas of canals. In the case of distributary 24, the downstream/tail end half was part of one constituency, and the upstream/head end half of another. This created a situation in which the downstream/tail end MLA had a relatively clear interest to defend, even when there were inequalities in distribution within the command area in his constituency. Distributary 93 was literally on the margin of a constituency, had a relatively small area of rice cultivation and therefore fewer (influential) people. According to farmers MLAs showed their faces only at election time.

A third factor is the political history of the constituency *cum* command. In distributary 24 some villages had very good connections with the MLA, others much less so. This had to do with their relative economic and electoral 'weight', and changes in that over time, but also with the availability of strong local leaders and other contingent factors. The type of political networks through which political support and influence can be mobilised are very important, and these are locally specific.[42)]

In summary, the Indian administrative system provides few possibilities for water users to hold Irrigation Department canal officials directly accountable for the performance of their duties towards them. Under certain conditions farmers can use the avenue of political lobby as one of the few ways to institutionalise such an accountability relationship. Farmers can

---

[40)] This confirms Wade's analysis (Wade, 1980a:366). One farmer leader from the tail end of distributary 24 told us that paying bribes was something that their fathers did, but they had different methods.

[41)] The basic condition that the resource should be scarce is fulfilled by design. Also see Wade (1980a:370-371) on the conditions under which politicians may involve themselves in water distribution.

[42)] One of the weaknesses of our research is that we have not documented the details of the social and political networks of the MLAs and the parties they belong to. Boss' work on the right bank suggests that different political configurations may also exist, for example with a prominent role of leaders of the Karnataka State Farmers Movement (KRRS) rather than MLAs (Boss, 1998). He also makes reference to the importance in canal management of the political agents of the different political leaders. More research on these local socio-political networks and practices would be of strategic importance for any intervention programme.

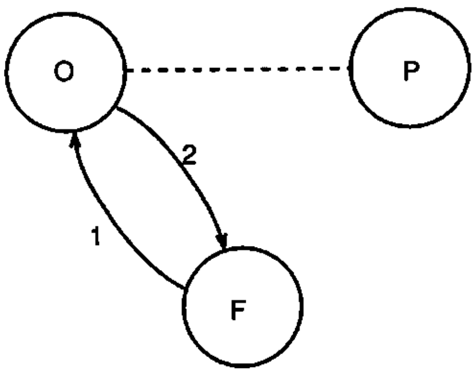
exchange their electoral support for the MLA's influence on Irrigation Department officials. In this relation the possibility to default lies on the farmers' side. The exertion of this influence allows the MLA to reproduce his/her base for re-election. (S)he can exert influence on the bureaucracy through the transfer system. Irrigation Department canal managers have very few resources to act as equal partners in this triangle, though they are not as helpless, and as innocent, as they often portray themselves to be.

Three examples

Three examples of interactions that occurred on distributary 24 are given to show the role an MLA can play in water management. The three examples are ordered in a sequence of increasing complexity of the interaction.

Example No. 1

One good morning my assistant and I were driving up the distributary to do some shopping in the local market, when we passed a pipe outlet where there was a lot of commotion. Some gangmen and a large group of farmers were fiercely arguing. We stopped and we heard that the farmers had refused to allow the Irrigation Department gangman on duty to close the gate of the pipe outlet. As it was Wednesday, this pipe outlet had to be closed, Wednesday being the one-day-a-week closure day for this pipe outlet in the distributary rotation system. Furthermore, the farmers had raised the sill level of the canal drop immediately downstream of the pipe outlet to increase the discharge through the pipe. They claimed the sill of the drop was damaged and at too low a level. One of the gangmen had already phoned the Section Officer and told him to come immediately, as there was a crisis situation. This was exactly what had been the farmers' intention. They had already prepared a place to sit in the shade of a tree, and had instructed the local tea-shop owner to brew K-tea, that is extra good quality tea. When the Section Officer came he was, after some initial discussion, seated under the tree, and given tea. A written petition, prepared and signed by all farmers the previous evening was presented to him. The farmers' problem was that insufficient water was flowing into the pipe outlet. They argued that the pipe level of the pipe outlet was too high relative to the bed level of the canal. The Section Officer argued back that they were cultivating rice instead of the authorised sugarcane, and that they therefore were in perpetual need of more water. After a long discussion the Section Officer agreed to leave the pipe outlet gate open this Wednesday under the condition that they would remove the stones in the drop. He told the farmers to bring the petition to his office the following day. He guessed that farmers would be satisfied with one extra day of water, and would not actually come to his office the next day. He was right.



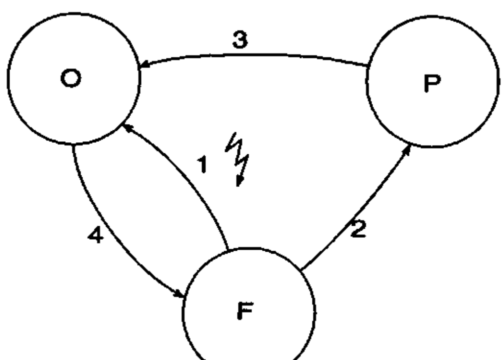
O = Irrigation Department Officials
P = Politician
F = Farmers

1 = pressure and request
2 = water

That the Section Officer came to the field so quickly is unusual. Usually farmers have to travel to the Division office first and present their case there. In this case however it was different. Most of the land in this pipe outlet was owned by a former well known MLA and MP (member of parliament at national level), who had leased out part of his land to a number of smaller farmers. The manager of the rest of his land was the person who spoke on behalf of the farmers in the discussion with the Section Officer. As one gangman said: "the Section Officer should take care with this pipe outlet". The role of the politician in this case was one in the background, but still clearly felt. The interaction is summarised in the figure on the previous page.

Example No.2

The second example is the standard type of interaction that took place. In one of the tail end subdistributaries the usual pattern of water supply was that three days in a week there would be 'good water' and three days 'poor water', while the subdistributary was closed one day per week as part of the distributary rotation system. In the course of the dry *rabi* season the water levels on the good days, Monday to Wednesday, were going down. Farmers of five pipe outlets at the tail end of the subdistributary organised a tail end association many years back. The leaders of this association went to the Irrigation Department office to talk to the Section Officer. Also small amounts were paid to the gangmen of the subdistributary, for which money had been collected on a per acre basis. Several visits were made to the Division office, but the situation did not improve. The farmers decided to go to their MLA and one good morning a tractor full of farmers, plus the leaders on motorbikes, travelled to the MLA's house in the local town, where they explained their case. They also took the opportunity to complain about the irregularity of the bus service to the village. The MLA settled this on the spot by summoning the depot manager of the bus corporation to his verandah, and instructing him to be more punctual. As the Irrigation Department office was some distance away from the town, the MLA could not summon the concerned Irrigation Department officials, and the farmers requested for a field inspection. A few days later the MLA plus Irrigation Department officials appeared on the canal to inspect the site. The Executive Engineer, head of the Division, had also come. A long discussion of the three parties followed and finally the MLA instructed the officials to release the water as per schedule. The Executive Engineer was courageous enough to protest. He said: "but Sir, how can I release water to tail enders when at the same time you send me slips with instructions to release water to head enders?" To this the MLA replied: "only work according to the approved schedule, ignore the slips, even if they come from me." For some time the water situation improved. To summarise:

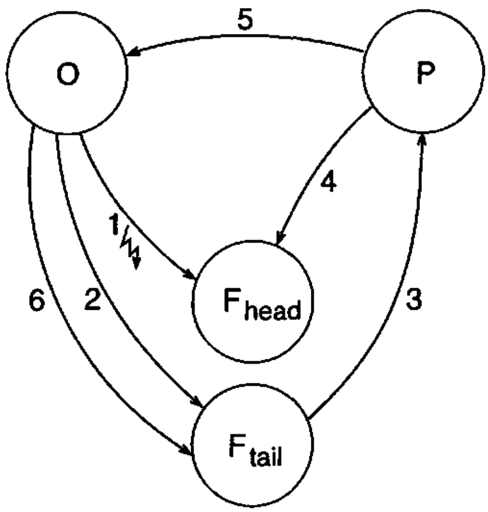


O = Irrigation Department Officials
P = Politician
F = Farmers

1 = request and pressure (fails)
2 = complaint
3 = instruction
4 = water

Example No.3

One of the head end subdistributaries, D24/4, was designed for the irrigation of light crops. However, a lot of rice was grown in the head end of this subdistributary, and a considerable tail end problem therefore existed in the subdistributary. Furthermore, the gate of the subdistributary was situated in a bend of the canal in a very unfavourable position. The drop downstream of the gate had been destroyed by farmers from lower reaches, which further reduced the discharge into the subdistributary offtake. One good night the tail end farmers of this head end subdistributary destroyed the subdistributary gate. As a result a lot more water entered the subdistributary. The Irrigation Department booked a case against the farmers for damaging government property, but the police took no action. The Irrigation Department tried to close the gate partially to reduce the flow, but farmers guarding the gate chased the officials away by throwing stones. The canal road was located on the other side of the canal than the subdistributary offtake, which was therefore difficult to reach for Irrigation Department officials. The Section Officer realised he would not be able to do something to change the situation on his own, and thought of another plan. He decided to approach the leaders of the distributary tail end farmers, who were suffering because of the lower supplies, and to ask them to go to the MLA to complain about lack of water, and ask the MLA to put pressure on the head end farmers. "When the Irrigation Department calls a meeting farmers won't listen, but when the MLA calls it, it is different", is how he explained his strategy. The tail end farmers went to the MLA to complain about the water shortage, and explained the cause of it. The MLA realised the seriousness of the situation, also after having collected additional information from the Section Officer. The MLA took immediate action. A number of people were arrested by the police and put behind bars. The MLA left to the State capital on other business for two days. The families of the arrested people got very nervous, and on the return of the MLA prayed him to release their kin. The MLA consequently organised a meeting in the village. The village was actually just outside his constituency, but he commanded some respect there. Apart from MLA he was also the owner of a ricemill and a fertiliser shop. The farmers of this village took fertiliser on credit and also borrowed money from his fertiliser shop. In the meeting the MLA promised to release the people from the police cells, if the village promised to allow the Irrigation Department to repair the gate and reduce the inflow into the subdistributary. The villagers accepted this. The MLA then instructed the Irrigation Department officials to do the work and release water to the tail end subdistributaries. To summarise:



O = Irrigation Department Officials
P = Politician
F_{HEAD} = Head End Farmers D24
F_{TAIL} = Tail End Farmers D24

1 = ID official tries to reduce discharge (fails)
2 = ID official goes to distributary tailenders
3 = complaint and request of tailenders D24
4 = pressure
5 = instruction
6 = water

Conclusion: a triangle of accommodation

Which interpretation of the role of MLAs in water distribution do these three examples suggest?

The examples show the large power of the MLA in his constituency. Rather than its representative he seems to be its ruler. Administrative officers are at his call and at his command. The verandah of his house is the *locale* where the grievances of the general public are listened to. The MLA actively engages in the day-to-day problems of administration and resource distribution, including water distribution in the canal in his constituency. The third example suggests the close relationship between his politico-administrative and his economic power. In that case the MLA used his economic power directly as a resource in his operation as a politician.

It is in the nature of the job of MLA however to have to please as many voters as possible. Because of this the MLA may be caught in contradictions. The example of the slips that he issued for water releases, illustrates this. But he can get away with the the Kafka-esque answer "ignore the slips even if they come from me". As a gangman later observed privately, "he never said he would stop writing slips".

Irrigation Department officials speak of politicians often as being terrible nuisances coming from a different sphere, making 'scientific water management' impossible. In practice their relationship may be more complex. The Section Officer in example No.3 had good relations with the MLA, built up over a period of 10 years, working in this region in different capacities.[43)] He used this relation to his advantage in his water management work. He had to be very careful with this. In the department he risked to be accused by others, particularly superior officers, of partiality. He had to be very careful with his relationship with the MLA because he played the game of resource broking himself, and might be seen by the MLA as a competitor.[44)]

In a more general sense the three examples, and particularly the third, show the more systematic role that an MLA can, under particular circumstances, play in the mediation of different interests within the command area of a distributary. The fact that an elected politician's vote bank necessarily consists of different groups with different interests means that he cannot simply defend a particular interest, but that the contradictions refered to above are systemic. MLAs can react differently to this situation. They can evade and avoid the problems in water distribution, and concentrate on less controversial things. However, when irrigation is important in a constituency this attitude is not likely to be feasible. The MLA in distributary 24 in 1991-92 seems to have done more than the least risky option, which is to only control conflicts that threaten to escalate. In implicit or explicit collusion with the Section Officer of the distributary an effort was made to improve water management in that canal.[45)]

It should be noted that the margins for improvement are limited. As another MLA in the Tungabhadra command area said to us in an interview "no politician who thinks of his career can ignore the interest of rice farmers." Also in distributary 24 no fundamental relocation

---

43) He was a native from the adjacent district and therefore wanted to stay posted in this region. His relative 'localness' may have helped him in building networks and judging situations.

44) This confirms Wade's observation that party factionalism has not penetrated the bureaucracy in a substantial degree (see Wade, 1980a: 372).

45) I do not know whether the cooperation of the MLA and the Section Officer was a joint strategy. I suspect it was mostly implicit, regarding the risks involved, and looking at the course of events in example No.3.

of water took place; unequal water distribution kept on being reproduced. However, the margin that seems to have been used is the efficiency gains that are possible by means of better organised management.

The Section Officer was first appointed for the third, tail end section, but he also took over the second, middle reach section of distributary 24 when the Section Officer of this section was transfered. The central element of this officer's approach was to consequently enforce rotation, but to be accommodating to farmers who really wanted extra water at particular moments. To cut down water use in the middle reach and increase supply to the tail reach he reduced the discharge into subdistributaries and pipe outlets on the main distributary. But, he let some farmers take extra water for a limited period when this could not be avoided, and squeeze the supply at places where he knew water was not short at the same moment. In this way he avoided escalation of conflicts.[46)]

This style of management required detailed knowledge of the situation along the canal. The Section Officer introduced a monitoring system alongside the routine two-hourly registration of water levels during the day by the gauge reader. The gauge book kept by the gauge reader came to the Subdivision Irrigation Department compound only rarely, because the gauge reader lived in a village 15 km away from this compound. Instead, the Section Officer arranged that he received slips of paper with the water levels at different points along the distributary written on them, early every morning. These were brought to him by the night patrol crew. He had also appointed a special person to collect and bring him this data during the day. He could therefore signal problems immediately, without having to be on the canal continuously.

Another institutional change he effected was the transfer of gangmen in the middle reach that were responsible for subdistributary gate settings. He replaced them by young gangmen with insecure jobs, who were - therefore - prepared to take risks in confronting farmers wanting to raise the gates. The transfers also upset existing patterns of bribe payments of farmers to gangmen.

It is difficult to be sure about the practical effects of the Section Officer's management style. A comparison of the distributary cropping pattern figures of the period before his tenure (pre-1989) and the period of his tenure up to the end of our fieldwork in 1991-92, shows that in the period that this Section Officer was active on the canal the total area irrigated and the area cultivated with rice and sugarcane increased substantially (see table 7.2). When I wrote the first draft of this chapter I concluded that the Section Officer's style of management had probably increased the efficiency of water use considerably.[47)] It was unlikely that the discharge into the distributary had been increased; maximisation of withdrawals had been the practice for a long time.[48)]

However, at the finalisation of the chapter this interpretation was put into serious doubt. Cropping pattern data up to and including 1996-97 had become available to me. After the Section Officer's transfer in 1993, the area cultivated with rice and the total area irrigated continued to increase (see table 7.2).

[46)] Once during the 1991-92 season this strategy encountered the limits of available water, and he decided to raise the gate of the distributary at the main canal to let extra water into the distributary.

[47)] Even at this stage the conclusion was a prudent one. Favourable rains also helped, certainly in 1991-92, as well as a large lift irrigation system that came into operation.

[48)] *For the unreliability of distributary discharge figures, see chapter 9.*

Table 7.2: Cropping pattern in distributary 24 from 1966-67 to 1996-97

Year	*Rice (acres)*	*Sugarcane (acres)*	*Rice and sugarcane (acres)*	*Total irrigated (acres)*	*Rice and sugarcane as a % of total*
1966-67	13416	478	13894	18053	77
1967-68	Not available				
1968-69	16152	969	17121	22845	75
1969-70	16791	1142	17933	22148	81
1970-71	16751	602	17353	23766	73
1971-72	13400	581	13981	20192	69
1972-73	9743	988	10731	19202	56
1973-74	10791	1451	11242	21413	53
1974-75	10454	2464	12918	23042	56
1975-76	13308	2315	15623	21241	74
1976-77	15055	2948	18003	25824	70
1977-78	Not available				
1978-79	10492	2444	12936	20376	63
1979-80	11985	2392	14377	19862	72
1980-81	12902	3164	16066	19044	84
1981-82	13005	3427	16432	19516	84
1982-83	11872	2767	14639	18192	80
1983-84	15240	1810	17050	21068	81
1984-85	16687	1387	18074	23117	78
1985-86	12116	551	12667	22514	56
1986-87	16415	732	17147	23369	73
1987-88	Not available				
1988-89	18308	2978	21286	28595	74
1980-90	15864	1321	17185	28515	60
1990-91	20508	1722	22230	28998	77
1991-92	21985	3511	25496	31317	81
1992-93	25806	1488	27294	34327	80
1993-94	28011	2352	30363	34362	88
1994-95	29652	1455	31107	36388	85
1995-96	30991	1832	32823	36871	89
1996-97	34897	976	35871	39785	90

Source: Demand lists for distributary 24 (Irrigation Department)

Furthermore, a similar increase in rice and total area that started around 1988-89, after a long more or less stable period, could also be observed in the cropping pattern data of other distributaries, and at the level of the Left Bank Canal as a whole.[49] At the same time the total drawals from the Tungabhadra reservoir remained constant or reduced (see table 9.2).

I do not have an explanation for this extraordinary phenomenon. It may have been caused by a system-wide increase in the efficiency of water use, but I have no other indications that this has occurred. Perhaps more likely is the explanation that the increases in figures reflect an improvement of the registration of actual crops cultivated (a reduction of underreported

[49] This can be concluded from data collected by R. Doraiswamy in 1997, which is not reproduced here.

rice for example). Whatever may be the background, it prevents a firm conclusion on the effects of the change in management style in distributary 24 in the early 1990s.

The evidence for the positive effects of the Section Officer's managerial efforts is therefore only qualitative in nature. Farmers, in 1991-92, were of the opinion that due to the new approach to water management the situation on the distributary had greatly improved. According to farmers there was less need for guarding at distributary level and less violence[50], bribing practices had disappeared as far as water distribution was concerned, there was less need to make representations to the Irrigation Department office[51], and the irrigated area had increased. We ourselves observed that in the 1992 *rabi* season the daytime water levels in the third section of the distributary canal were maintained during the night. When the Section Officer came up for transfer, farmers lobbied for the continuation of his tenure, and this was supported by the MLA.[52]

What I conclude from this case study is that politics and the involvement of politicians is not something that is necessarily detrimental to the quality of water distribution, and should be seen as undesirable interference. This is the common position of Irrigation Department staff, and Wade's and Ramamurthy's work may also be read in this way. This case shows that, even under extremely difficult circumstances like that in the Tungabhadra Left Bank Canal, political configurations may be possible which exhibit constructive features. A management style based on strategic (political) manoeuvring may be more effective than prescriptive and administrative styles. The triangle of leading farmers, politicians and government officials is a true 'triangle of accommodation' (Migdal, 1988), in which neither of the three parties fully has the upper hand, and which therefore leaves room to manoeuvre.

7.5 CONCLUSION

All four chapters on water distribution are designed to illustrate the book's two central theoretical premisses: 1) that water control can be usefully analysed as the political contestation of resource use, and 2) that water control is multi-dimensional. The second premiss will only be fully clear for the distributary level at the end of chapter 8. The first premiss requires, I hope, no further argument after the description and analysis of the events above.

In this concluding section I limit myself to the more specific conclusions that can be drawn from the chapter. In section 7.1 I mentioned that the argument of this chapter was a critical engagement with Wade's and Ramamurthy's work. I structure the concluding section accordingly.

[50] Stories of extreme conflict include examples in which farmers put a circle of straw around Irrigation Department jeeps, with officers in them, and threatened to put the straw on fire, or farmers who threatened to drink a bottle of pesticides when water supply into their canal was reduced. Also organised raids to the head end of the distributary by Irrigation Department jeeps together with groups of tail end farmers in tractors were part of water distribution practice.

[51] A farmer in the one before last pipe outlet on the distributary canal told us that trips to the Irrigation Department office had not taken place since the officer was appointed. Water was coming he said.

[52] In order not to make too much of a hero of this Section Officer, the following information is interesting. We were told that several years later while he worked in a different area, he seems to have overplayed his hand and was suspended on a corruption case (in relation to construction and maintenance funds).

Scarcity
Wade and others have convincingly argued that water scarcity is a major inducing factor in the emergence of collective action of water users in water distribution. This chapter supports that conclusion, and generalises it to forms of organisation in water distribution, of which Wade's 'common interest corporations' are one example. However, the chapter has also raised a number of questions regarding Wade's conceptualisation of scarcity.

I have argued that scarcity is a historically, spatially, socially, and we could add here, technologically, constructed phenomenon. The forms of organisation that occur in response to scarcity in their turn influence its characteristics. Scarcity is thus both cause and consequence of organisation, and not a (fully) independent explanatory variable.

Wade's operationalisation of the degree of scarcity is a very straightforward one: relative location on the canal. The discussion above shows that in the Tungabhadra Left Bank Canal this operationalisation is not very workable. For example, when the subdistributaries along distributary 24 would be taken as the parallel of Wade's villages along the canal, it is clear that location is not related to the forms of organisation in these subdistributaries in an immediately transparent way. A second factor that influences scarcity is the design capacity of the subdistributary in relation to its command area (the overall duty). But even these two factors together do not give a straightforward empirical regularity in the forms of organisation. Scarcity means different things in different subdistributaries, and the design of a single indicator for it would in my view be both impossible and undesirable. Only when we understand the different dimensions of scarcity we may understand, for a particular locality, which forms of organisation scarcity has induced. Put differently: in contrast to what Wade argues, also the occurrence of particular forms of organisation requires a multi-factor explanation, and not only their form.

Villages
The organisation of water distribution in the Tungabhadra Left Bank Canal is canal-based, not village-based. This is evident for the rotation schedules, but it also applies to the examples of water users organisations that were found.

In the systems studied by Wade and Ramamurthy each village is supplied by one or more separate water courses. In the Tungabhadra Left Bank Canal distributaries, subdistributaries and outlets cross-cut village boundaries in an arbitrary manner.[53)] The differently designed systems are located in different States, but why this has resulted in these design differences is unclear (also see chapter 4).

Furthermore, the creation of the canal system has changed the social landscape radically in the Tungabhadra Left Bank Canal. Camps were built by settlers along the canals and roads. Camps are located in the territory of villages, and in that sense are part of them, but are in important respects independent social entities.[54)] Often camps belong to several

---

53) In the case of outlets this is less so, because these are small units and have a fair chance of fully falling within the territory of one village. Furthermore, the physical boundaries of outlets, particularly natural drains are sometimes also the village boundaries. But D24/9 is a case where the subdistributary was constructed parallel to a village boundary at 160 meter distance. It roughly cut the outlets in half, which implied that all pipe outlet command areas on one side of the canal had farmers from two villages.

54) These differences are clear even to the casual visitor: houses, the language, food and clothing are all different. There is virtually no inter-marriage between the settlers and the original inhabitants of the area.

villages because the ridges on which the canals and the camps are located, are frequently village boundaries. The main camp on distributary 93 lies in the territory of five different villages. The largest camp on distributary 24 has acquired village status itself and has been allocated territory that first belonged to surrounding villages. In both distributary 24 and distributary 93 some villagers had changed, or were contemplating to change, their place of residence from the village to a place along the canal close to their irrigated fields. The advent of irrigation has caused considerable fluidity in the definition of 'the village' as a social and territorial unit. In such a situation it is perhaps not surprising that the canal (section) is the unit of organisation rather than the settlement unit (village or camp).[55]

The farmers/Irrigation Department interface

My main argument with Wade and Ramamurthy however is the picture they sketch of the relationship between irrigators and the Irrigation Department in main system management. The discussion of the rotation schedules at distributary and subdistributary level has served to illustrate that in the Tungabhadra Left Bank Canal locally negotiated and jointly controlled forms of organisation have emerged which seem to have created more predictable, and perhaps more efficient patterns of water distribution than in the systems studied by Wade and Ramamurthy. In the systems they studied the relation of Irrigation Department staff and water users is one of constant confrontation, with bribes and political pressure as the main intermediaries. In the Tungabhadra Left Bank Canal a lot of the turmoil on the canals and in the offices is related to the implementation of a set of rules on rotational distribution that is considered legitimate by (large parts) of all parties concerned.

This also implies that the role of politicians in water distribution should be slightly differently evaluated. In Wade's and Ramamurthy's work the evaluation of the role of MLAs is largely negative. It is part of the 'syndrome of anarchy' on the canals. Although it is evident that the access to political influence is highly skewed and is a means by which local elites reproduce their dominance in Migdal's 'triangle of accommodation', I still have a more positive interpretation of politicians' enrolment in water distribution. Through the mechanism of political lobby rich peasants[56] create an accountability relationship between the Irrigation Department and themselves, a relation that is otherwise absent. This I suggest is one of the stabilising factors for forms of organisation like rotation schedules that have a potential to distribute water more efficiently, and in principle also more equitably.

The evaluation of the role of politicians in water distribution just presented points to a larger issue. When it is acknowledged that water distribution is an inherently political process, and that the distribution of scarcity requires political mediation, the question arises how this political mediation can and should be organised. This involves addressing questions like: who has access to the political process, and on which terms, how are different interests balanced, and which institutions and negotiation procedures are required for this? It leads to

---

[55] The situation is, of course, complex. In some cases canals or outlets are mainly or only occupied by either villagers or settlers. But, even in such a situation it would not be fully correct to suggest that the village or camp is the unit of organisation. At the same time, social relations in villages and in camps do play a role in water distribution.

[56] When I discuss the role of 'farmers' and 'water users' at distributary level in this chapter, these are the rich peasants (see chapter 5 and 6) from different localities who compete for water. They do this for their own benefit, but also on behalf of, and by mobilising the support of, the farmers in their locality.

a position which says that the basic issue in changing existing water distribution patterns and practices is that of democracy (for further discussion see chapter 10).

8

POINTS OF CONTACT

Outlets as the contested linkage of water users and the state[1)]

> [T]here is probably no single item in the design of an irrigation system which has a greater effect on the distribution of water than the type and design of an outlet. (...) [T]he outlet is the point of contact between the Canal Administration and the cultivators. It is here that the cultivators receive their supply of water, and any alteration in the size or type of an outlet, even if it does not affect its discharge, is at once a cause for suspicion and consequently a source of misunderstanding between the public and the Administration. There have been cases of prolonged controversies between the Administration and the cultivators when the remodelling of outlets was taken up individually or collectively over a long reach of a channel. At times, considerable capital is made out of these controversies by interested political parties, with considerable loss both to the cultivator and the public revenues. (Mahbub and Gulhati, 1951:4)

This chapter begins with a tribute to a very special book. To my knowledge Mahbub and Gulhati's volume is the only book that not only lists India's (once) existing irrigation outlet structures, but also discusses their history. In irrigation textbooks this 'mundane artefact' (Latour, 1992) normally gets scarce treatment relative to the importance Mahbub and Gulhati - in my view rightly - attribute to it. The main focus in the textbooks are the more spectacular works like dams, aqueducts and major canals. The book, written by two senior irrigation engineers, is also special in that it does not take a patronising attitude towards the 'uneducated farmer', who so often figures in accounts of irrigation management. Instead, the authors in the *Preface* express the hope that farmers may use their book to verify whether they receive their due share of irrigation supply.

In the preceding chapter on water distribution at distributary level, the technical irrigation infrastructure did play a role, but was not discussed in detail. It was shown that the distributary canals, and particularly the division and regulation structures on them, are an important site of social interaction for water distribution. It was also made clear that the design and construction characteristics of these devices give rise to particular forms of social activity, and that the structures are materially transformed in the process. This chapter

---

[1)] Sections 8.2 and 8.3 were published in an earlier version written with Alex Bolding (Mollinga and Bolding, 1996; also see Bolding, 1992). Kees van Straaten contributed to section 8.1 (see van Straaten, 1992 and Bolding, Mollinga, and van Straaten, 1995).

further explores the technical dimension of water distribution. It focuses on the outlet structure.

Outlet structures, or outlets, are the technical devices through which water is released from the distributary canal system into the field channels of the outlet command areas. They are the material connection of the farmers' domain of water management in the outlet command area, and the - contested - Irrigation Department's domain of main system management. Farmers try to secure and increase water supply through the outlets by means of activities 'above the outlet' (Chambers, 1988), and/or by physically remodelling the outlet structure itself. This chapter discusses the technical diversity that exists among outlet structures as a result of these adaptations by farmers and the Irrigation Department engineers' responses to them.

Design and construction characteristics of outlets are interpreted in this chapter as the outcome of a negotiation process between different categories of water users and government engineers, and as an expression of the balance of forces among these groups. The technical characteristics of the outlets are the product of evolving water distribution practices, and at the same time structure, that is, constrain and enable, these practices. The analysis illustrates the importance of the space and time coordinates of social interaction to understand its causes, characteristics and effects. It adds to this the relevance of the way human behaviour is materialised in artefacts. In terms of water control the chapter investigates the manner in which different actors try to give material shape to the control mechanisms that they try to establish.

The theme of the chapter is treated in two ways. In the first part of the chapter the history of outlet structures in Indian canal irrigation development is sketched in two sections. In section 8.1 three responses to the emergence of control problems in water distribution in the 19th century are outlined: water distribution through the invisible hand of the market, by rotational water distribution, and by legal-administrative prescription of cropping patterns (localisation). The outlet technology that belongs to each of these three responses is discussed. In section 8.2 the reasons for the continued use of pipe outlets in South India's protective irrigation systems are investigated.

The second part of the chapter focuses on pipe outlets in the Tungabhadra Left Bank Canal, again in two sections. In section 8.3 two examples are given of the spatial distribution of different types of pipe outlet structures, along subdistributary D24/9 and distributary 93. It is shown that the technical characteristics of the pipe outlets vary systematically with different water management situations in different parts of the command area of these canals. In section 8.4 the subject is the process of the adaptation of pipe outlet design and construction. This adaptation is a response to changes in water availability, and to the - related - evolution of the patterns of interaction between water users and government officials. The example discussed is distributary 97, a tail end distributary.

In the concluding section 8.5 the relation between design, construction and water control is recapitulated, and some conclusions are drawn on the relation between the state, farmers and technological change.

8.1 OUTLETS IN INDIAN IRRIGATION HISTORY

From construction to (lack of) control

From the beginning the British faced control problems of various kinds in the canal irrigation systems that they started to construct in the 19th century. One of these problems was the control of water distribution.[2] With the act of the construction of a canal came the issue of the allocation and distribution of the newly available water. In the beginning of canal irrigation development, the engineers concentrated their efforts on the head works at the point of diversion of water from the river, and on the main canal. "The construction, operation, and management of the actual water distribution system was, by default, placed in the hands of the irrigating community." (Stone, 1984:196) This concentration of effort had to do with the lack of skills, experience and resources of the engineers[3], but also with the principle of British colonial rule to interfere as little as possible with processes at the local level.

Initially, cultivators were allowed to make cuts in the banks of the canals to bring water to their fields. This had the disadvantage of a very limited spread of irrigation water. Irrigation was concentrated close to the main canal, and waterlogging problems started to occur. To spread the use of irrigation water, and consequently increase revenues and protection against famine, the network of canals was gradually expanded by the addition of branches, distributaries, subdistributaries, minors and watercourses to the system. Also, the system to let out water from the canals was changed. The maintenance-prone cuts were replaced by earthenware pipes (called *colabas* in North India). These were the first pipe outlets. In the second half of the 19th century the pipe outlet was the outlet structure used all over India (for an example, see figure 8.1).[4]

The introduction of pipes contributed to the improvement of the maintenance of canals, but they were hardly a device to control water distribution in a quantitative sense. Hydraulically, the pipe outlet is a non-modular structure. This means that discharge depends on both the upstream and downstream canal water level.[5] The discharge also depends on the diameter of the pipe, but this is not related to (non-)modularity. This makes the pipe outlet highly unsuitable as a regulation or rationing device. In North India canal water levels fluctuated considerably. The canals diverted water directly from rivers with discharges that

---

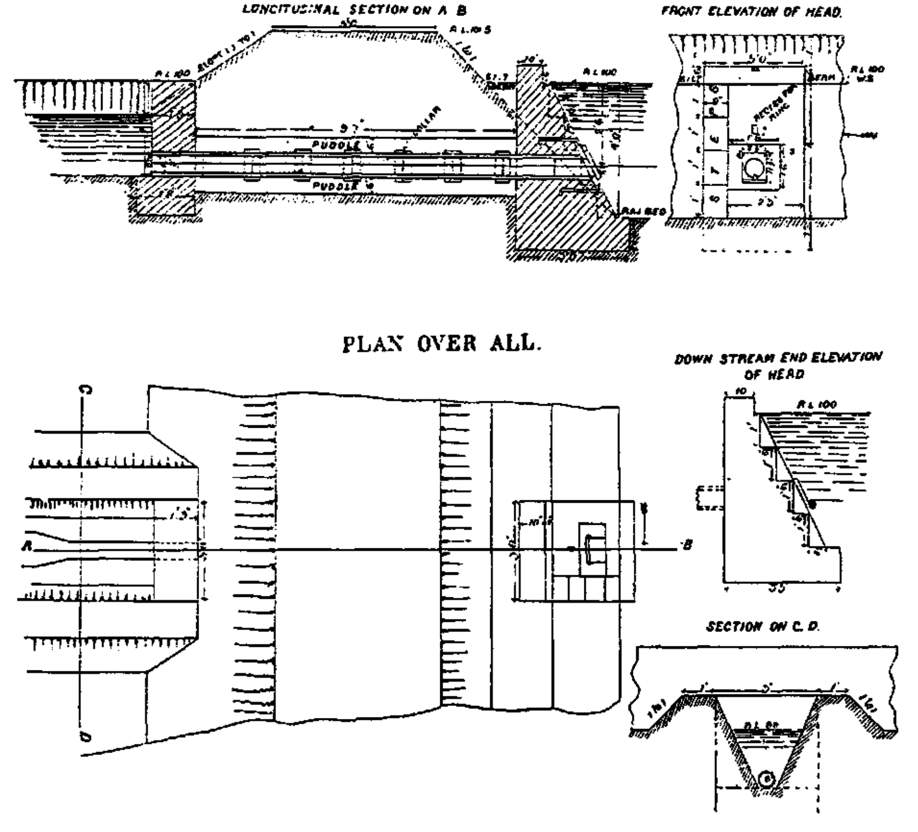
[2] Other problems were the control of waterlogging, salinity and the malaria effects of canal irrigation (for discussion see Whitcombe, 1972, 1983; Stone, 1984:134-157).

[3] Technically the construction of the canals initially was very much a trial and error process. The British did not have a lot of experience to build on, as the scale of the irrigation systems that were contemplated was unsurpassed. Engineers were sent on study tours to Southern Europe by the East India Company and the Government of India to document experience with irrigation in Italy, France and Spain (Baird Smith, 1852; Scott Moncrieff, 1868). But the technologies and procedures employed there were not directly transferable to the Indian context. To what extent the British learnt from existing Indian irrigation technology is not clear.

[4] All design drawings of North Indian pipe outlet structures that I have seen show gated structures. The gates in figure 8.1 are of the open/close type, and do not allow regulation of the discharge into the pipe. Buckley (1905) also contains a drawing of pipe outlets in Bengal which do have movable gates and can be fixed at different levels/pipe openings.

[5] For explanation of the differences between modular, semi-modular and non-modular structures see for example Mahbub and Gulhati (1951), and -in summary- below. The condition of non-modularity of pipe outlet structures applies under conditions of submergence, which is common in Indian systems. What in practice also occurs is a situation in between full submergence and free flow, which is hydraulically even more complicated. For discussion see Hoogeveen (1991) and Bolding (1992:100-105).

Figure 8.1: Pipe outlets for village channels in the United Provinces



Source: Buckley (1905:296)

vary with changes in snowmelt and rainfall. Furthermore, there were no cross regulators in the canals to stabilise water levels with varying discharges. It is therefore difficult to determine the driving head of a pipe outlet, because it changes frequently. Also pipe outlets require individual calibration, and because the discharge coefficient in the discharge formula of pipe outlets[6] varies with different water levels and heads, calibration is very complicated indeed. These hydraulic characteristics were poorly understood in the 19th century. The relation between pipe diameter, canal water levels, discharge and irrigable area were based on practical experience, rather than insight in the physical processes involved. Improvements could be made in site selection when contour maps of the command area started to be made

[6] The discharge formula is $Q = C_d.A.(2gH)^{½}$, with Q is discharge, C_d is the discharge coefficient, A the cross section of the pipe, and H the driving head (difference between upstream and downstream water level).

in the 1890s (Mahbub and Gulhati, 1951:24), but the distribution and rationing of water by means of pipe outlets remained a very approximate affair.[7]

There were three different responses to the limitations of the technical control of water distribution by means of pipe outlets.[8] The first was the effort to employ the market mechanism for the efficient distribution of water. This required devices for volumetric water supply in order to be able to introduce volumetric pricing of irrigation water. Efforts to develop modular outlets for this purpose were undertaken. The second response was to introduce rotational systems of water distribution with proportional distribution of surpluses and shortages occurring during the season, over all water users. This required a semi-modular outlet structure. The third response was legal-administrative control of water distribution by prescription of cropping patterns as in localisation (see chapter 3). For each of the three responses I discuss the outlet technology associated with it.[9]

Response 1: The invisible hand

In line with the economic theory and ideology in vogue, the British in the 19th century first tried to use the price mechanism for better distribution of irrigation water. With prices regulating water distribution, the invisible hand of the market would do the work, and no direct government intervention at the local/field level would be required. In an initial application of this principle in North India, the British sold the *colabas* to local people at prices set to recover the cost of construction of the distribution network. They hoped 'local enterprise' would do the rest of the work of spreading the water economically. What happened instead was the creation of durable property rights to the water supply, which was put to speculative use by the locally powerful who had bought the *colabas*. These owners extracted sometimes exorbitant rents from cultivators who depended on the water that came through the *colaba* (Stone, 1984:196-199).

Another experiment to employ the price mechanism for water distribution took place also in North India, in the 1850s. Some engineers believed that economy of water use could only be effected through charging by volume. In 1855 an experiment was done with an adapted version of the *Modulo Magistrale*, investigated by Baird Smith on a study tour to Italy for the East India Company (Baird Smith, 1852:26-57; see figure 8.2). The device was supposed to be able to give constant discharge with varying water levels in the parent canal.[10] In

---

[7] The technical trajectory of the North Indian *colaba* pipe outlet in the 19th century was from the loose earthenware pipe to the earthenware pipe with head and toe walls, to the rectangular wooden and masonry barrel, to the steel or cast iron pipe (Mahbub and Gulhati, 1951:49). The hydraulic principle of the outlet structure did not change with these adaptations.

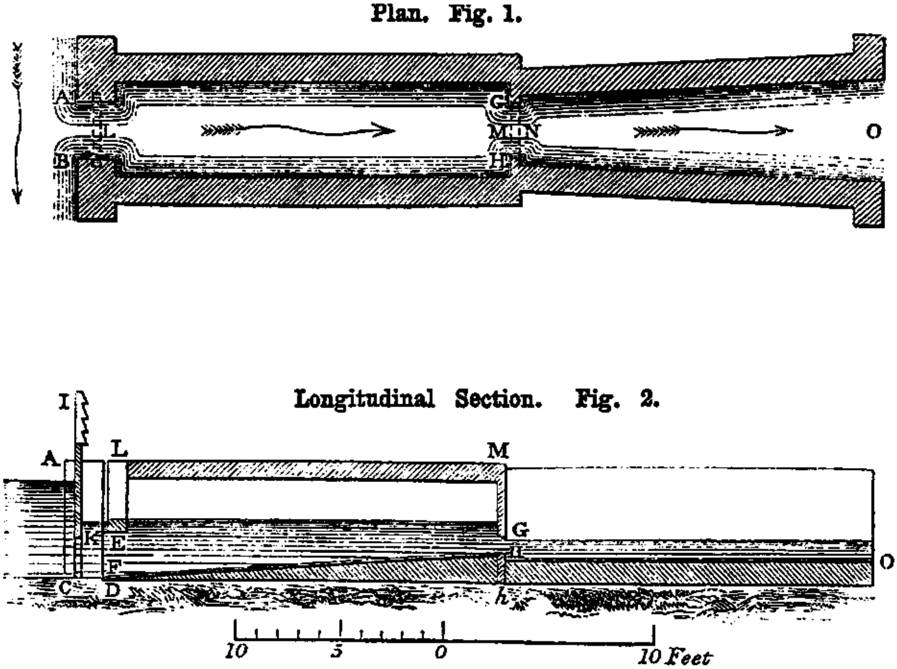
[8] The identification of three responses is no claim to comprehensiveness. This chapter, together with Bolding, Mollinga and van Straaten (1995), is to my knowledge the first attempt to write a sociotechnical history of outlet structures in Indian canal irrigation. It is an element of a research project that focuses primarily on contemporary canal irrigation, and therefore the historical analysis has limitations. The East Indian situation (Orissa, Bengal) for example is not considered at all, and closer study of the responses and areas discussed here would undoubtedly uncover larger diversity. The discussion does serve the purpose of situating the Tungabhadra Left Bank Canal case.

[9] The story of changes in the modalities of water control starts in the 1850s, but the first few decades of the 20th century were the period in which most change took place. By the 1940s the regional differentiation of the subcontinent in terms of types of outlets used and institutional arrangements for distribution seems to have consolidated. No major changes have taken place since then.

[10] For other designs contemplated in this period see Mahbub and Gulhati (1951:chapter 10).

Indian practice it turned out to be ineffective. The structure silted up, and cultivators were suspicious of the machine and interfered with it. And, but this was not specific to India, the discharge was not constant with varying water levels (Stone, 1984:180-181; see figure 8.2). With delivery by volume impossible, charging by volume also became unattainable.

Figure 8.2: The Modulo Magistrale of Milan



The distributary canal is on the left side. EF is the gate orifice through which the water enters, GH the one through which it leaves the structure. IK is a shutter which can be raised and lowered to adjust the flow. DLMH is a closed chamber "the under surface of which is at precisely the same height as the water ought to have over the outlet GH" (p.50). The objective was to keep the water level in the chamber constant to assure, so it was assumed, a constant discharge through GH (GH had standard dimensions to allow measurement). The spout NO, which had a small downward slope, led the water to the watercourse. The quotation suggests that the influence of water levels and pressure on discharge were not fully understood. On the other hand, the water level/pressure in the chamber could be measured through an open groove in the masonry LD, and the gate IK was to be adjusted to keep this constant. The original Italian sources would have to be consulted to decide whether the hydraulic confusion was only Baird Smith's.

Source: Baird Smith (1852:48-49)

Stone describes a subsequent experiment of sale of water by contract between the mid-1860s and 1874 (Stone, 1984:181-182). This involved 3 year leases for fixed, but not volumetrically quantified, water delivery through existing pipe outlets. The cost of the lease was based on the earlier revenue assessment of the irrigated area under the outlets (with some discount). The system stimulated expansion of irrigation under the outlets and economy of water use, because farmers were free to use the water they leased as they saw fit. The lease system failed through problems among the cultivators to proportionally share the costs and benefits of the leases. More than an effort to establish a water market, this experiment was a way to spread the use of irrigation water and reduce the management tasks of the government.

The two experiments described just now, volumetric and contractual delivery, were combined in a new effort several decades later. The introduction of the 'block system' of water distribution in the Nira Left Bank Canal and other irrigation systems in Bombay Presidency in the first decades of the 20th century was the most comprehensive attempt to employ the market mechanism for water distribution in large canal systems. This system was to include volumetric water delivery and volumetric pricing (see Bolding, Mollinga and van Straaten, 1995). The system involved contractual water supply to groups of farmers with lands in contiguous blocks, and required a modular outlet to fix and measure the water supply. The discharge of modular outlets is independent of both the upstream and downstream water levels, and discharge is therefore fixed and total water use easily measured. By this time the hydraulic aspects of modularity were better understood than in the 1850s, and a number of technically modular outlet structures were designed (see figures 8.3 and 8.4).

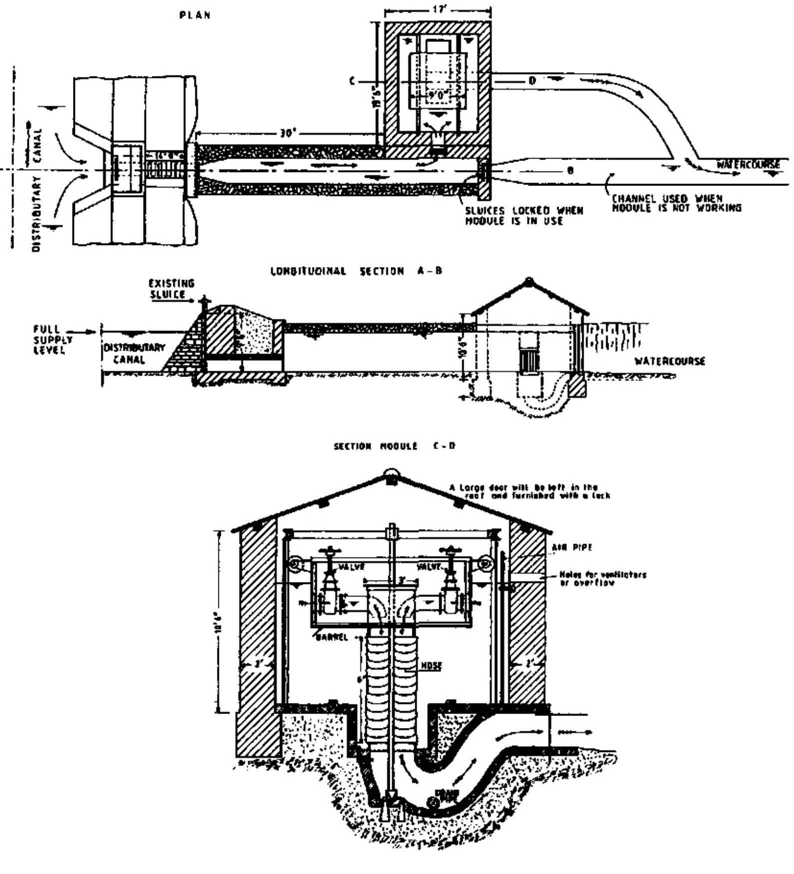
However, the modules could not be transformed into working artefacts in the field, as they did not fulfil the design criteria that they should be cheap, and, more importantly, tamper-proof.[11)] Tamper-proofness was necessary to counter the appropriation of irrigation water by entrepreneurial sugarcane farmers, who desired to intensify this cultivation far beyond what was allowed in the contractual arrangements of the block system. When the intensive cultivation of sugarcane turned out to be very profitable to the government in terms of revenue collection, the Bombay Presidency government became a supporter of the sugarcane interests, and abandoned the protective objectives that were part of the block system.[12)] The efforts to introduce modular outlets, notably Gibb's module, were also abandoned, and pipe outlets are used in the system till today.

A major institutional stumbling block at the policy level for the employment of the price mechanism for water allocation was the fact that water fees were part of the land revenue (the land revenue varied for 'wet' and 'dry' land and for different crops). The separation of charges for irrigation water from land revenue proper, and variation of the irrigation charges in relation to changes in water scarcity, are both necessary to create a situation in which prices may affect distribution and to introduce a competitive element. This conflicted with some of the main characteristics of imperial revenue policy. The politics of imperial administration implied that there was downward pressure on land revenue rates as a result of considerations of social stability, increase of cash crop production and other reasons. For poor cultivators, owners and tenants, increased rates would cause serious problems. Uniformity of rates (for example across irrigation systems) was also considered to be politically desirable. (For detailed discussion of these issues, see Stone, 1984:159-179.)

[11)] See Pinch and Bijker (1984) for discussion of this issue of the 'stabilisation' of new artefacts in social and technical networks.

[12)] The block system was a departure from the original objective of irrigation of 'irrigated dry' crops only, but still contained a protective element (see chapter 3, section 3.1, and Attwood, 1987, 1993; Bolding, Mollinga and van Straaten, 1995).

Figure 8.3: Visvesvaraya's self-acting module

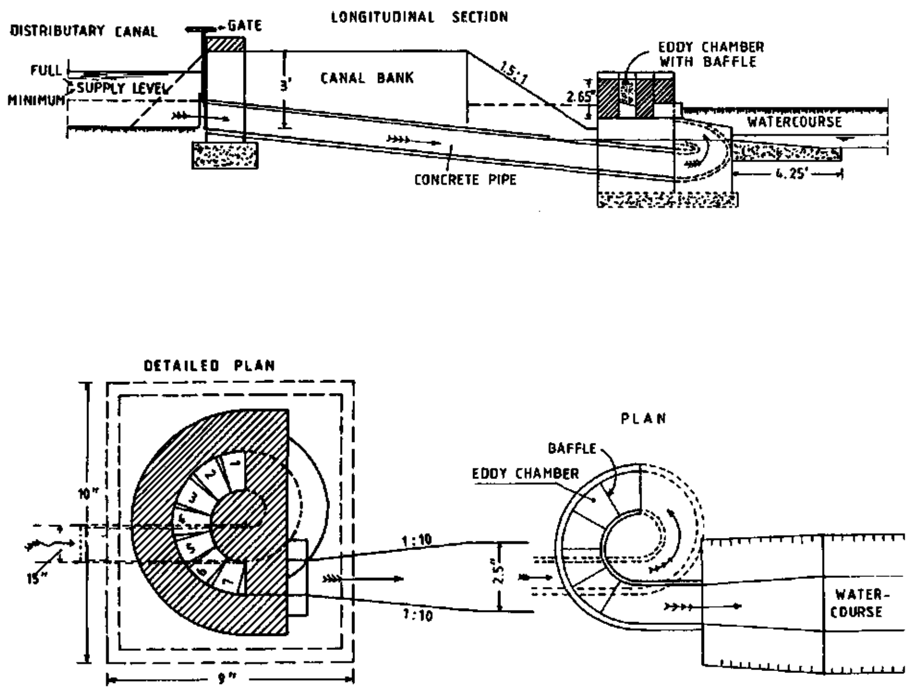


This rather complex apparatus consists of a chamber which communicates with the distributary (and consequently has the same water level), a barrel which floats on the water in the chamber, and a hose which connects the barrel with the watercourse. From the distributary, the water flows into the chamber, through the valves of the floating barrel into the barrel, and through the hose into the watercourse. Because the barrel is floating and follows the fluctuations of the water level in the chamber, the working head of the water flowing into the barrel remains the same. Consequently the discharge will remain constant. The discharge can be altered by changing the weight of the barrel (changing the working head) or by opening or closing the valves (changing the area of flow).

Source: *The Irrigation Conference, Simla, 1904* (1905)

There were thus a number of reasons why economic control of water distribution through the invisible hand of the market failed in 19th and early 20th century India. Distribution through the economic mechanism of the market is an idea that has recently attracted new attention and support, as will be discussed in chapter 10. But in the 19th and early 20th

Figure 8.4: Gibb's module



This module has the shape of a snail's shell. The water enters through the bell-mouth entrance, moves upward into the curved rising pipe, makes a full turn under a series of baffles, and flows into the watercourse through an expanding spout. The result is a constant discharge within a limited range of fluctuating water levels in the distributary. The baffles restrict the area of flow in the snail's shell structure; a rise in water level would result in rotating movements of the water in front of each baffle. This would mean increasing loss of energy and thus loss of head, which helps to keep the discharge constant.

Source: Inglis and Joglekar (1940)

century irrigation water was "of necessity allocated through a combination of technical and institutional mechanisms" (Stone, 1984:195). These mechanisms I will now discuss.

Response 2: proportional and rotational water distribution

From the second half of the 19th century the Indian government tried to increase its control over water distribution through combined technical and managerial means. The government took on the responsibility to construct the technical infrastructure at ever lower levels of the system, and brought the canals closer and closer to the farmers' fields.[13] The government also claimed the ownership of this infrastructure.[14] The increasing prominence of the objective to spread irrigation water for protection against drought and famine (see chapter 3), reinforced the interventionist character of government involvement in irrigation water distribution. North India (including present Pakistan) experienced important institutional and technical changes in irrigation water distribution in canal irrigation in the early decades of the 20th century. Institutionally the development and consolidation of the so called *warabandi* proportional and rotational system of water distribution was the key change.[15] It involved and became possible by the invention and widespread introduction of a semi-modular outlet structure.

The problems experienced in the technical control of water distribution by means of pipe outlets, and the advance of hydraulic science, in the first decades of the 20th century led to an intense search for new types of outlets that allowed greater control. The outlet that closed the debate on water distribution in North India and ended the quest for new designs was Crump's design of a semi-modular outlet (Crump, 1922) (see figure 8.5). This device, installed at the head of the outlet command area, discharges quantities of water into the outlet command area in a fixed proportion to the discharge in the distributary canal. Because of the standing wave, the outlet structure's discharge is independent of the water level in the downstream watercourse. When the sizes of the semi-modules are designed to fit the irrigable area behind them, a system of fixed proportional distribution is created. This outlet, and adapted versions of it, are the dominant type of outlet in the canal systems of North India and Pakistan till today.

In the new system experience-based *'tatiling'* [turn-taking] was replaced by the 'scientific' system of proportional and rotational water distribution that we now know as *warabandi*. The introduction of the semi-module allowed a more precise form of water distribution, in which distribution could reliably be based on time-shares, as the proportion of outlet discharge to distributary discharge was stable.[16] Mahbub and Gulhati compare the old and the new system as follows.

> The *tatiling* of outlets on distributaries or among channels on a distributary systems continued as normal irrigation practice until about 1930, when, with the installation of

---

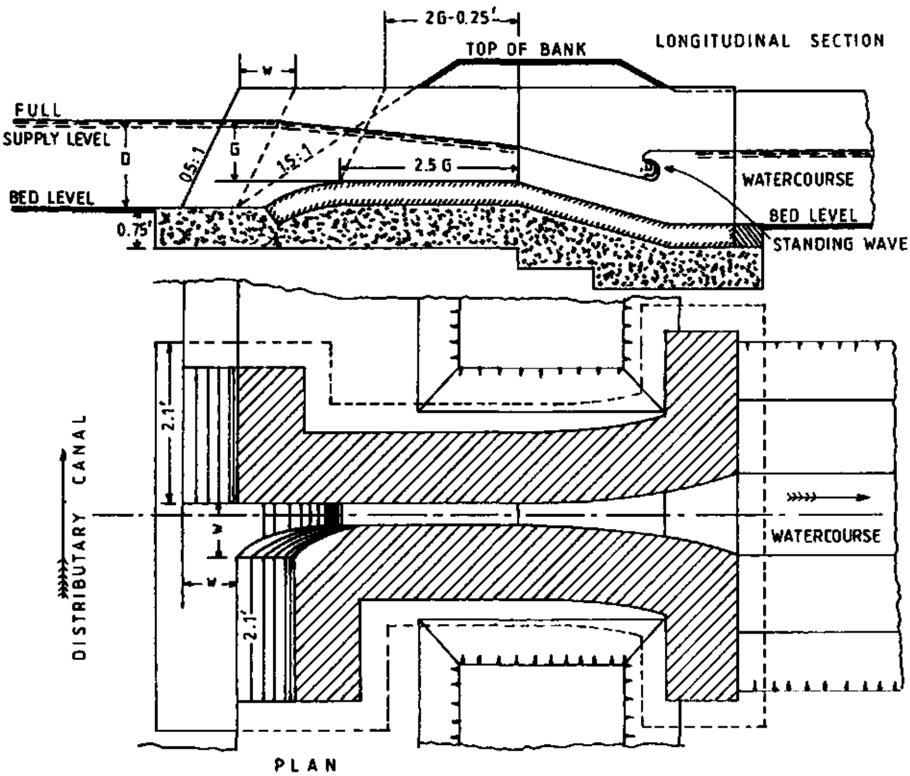
[13] This development was completed after Indian Independence, when the government took on the responsibility to construct the field channels in the outlet command areas at government cost.

[14] In North India definitively through the 1873 Irrigation Canal and Drainage Act. In Madras Presidency the operation of the 'regulation sluice' that leaves water out of the canal to one or more villages, became the official responsibility of the government also in 1873 (Famine Commission, 1881-V:112).

[15] See chapter 3 for references that give descriptions of the *warabandi* system. Its historical origins as a rotation system are not fully clear. It is probably a development of the 'tatiling' system of turn taking in use in the 19th century (which used pipe outlets). On 'tatiling' see Buckley (1905:282-285).

[16] The success of the *warabandi* system, and the semi-module outlet structure that belongs to it, has been much acclaimed. The image of success has been particularly advanced in the context of debates on the introduction of *warabandi* in South Indian canal systems (see chapter 9). The fact of the matter is that there are very few reports on the actual working of the *warabandi* system, at present or in the past, on the basis of which success or anything else can be argued. For discussion of *warabandi* in Pakistan, see Merrey (1983), Merrey and Wolf (1986), Beeker (1993), van Halsema and Wester (1994), and Bandaragoda (1998). For India, see for example VanderVelde (1980), Malhotra, Raheja and Seckler (1984) and Jacobs *et al.* (1997).

Figure 8.5: Crump's semi-module



The throat plus the sill cause a standing wave, which eliminates the influence of the downstream water level on the discharge. To regulate the discharge only the water level in the distributary requires control. In later designs a gate or roof block is put in the throat, to make the structure adjustable. It then becomes an orifice semi module or adjustable proportional module.

Source: Mahbub and Gulhati (1951:69)

semi-modular outlets and the installation of flumes and control points in distributaries, it was gradually found possible to give regular supplies to all outlets on a running channel. The *tatiling* of channels is now [in the 1940s] resorted to, not on account of any defects in the design of outlets, but during winter when the water supply available in the rivers is not enough to feed all the distributaries on a canal. The unit of distribution is now a distributary and all outlets and minors of a distributary are always running full supply when full supply is let into the distributary. The *tatiling* of outlets on any channel is regarded as a sign of inefficient working of a system and is looked upon with disfavour. (Mahbub and Gulhati, 1951:28)

Response 3: localisation
The third response to lack of control over water distribution was the policy of localisation, as implemented in the protective irrigation systems of interior South India. This legal-administrative instrument of land use planning and the way it is meant to structure water use was discussed in chapter 3. Here I focus on the outlet technology that belongs to it.

Localisation leaves perhaps the largest scope of the three responses for choosing the appropriate outlet technology. Semi-modules would however be most logical in a situation like the Tungabhadra Left Bank Canal. The system has continuous flow without cross regulators, and a fixed area entitled to receive irrigation water, with fixed crops. Semi-modular outlets could both accommodate the situation of constant water levels in the main system when a constant discharge is released from the reservoir, and the situation that the discharge varies over the season with changing demand. In the latter case the proportional distribution of the variable discharge over the command area would remain the same. The choice for pipe outlet structures, with their problematic regulation characteristics, that has been made in the Tungabhadra Left Bank Canal is therefore at first sight, and with the benefit of hindsight, not a technically and managerially logical one. In the next section I investigate the background of this choice for pipe outlets.

8.2 THE CONTINUED USE OF PIPE OUTLETS IN SOUTH INDIA

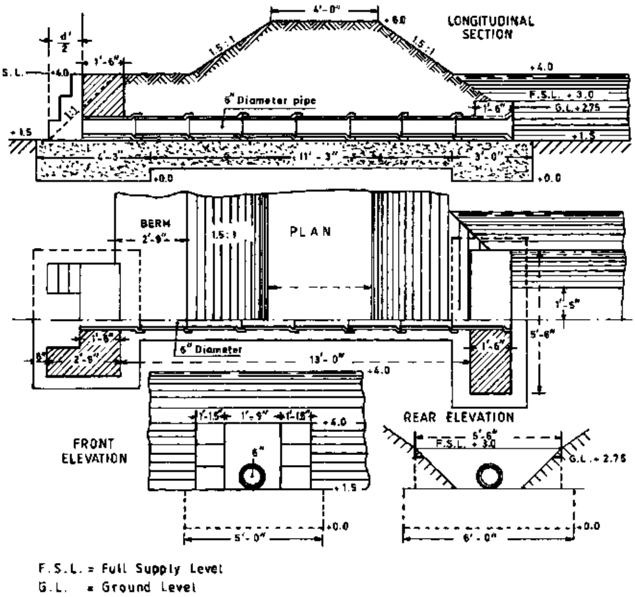
In South India, no development towards semi-modules or modular outlets has taken place, despite the fact that the protective irrigation systems constructed in interior South India are similar to the Northern ones in their objective to spread water thinly. In this section I first explore the reasons for lack of outlet innovation in South India generally, and after that discuss the developments in the Nizam's Dominions and Hyderabad State.

Pipe outlets in South India
A major difference between South Indian and North Indian protective irrigation systems is that for a long time there was no great demand for water in the systems in the Deccan. Farmers took a 'lukewarm' attitude to irrigation in these dry tracts because of productivity, market and soil conditions (Famine Commission, 1881-V:120; for discussion of these and related points see chapter 4). In addition, the protective systems of interior South India were not colonisation schemes, unlike many of the systems in the North. In the new Northern systems farmers were selected who were thought to be interested in and capable to start irrigated agriculture. The South Indian systems were constructed in settled areas with social relations characterised by a poor, differentiated and indebted peasantry that lacked the means to invest in irrigation even if they wanted to (Attwood, 1987; chapter 5).[17)]

[17)] Just like the 'capitalist farmers' that were selected by the British as the leading group of settlers for the canal colonies in newly constructed irrigation schemes in North India were important for the rapid development of irrigated agriculture in the new schemes (Jairath, 1984), so were the Shaswad Mali farmers who migrated into the Nira Left Bank Canal in Maharashtra, as described in Attwood's case study, important for the development of an expansive sugarcane sector. The role of the migrants from Andhra Pradesh in the Tungabhadra Left Bank Canal has been discussed in chapter 5. What these groups had in common was that they brought with them capital to invest in irrigated agriculture, experience with commercial irrigated farming, and no 'feudal' ties that locked them into marginal production and productivity.

As a result, the water management problem in the protective systems of the South for a long time was much more to induce farmers to use the water, than to ration it (see chapters 3 and 4). The actual situation in the systems created little inducement to increase technical control at the outlet level.[18]

Figure 8.6: 6 inch pipe outlet as used in Madras Presidency



Source: Ellis (1931:304)

Technical control at outlet level was also not part of the dominant engineering tradition in the South, which was based on rice irrigation in the delta regions (see chapter 3). In the few pages devoted to outlets in the classic textbook of South Indian irrigation engineering, Ellis' irrigation manual, the pipe outlet is the most important structure discussed (see figure 8.6).[19] Figure 8.6 shows that the pipe outlets in the deltas were ungated. This implies that

[18] The effort to increase technical and other forms of control in the Nira Left Bank Canal referred to above was also an effort to *increase* the use of irrigation water in this system, which was one of the protective systems with low utilisation rates, rather than to spread and ration it.

[19] In the 1931 edition of Ellis' manual attention is paid to the North Indian Kennedy gauge outlet, and in the 1950 edition one paragraph is devoted to the North Indian adjustable proportional module, a development of the Crump semi-module (Ellis, 1931:307-308; 1950:323-324). The disadvantages of pipe outlets are also discussed, but the Kennedy gauge outlet is considered unsuitable for the South Indian continuous flow conditions, as discharge does not vary proportionally with changing water levels (it is too close to modularity). With regard to the adjustable proportional module no remarks on suitability are made, though it solves the problem of proportionality.

no regular opening and closure was envisaged, or possible, as would for example be required in the '*tatiling*' as practised in the North.

In delta irrigation the reasons not to be interested in the increase of control capacity at outlet level were the lack of water scarcity, and the lack of government involvement in local water management. The first reason is illustrated by the following quotation.

> [T]he irrigation [in the Godavari and Krishna Canals] is in the monsoon, and hitherto there has been abundance of water for the irrigable area. The ryot may wish to flood his rice-field a foot deep, and the irrigation officer may know that six inches is enough and dole it out accordingly. But, generally speaking, when the outlet has been granted to supply water to a certain area, the water flows uninterruptedly throughout the season, and, if one ryot gets twice as much as another, both get enough and they are tolerably contented. Distribution like this is rough indeed compared to that on a North Indian canal, where a two-inch flooding may save the crop, and an inch and a half may lose it, and where the ryot has only a chance of water at all three or four days in the fortnight. The Madras Canal Engineer then needs to bestow little attention on water duty. Nor does he care much if the distributary channel is untidy and wasteful of water. There is plenty more to draw from. (Scott Moncrieff, 1879:135)

With abundance of water, pipe outlets were the cheapest and easiest to construct type of outlet. In the very flat delta areas pipe outlets had the advantage that they could work with a very low driving head. Demand for water and scarcity did increase in the deltas in the course of time, but the perceived scarcity still occured in a context of very intensive cropping patterns with a high percentage of rice cultivation. This is an altogether different situation than the dry tracts of North India and of interior South India, where scarcity and rationing were design principles. This situation can be guaged through another quotation of Scott-Moncrieff.

> In a dry season in Northern India, the canal officer is mobbed by thirsty ryots imploring him to supply water. He spends his days, sometimes even his nights, in patrolling his distributaries and seeing that the volume at his command is being fairly dealt out. He gets daily reports (at times twice or thrice a day) of the depth of water at points three or four miles apart down his channels. He is always on the watch lest the flow of the water be checked by silt deposit, weeds, tufts of grass, or rubbish, and it is his pride to have clean orderly channels. Nor does his care end with the outlet from the distributary bank; but as he rides through the village lands he keeps an eye on the field channels and advises how they should be laid out as to secure that as little water as possible should be lost in them. A glance at any Revenue Report of Irrigation in the North-Western Provinces or Punjab will show how much prominence is given to 'high water duty', that is, to the area irrigable from a given unit of discharge. The Engineer is held responsible for the water in his canal as he is for the money in his cash-box, and every year a more rigorous account is required of it. (Scott Moncrieff (1879), published in Famine Commission (1881V:135-137))

Lack of government involvement in local water management, the second reason for limited interest in the increase of technical control at outlet level, derived from the existence of strong traditions of self-management in the Southern systems. Many of the 'government works' were expanded and/or improved indigenous systems (see Famine Commission, 1881-V for historical examples, and Sengupta, 1991 for contemporary ones), in which farmers seem not to have welcomed government intervention at the lower system levels. At the beginning of the twentieth century Buckley noted that it was difficult to convince Madras rice farmers of the usefulness of field channels (Buckley, 1905:295). The construction of village and field channels would have enabled stronger government involvement in local water management, through the introduction of rotational water distribution for example. The existing field-to-field irrigation method was fully farmer controlled. South Indian irrigation engineers may thus have had relatively little exposure to outlet level water distribution problems.

It must be assumed that the South Indian engineers continued to use the pipe outlet structure as current in the delta regions when they undertook to construct new large scale protective systems in the upper parts of the rivers in the 20th century for two reasons:

1) there was no immediate pressure to reconsider this design choice, because the systems they knew from close by either had abundant supplies or suffered from lack of demand for irrigation water;
2) the possibly problematic nature of water distribution at local level was not recognised or appreciated because there was little experience with local water management.[20]

Pipe outlets in the Nizam's Dominions and Hyderabad State

As noted in chapter 4, the construction of larger irrigation systems in the Nizam Dominions, where the Tungabhadra Left Bank Canal was conceived, started in the first half of the 20th century. The first large scale system, constructed between 1924 and 1932, was the Nizam Sagar project, which would eventually irrigate 110.000 acres (Anjaneya Swamy, 1988:48-52; HYDBUL III/9:707-710). It was originally planned to irrigate 275.000 acres, but the government seems to have had little control over the system's actual use by farmers. The project has effectively become a rice and sugarcane scheme. The outlets that were used in the Nizamsagar system were 6 inch pipes (HYDBUL III/9:707). It can be assumed that these were direct copies of the pipe outlets used in Madras Presidency.

The reference to Madras is explicit in the later Dindi project (Azeemuddin, 1944, 1947). The Dindi project however had explicit protective objectives. "[T]he system of irrigation proposed is based on the underlying principle of giving the maximum benefit to the largest numbers of cultivators." (Azeemuddin, 1947:38) All 'paying crops' had to be excluded. "Even rice for which this tract of Telingana is eminently suited had to be curtailed to the minimum possible extent in order that more rabi and kharif crops may be protected." (Azeemuddin, 1944:96) The protective nature of the system showed in the limitation of rice cultivation to 7000 acres of a total of 39,000 acres, which is 18%. The rest were 'irrigated dry' and garden crops (Azeemuddin, 1947:38).

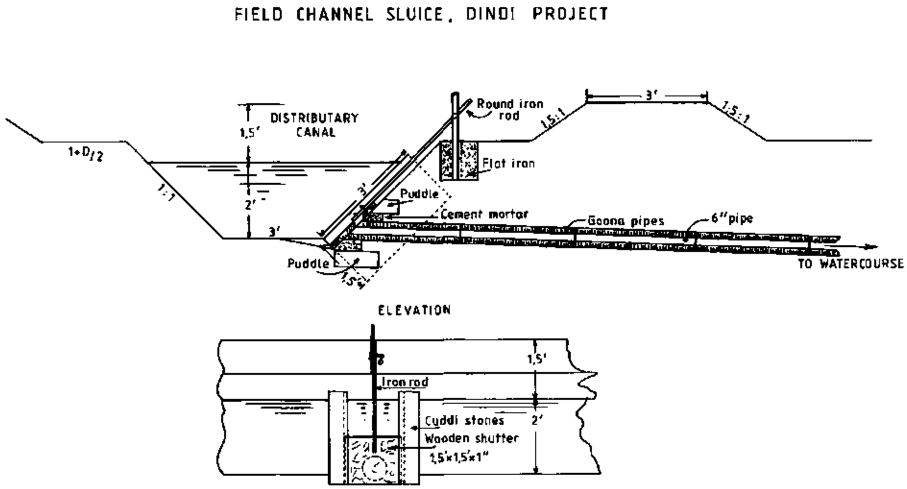
Khaja Azeemuddin, the engineer who oversaw the design and construction of the Dindi project in the early 1940s[21] employed Ellis' manual for his calculations of available water supply and other things. He also designed a new type of pipe outlet (see figure 8.7), which, he notes, gave very satisfactory results in trials at an experimental station (Azeemuddin, 1947:41).

Azeemuddin's design of this pipe outlet was based on several considerations. He stated that "[i]n a canal system usually [that is, in Madras Presidency. PM] very few, if any, regulators are provided at the mouth of field channels." The reason for this was the "heavy burden on the channel estimate" if they were provided. However, "[t]he cultivators naturally waste a good deal of water and there is always quarrel between the cultivators under the same distributary." And as "water is very precious in these parts (...) every effort has to be

[20] Engineers themselves, with hindsight, usually also explain the use of pipe outlets in the protective systems to be the result of an extreme 'rice bias' in the training of the South Indian irrigation engineer.

[21] He also played an important role in the Tungabhadra Left Bank Canal design some years later (see chapter 4).

Figure 8.7: Field channel sluice for Dindi project



Source: Azeemuddin (1947)

made to control the wastage of water by the ryots." (Azeemuddin, 1947:41) Azeemuddin thus designed a cheap and gated outlet for the protective Dindi system, that cost only 10-12% of the 'ordinary design', and which had locking arrangements.[22]

The objective of protection also became definitive for the next large scheme, the Tungabhadra Left Bank Canal (see chapter 4). Gated pipe outlets were introduced in this project from the start.[23] The fact that the pipe outlets were equipped with gates may be interpreted as an indication of the existence of some awareness of the need to regulate the supply. I have not found any documentation on the type of regulation envisaged, and oral explanations in interviews mostly emphasised the open/close function of gates rather than their capacity to regulate water flows in quantitative or qualitative ways (also see discussion in the next section). It seems that the concept of water control by means of pipe outlets was thought through very little in the design stage. This is illustrated by the following remark in the project report for the right bank canal. After the statement that pipe outlets will be used

[22] It is not known to me whether and on what scale the pipe outlet as designed by Azeemuddin has been actually introduced in the Dindi project.

[23] This information comes from interviews with engineers who worked in the construction of the canal. The 1934 project report of the Tungabhadra Left Bank Canal (Gopalan, 1934) makes no mention of the type of outlet structure to be used. The same is true for the project report published, most probably in 1954, by the government of Hyderabad State (GOHYD/PWD, n.d.). For the right bank canals of the Tungabhadra system, pipe outlets were also envisaged (Thirumalai Iyengar, 1945:para.34).

it is observed that "supply will be delivered strictly on an acreage basis" (Thirumalai Iyengar, 1945:para.34). Seemingly, no contradiction between the use of pipe outlets and strict acreage-wise supply was felt to exist.

A second design feature of the pipe outlet structures is even more puzzling. The pipes of the Left Bank Canal outlets were systematically overdimensioned in the first phase of the project. A standard pipe diameter of 1 foot was used, despite elaborate calculations of the design discharge for the outlet command areas (see Appendix 4.1). A 1 foot diameter pipe can discharge 2 to 4 times the design discharge of an average outlet, and thus makes over-appropriation technically very easy.[24] The Tungabhadra case thus supports the general conclusion drawn in the previous section that the engineers did not realise what the complexities of water distribution might be.[25]

When these complexities presented themselves (see chapter 7) engineers did start to make adaptations to the standard pipe outlet design. Pipe diameters were reduced in many places to 9 inches or, less often, 6 inches (for more discussion see the next two sections).[26] However, to my knowledge it was never considered to use any other type of outlet than a pipe outlet in the Tungabhadra Left Bank Canal (and other protective systems in Karnataka).[27]

It is not the case that knowledge on other outlets is or was not available within the Mysore/Karnataka engineering community. For example, a note of the Mysore Engineering Research Station contains a detailed description of different types of outlets used in India (MERS, 1966). Experiments were also done with some of these structures.[28]

---

[24] See Bolding (1992:100-105) for an example. With all pipes installed at the bed level of the (sub)distributary canals, distribution along a canal automatically became unequal because of the reduction of water depth that normally occurs in the downstream direction. The reduction in water depth is not proportional to the reduction in discharge because the canal cross section is also adapted, but still there normally is a reduction. This gives higher discharges through upstream outlets when gate openings are the same. This can only be avoided by the closure of upstream gates for longer periods than downstream ones, or by the adaptation of the gate openings to the water depth. The complexity of this calibration has been mentioned in section 8.1. As noted above I have found no evidence that these complications were considered in the design phase.

[25] In the forms used in distributary and outlet design in distributary 85 (see Appendix 4.1) the 1 foot pipe diameter for the pipes in the pipe outlet structures was preprinted. This shows that the 1 foot diameter design element was a standardised feature of the structures. When directly asked about the reasons for the standard 1 foot diameter design of the pipes, some retired engineers whom I interviewed stated that it was feared that smaller-size pipes might get easily blocked, particularly in black cotton soil. This could easily have been tested in the first distributies put in operation, but this seems not to have been done. It is therefore not a very satisfactory explanation.

[26] With a 9 inch diameter pipe the pipe outlet structure is often still over-dimensioned; a 6 inch diameter pipe comes close to what is usually required. Because the engineers assume an arbitrary working head of 1 foot in the calculations, for which there is no empirical basis, and because outlet command area size is not always adapted to the stated standard design discharge of 1 cusec (see chapter 6), it is difficult to make exact statements about the over-dimensioning of pipe outlet structures on the basis of pipe outlet diameters alone.

[27] What was also not considered was the possibility to install (smaller) pipes at one-third design depth below the full supply level, to get proportional division of water (Mahbub and Gulhati, 1951:155; also Pradhan, 1996:69, 131 for discussion in the Nepalese context).

[28] An earlier example is the *Silver Jubilee Souvenir Volume* published by the Mysore Engineers Association in 1932, which contains pictures of a '90° 'V' Notch with baffles, with hook gauge', a '0,3 cusec Gibb module, with baffle vanes in view to consume the extra head' and a 'unit for experiments on notches and the standing wave flume' (Mysore Engineers Association, 1932).

What needs to be explained is why the experience of many problems with the pipe outlets in actual water distribution (see chapter 7) has not resulted in a reconsideration of the type of outlet to be used, or at least a debate on the pros and cons of pipe outlets, among engineers. I will not try to provide this explanation at this point, but leave it to the concluding section of this chapter. In the following two sections I take the continued use of the pipe outlet structure in the Tungabhadra Left Bank Canal as given, and discuss what happened to the standard design when it started to be used.

8.3 THE SPATIAL DISTRIBUTION OF DIFFERENT TYPES OF PIPE OUTLETS ALONG TWO CANALS

A close look at actually existing pipe outlet structures in the Tungabhadra Left Bank Canal shows that there is considerable diversity in the precise characteristics of individual devices. As has been shown in the previous chapter, farmers generally do not sit and wait to see how much water the Irrigation Department will supply to them, and when it prefers to do so. Farmers actively intervene in main system management, formally the domain of the government, to secure sufficient water supply to their fields. 'Remodelling' of the physical characteristics of the pipe outlet structure is part of this intervention.

There are at least two ways in which farmers can manipulate the pipe outlet structure in order to increase the discharge into the outlet command area. One is to increase the driving head. This can be achieved by a raised upstream water level (through obstructions in the canal like stones or bathing buffaloes) or by a lowered downstream water level (through a dug out field channel bed level for example). Another strategy is to increase the pipe's cross section, by convincing the Irrigation Department to install a larger pipe, by damage to the pipe that creates favourable leakages, or by installing an extra, illegal, pipe.

The general response of the Irrigation Department to these interventions of the farmers has been to use the gate of the pipe outlet to regulate the water flow. The gate was made more finely adjustable, and a lock was put on it. In this way, the Irrigation Department has tried to control the flow through the outlets and to fulfil at least part of its responsibility to distribute water equitably among all farmers. The effort to regulate flows by gate settings stimulated farmers to seek new strategies to increase supply. These include convincing Irrigation Department officials to raise the gates, and manipulation of gates by farmers themselves (see chapter 7 for detailed discussion).

We have found that the type of modifications made to the pipe outlet structures depend on the scarcity of water and the modes of interaction (and their development over time) of the groups of people involved. Hence, the characteristics of outlet structures will differ from place to place in the system. In this section I give two examples of the spatial distribution of pipe outlets along canals in the Tungabhadra Left Bank Canal, and suggest the significance of this spatial distribution for understanding the daily reproduction of the pattern of unequal water distribution.

First example: from head to tail in a subdistributary

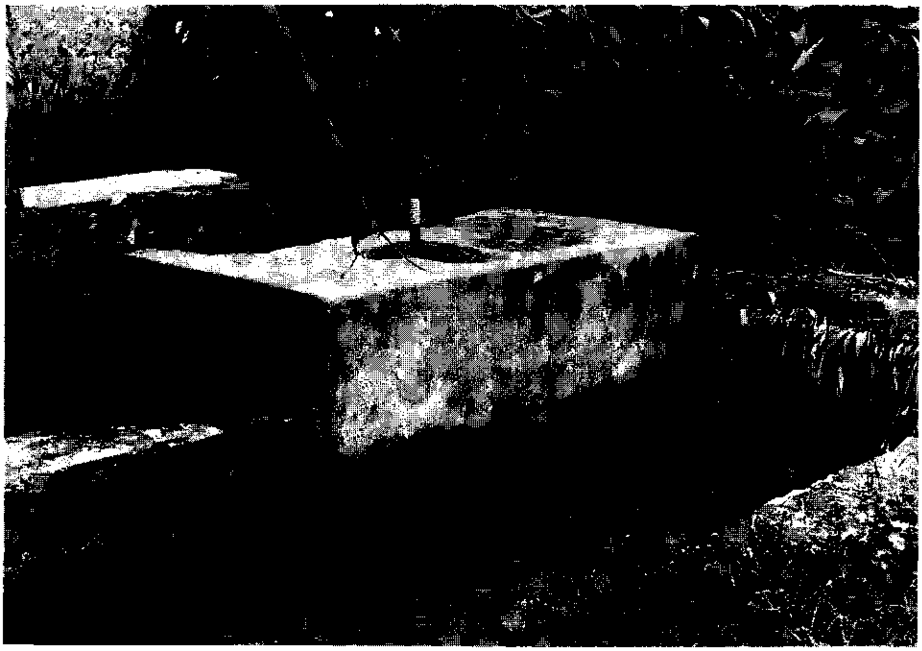
The first example is sub-distributary D24/9. Distributary 24 is located in the head end of the Tungabhadra system, and was constructed in the early stages of the project, more than 35 years ago in 1991-92. In subdistributary D24/9 a clear head-tail pattern had evolved in this period (see chapter 7). The cropping pattern along this almost 3 km long subdistributary in 1991-92 showed 100% rice cultivation in two seasons in the head end outlet command areas, and less than 10% rice cultivation in one season in one of the tail end outlet command areas. This change was also visible in the pipe outlet structures. The subdistributary can be divided into four sections. In each of the sections a different type of pipe outlet was found, related to a different water management situation.

Photo 1: Thread-gate mechanism found on the canal side (held by research assistant R. Doraiswamy)

In 35 years of water distribution the outlets of the subdistributary had undergone several changes as a result of increasing water scarcity. At the very beginning, when as yet there was no water scarcity, pipes of standard size (1 foot diameter) were installed in the outlets of this sub-distributary, with 'pen-gates'. These gates could be fixed at different levels by inserting a wooden or iron 'pen', or rather pin, through the holes made at regular intervals in the handle of the shutter. This gate type is now distant history, and most farmers only knew the thread-gates that are presently used (see photo 1). In the thread-gate the gate handle is a long bolt, and a hexagonal nut has to be turned with a special key to raise or lower it. The mechanism also has a spring lock, to prevent that the nut is turned. For this an additional key is needed.

The thread-gates were introduced when water distribution problems started to occur because of increased water scarcity. The gates began to be used as regulation and control devices to limit discharges into the outlets. But thread-gates could also be manipulated by farmers, either by damaging them or by means of copied keys. In the 1980s another change took place. The Irrigation Department adjusted (in effect, reduced) the standard size pipes to diameters supposedly calculated on the basis of the command areas of the outlets.[29]

Photo 2: The bunker type outlet



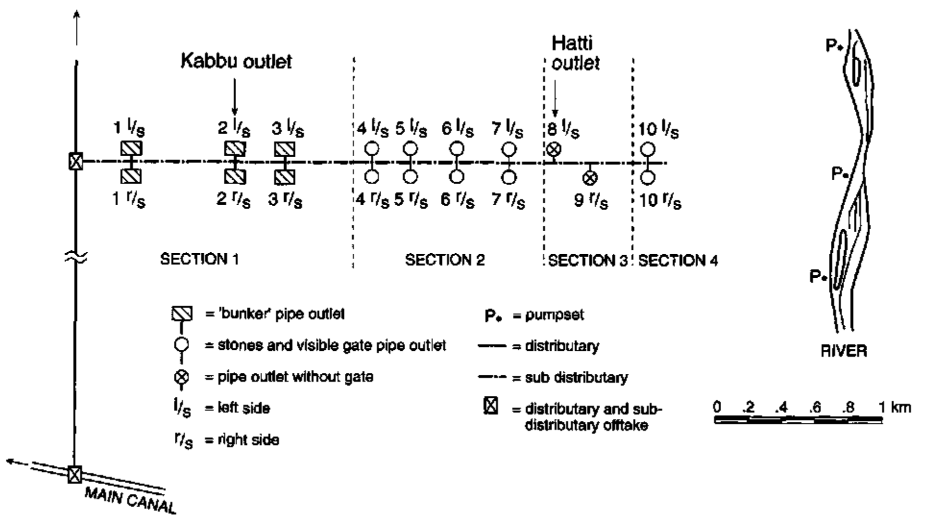
The design of the outlet structures along the subdistributary was standardised in the 1980s in the sense that they, in principle, all possessed thread-gates and had recalculated pipe diameters. But the details of the shape of the outlet structures varied from head to tail.

In the first, head end section of the sub-distributary the problem was excess withdrawal of water for the cultivation of two crops of rice per year. In an effort to control damage to the gate/outlet structure and prevent manipulation, the Irrigation Department had constructed what can best be called 'bunkers' at the first six outlets (1, 2 and 3 l/s + r/s, see figure 8.8). These were heavy, rectangular concrete blocks of about 0.80 x 1.60 m, with the gate mechanism in the middle of the concrete block, hidden and protected in the structure (see photo 2). The gate itself was concealed, and could not easily be reached by hand, hammer

[29] I write 'supposedly' because of the arbitrary assumptions made about the driving head (see above), which implies that actually existing hydraulic conditions were not considered. In many cases the pipe was not reduced to a size that no longer required reduction of the discharge by partial closure of the gate.

or crowbar. The lock mechanism was - necessarily - visible and could be reached on the outside top. It remained the Achilles heel of the structure. However, because it was less easy to inflict physical damage on this structure than on other types, it was mostly manipulated by means of copied keys. The relation between the farmers and the Irrigation Department operators was one of negotiation of the number of threads that the gate was opened.

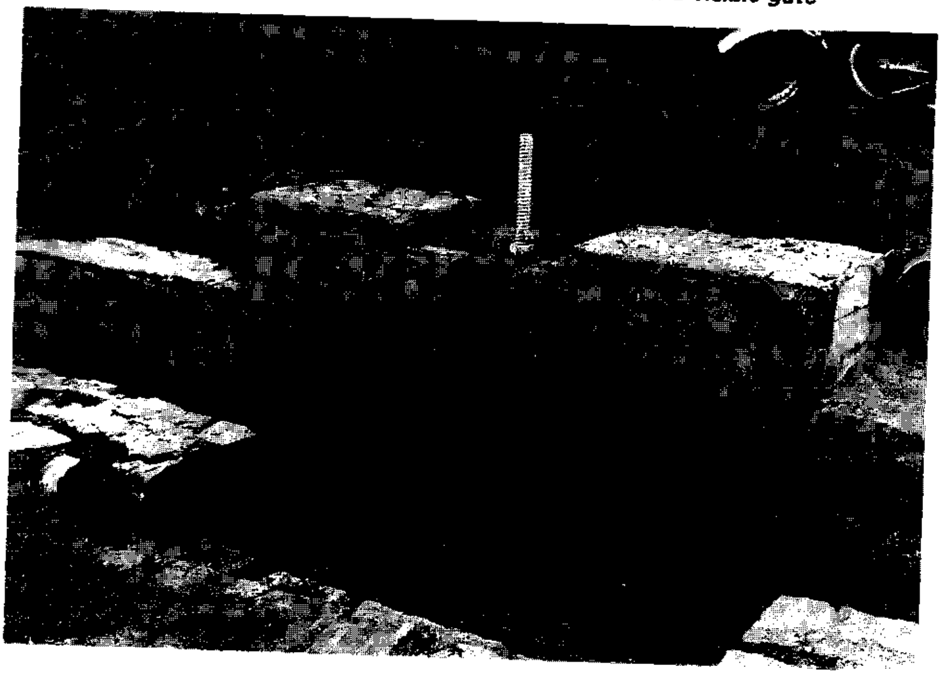
Figure 8.8: Pipe outlets along a subdistributary canal



The second, middle section of the sub-distributary consisted of eight outlet structures of a different construction (4, 5, 6 and 7 l/s + r/s). These were built of stone blocks from local granite and mortar, the materials originally used in all structures. The gates were visible and accessible (photo 3). The structures were smaller than the 'bunkers' in the first canal section. Many of the middle section outlets had been slightly damaged to increase the discharge through the pipe. A common type of damage was a hole in the structure in such a way that when the water depth exceeded the top of the gate, water could also enter the pipe over the gate. Apart from manipulation of the gates themselves, the farmers in this section of the canal tried to raise water levels in the subdistributary by the creation of canal obstructions with stones, wood, mud and straw. This was possible in this canal section because water levels were lower than in the first section. There the canal was still so deep and wide that obstruction was difficult.

In the third section of the sub-distributary the situation was different again. Here, water was really scarce. Actual water depths were well below design water depths. Outlet 8 l/s was a structure of the stones and visible gate type, but the gate was no longer there. When this pipe was scheduled to be changed from a 1 foot diameter pipe to a smaller pipe, the farmers fiercely protested. The farmers alleged that an official verbally abused a leading farmer during one discussion between farmers and Irrigation Department officials. The farmer then gripped the official by his collar. As a 'punishment', the official installed the smallest available pipe - one with a 6 inch diameter - after which the farmers removed the gate mechanism. The situation was left at that.

Photo 3: The stone-and-mortar type outlet with a visible gate



Pipe outlet 9 r/s consisted solely of a pipe under the canal bank, with a small wall built of stones on the canal side. A full structure was never built, even though the gate mechanism was brought to the site. According to the Irrigation Department canal operators, it was not built because the closure period of the canal ended before construction could start. It is more likely that the absence of the structure had to do with the fact that the outlet was located opposite the house of a local political leader, whose family and clients had land in this outlet command area, and who was an important liaison person for the Irrigation Department.[30] Both the 8 l/s and 9 r/s outlets were 'operated' by putting obstructions in the canal, and, more importantly, by guarding upstream sections and gates.

In the fourth section, the pipe outlet structures were again of the stones and visible gate type, and in good shape (10 l/s + r/s). The reason was that hardly any water reached this point. The height of the gate opening was of no consequence, because water levels hardly ever exceeded one or two inches. Also, the command areas of these two outlets were largely

---

[30] For example, through this person the Irrigation Department recruited and payed extra canal operators to guard the canal at night during crisis periods.

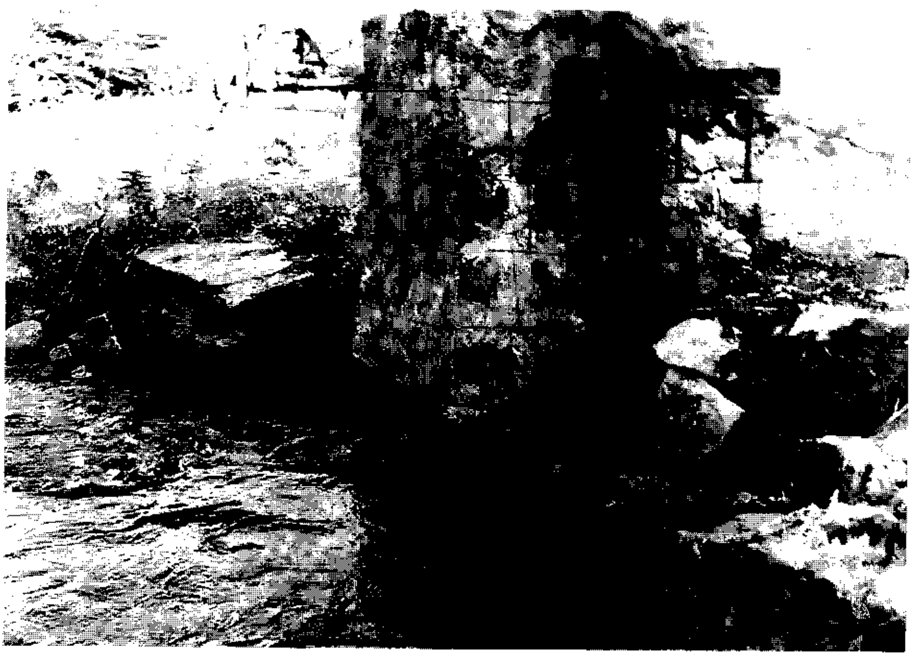
irrigated through pump-lift irrigation from the river, and waste water diverted from a natural drain. Farmers had solved the scarcity problem by tapping other water sources.

Second example: migrant entrepreneurs in a tail end distributary

Between 1978 and 1990 the rice area in distributary 93 increased from several tens of hectares to 1500 ha. The demand for water in the distributary increased enormously. There is now considerable conflict over water distribution because of increased scarcity (see chapter 7).

As in the previous example, the pipe outlet structures were originally built of granite and mortar, and furnished with pen-gates.[31] The pen-gates have been replaced with thread-gates, but can still be found in the area, even when they are used only as a post to tether buffaloes. The problem of increased water scarcity led to the destruction of most pipe outlet structures: gates were removed, and half or more of the stonework was demolished in some cases (see photos 4 and 5). The response of the Irrigation Department had been to start the construction of more solid, concrete structures in the place of the stone-and-mortar ones.[32] The spread of these new structures in 1991-2 illustrates the water management problems in this distributary (see figure 8.9).

Photo 4: Half demolished stone-and-mortar pipe outlet with gate frame still visible



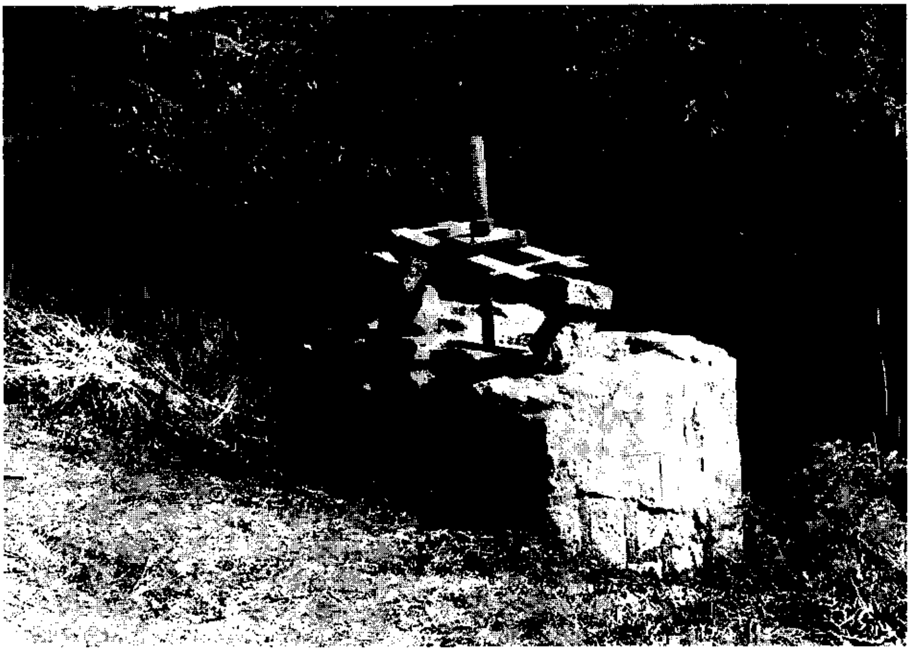
The migrant farmers, who were mainly responsible for the increase in rice cultivation, had settled on the banks of the canal, in or near the fields they cultivated, in the middle reach of

[31] Also in this distributary the pipes of the pipe outlet structures were over-dimensioned.

[32] These were of the visible gate type. The bunker type had not been introduced in 1991-92.

the canal. Figure 8.9 shows that the Irrigation Department started its work of pipe outlet reconstruction in the area close to the migrant camps in the middle reach. The other sections of the canal, closer to the original villages, received their water through the original stone-and-mortar structures. In the head end there was no great need for water control, because water use was low (see chapter 5, section 5.4 and chapter 7, section 7.2). In the tail end section of the distributary the problem was not the condition of the pipe outlet structures, but the arrival of water, as in the first example.

Photo 5: Demolished stone-and mortar pipe outlet with raised gate mechanism

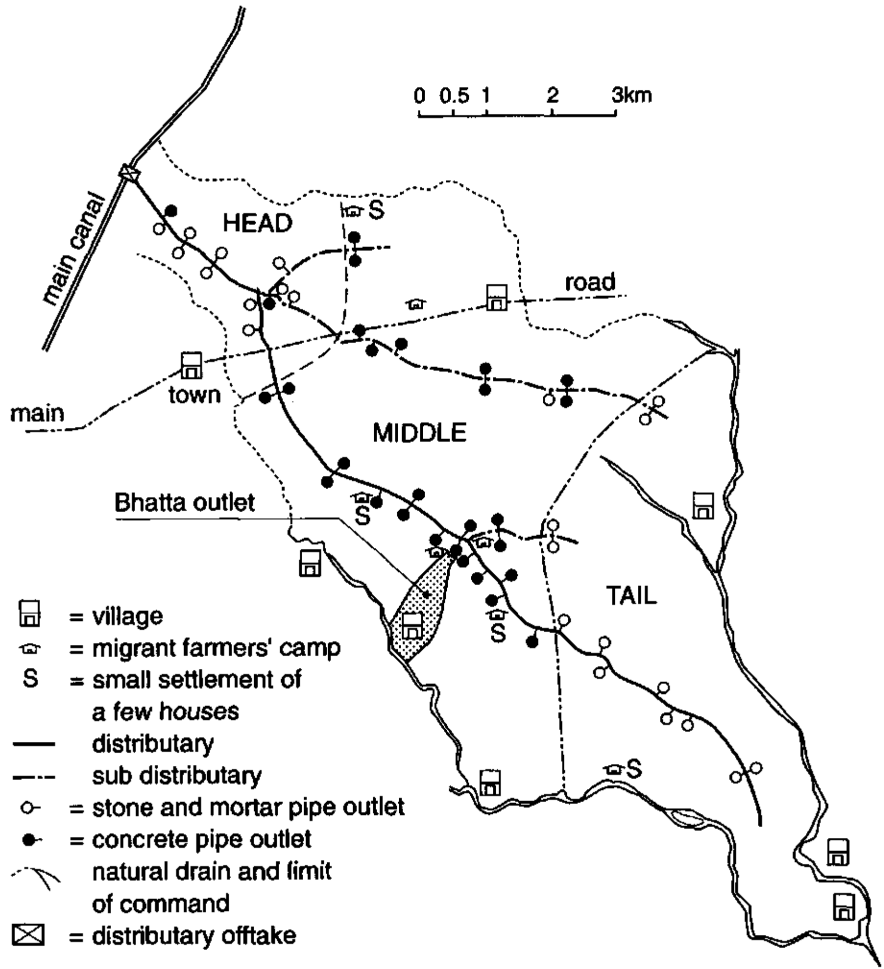


Both the sub-distributary and the distributary case exemplify the significance of the material characteristics of pipe outlet structures for the social dynamics of water distribution. If nothing else, these structures are signposts of complex social processes. The two cases show that the shape of the structures is itself the subject of negotiation and change. This point is elaborated in the following section, where the *process* of negotiation and renegotiation the shape of pipe outlets is the focus.

8.4 THE SOCIAL RECONSTRUCTION OF PIPE OUTLETS IN A TAIL END DISTRIBUTARY

The example to illustrate the process of pipe outlet adaptation over time, is a story about a distributary at the tail end of the main canal, distributary 97. Also in this canal, water has become scarce over the years and this growing scarcity has led to fierce interaction on the canals and elsewhere. The confrontation of the Irrigation Department officials and farmers

Figure 8.9: The geographical spread of pipe outlet structures in distributary 93



over water distribution also triggered a process of pipe outlet structure redesign. This process went through several phases, in which different types of pipe outlet structures emerged.

Phase 1: the 1960s and 1970s

The construction of the 16 km long distributary was completed in 1964. Initially, local cultivators were somewhat reluctant to develop their land and to start practising irrigated agriculture. As a result there was ample water at the time. In view of the abundance of the supply compared to demand, the distributary was extended in 1969 to a total length of 31 km.[33] Approximately 100 pipe outlets now tap water from the distributary and its sub-distributaries.

With the immigration of settler farmers, demand for irrigation water rose gradually, as they cultivated rice and developed (leveled and bunded) large pieces of land. In the 1970s patches of land must have been developed all along the canal. In the tail end village of the canal, near Km 30-31, groundnuts were grown under irrigation on the fertile red soils that are found there. In the head reaches of the distributary and subdistributaries, settlers grew rice.

The type of pipe outlet found in this period was one with a pen-gate without a padlock. On the subdistributaries the steel gates of the pipe outlet structures were cast in a vertical round pipe, as such pipes were readily available during the construction of the canal system. The pipe outlets on the distributary itself were of a more fortified type, with the pen-gate cast in a U-shaped concrete block (see photos 6 and 7).

Photo 6: The vertical pipe type outlet

Also in this distributary the pipe diameters were systematically designed larger than required.[34] The management of the pipe outlets by the Irrigation Department was of low intensity. One gangman, the Irrigation Department employee responsible for gate operation, oversaw the operation of three to four pipe outlets. It was considered unneccessary to have

[33] This extension was an electoral promise of a local parliamentary candidate.

[34] In this distributary 1 foot diameter pipes were not the maximum, but 1.5 foot diameter pipes were also found. This has to do with very large-sized pipe outlet command areas. The over-dimensioning situation still applies (see Bolding, 1992).

gauge readers to monitor water levels in the canal. This type of outlet and low surveillance intensity allowed farmers to appropriate water easily for water-intensive cropping patterns.

Photo 7: Outlet with a concrete U-shaped block, with pen-gate or thread-gate

Phase 2: the 1980s to 1987

In this phase the *status quo* between the cultivators and the Irrigation Department changed and gradually an unmaintainable situation emerged. More and more land was developed, and the cropping pattern shifted towards 'wet' crops. The Irrigation Department started to face a water distribution problem, because the water supply remained the same, or even decreased due to growing demand in the upstream distributaries. Average daily supply in the *rabi* season (December-March) fell over the years, with 1986 as the year with lowest supply.

A new type of pipe outlet was introduced in the subdistributaries to replace the damaged 'vertical pipe with pen-gate' type of outlet. The vertical pipe was replaced by a more robust rectangular block built of granite stones. More gangmen were deployed - one for every two to three outlets - but the outlets were still easily manipulated. The tail end of the distributary started to fall dry. At first the water still reached Km 31, but later it only got as far as Km 28 and Km 25.[35)]

[35)] The cut-off point used was when water reached the area less than three times per season. Three irrigations are required for the cultivation of crops like irrigated sunflower.

In the second half of the 1980s the tail enders organized themselves into a 'body'.[36) This organisation of over 350 water users organised actions against the Irrigation Department in order to increase the water supply to the tail end reaches. From 1984 to 1987 this organisation was responsible for many violent actions, the operation of pipe outlets and the intake of the distributary from the main canal, strikes at the offices of the Irrigation Department and physical threats to Irrigation Department officials to obtain more water. The authority of the Irrigation Department crumbled and its power proved to be weak. Police cases were booked against 'the body' but were suspended, thanks to the intervention of local members of parliament (MLAs) and other politicians who backed the cultivators. The Revenue department, which collects the penalties imposed by the Irrigation Department to correct farmer behaviour, also proved susceptible to political influence. Practically speaking, pipe outlet management was controlled by competing groups of cultivators.

The end of this period was marked by the dissolution of 'the body' in 1987. There were several reasons for this break-up. As explained by the original treasurer, there was no longer unity among the farmers. Initially, when one member did not receive sufficient water a delegation of members would go to the Irrigation Department office, or forcibly raise the gates out of solidarity with that one member. This feeling of solidarity disappeared and people became focused on their own water situation. Why bother about others some kilometres downstream? It seems likely that water scarcity became so acute that collective organisation was no longer feasible (see Wade, 1988a). Another reason is that one Irrigation Department officer who worked on this canal succeeded to mobilise sufficient political support to get 'the body' convicted for illegal activities at the district court.[37)

Phase 3: 1987-1989

In this period the Irrigation Department tried to regain control over water distribution and concentrated on the control of the operation of the pipe outlets. It designed and constructed a new pipe outlet: the fortified thread-gate. This is the same type of structure as the fortified pen-gate, but with the pen-gate replaced by a thread-gate. The shutter can be moved up and down by turning a hexagonal nut with a special key. This turning mechanism was sometimes covered with a small iron box that could be locked with a padlock. The Irrigation Department thus tried to make it impossible for the farmers to manipulate the gate. The thread-gates were installed along the main distributary and along the subdistributary where most members of the collapsed 'body' had their land.

With the same determination to retake charge of the water distribution, the Irrigation Department fortified the offtakes of the sub-distributaries. The number of staff on the canal was increased. Whereas there had previously been one Assistant Engineer/Section Officer for the whole canal, the distributary was divided into four sections, each with an Assistant Engineer/Section Officer. More gangmen were recruited, night control by means of patrolling

---

36) The organization never had an official name or legal status. It was formed spontaneously during one of the many strikes (*bandhs*) of tail enders at a point halfway along the distributary. A president, secretary and treasurer were appointed, and every member had to pay Rs.10 per acre as contribution. Besides actions upstream of their pipe outlets to improve water supply to the tail, 'the body' also organised water rotation within pipe outlet commands. Two paid labourers functioned as common irrigators to operate the water turn for each member.

37) After this conviction, the officer was demoted to supervise a subdistributary, whereas previously he had been responsible for a whole section of the distributary. Apparently, this action against 'the body' had triggered other political forces who organised his demotion.

trucks was introduced, and paid labourers were recruited from among the tail end farmers, to guard pipe outlets during the night.

This offensive met with strong resistance, which was enhanced by the fact that 1988-89 and 1989-90 were crisis years for the tail end section of the main canal generally. During *rabi* 1989 farmers for the first time did not merely damage pipe outlets, but actually destroyed them. The fortified thread-gate is not easy to manipulate, therefore the farmers removed the gates and sometimes chipped away the concrete casing. In other cases farmers copied the keys of the gangmen and operated the pipe outlets themselves. The gangmen, night labourers and night patrols of the Irrigation Department were bribed, outnumbered or beaten up by cultivators. In the absence of political and juridical support the Irrigation Department was unable to impose the planned control. The tail end of the distributary moved further upstream.

In the tail end the fortified thread-gates were damaged much less frequently (see table 8.1). It makes no sense to manipulate the pipe outlet if there is no water. To go upstream and close all head end pipe outlets was an impossible and dangerous task for tail enders. With occasional strikes and the organisation of functions for politicians the tail enders were able to effect short periods of water supply, but these did not bring them long term victories. For most tail enders this was the signal to concentrate on other strategies to get water. Groundwater wells were dug in the red soils near the river. Lift irrigation with the help of motor pumps seemed to be the only solution for the tail enders.

Table 8.1: Frequency of damaged pipe outlets on the main distributary, and relative distance from distributary intake in distributary 93

Rank number (from head to tail)	*Number damaged*	*Percentage damaged*
1-15	15	100
16-30	12	80
31-46	6	37.5

Phase 4: Rabi 1990 to Rabi 1992

The Irrigation Department had overestimated its power but developments at the level of the main canal provided some relief. The water crisis of 1988-90 in the tail end section of the main canal led to changes in the management of the main system. These changes increased supply to the tail end section of the main canal. Also, a system of rotation over distributaries was introduced, which increased the efficiency of water use (see chapter 9). As a result, the average discharge into the distributary in the dry and hot *rabi* season increased and in 1992 was almost twice that in 1986. However, settlement and development of land for irrigation continued, and concentration of irrigation in the head region of the distributary intensified. By 1992 the tail end started at Km 21.

Faced with damaged pipe outlets that could only be operated on an on/off basis, the Irrigation Department devised another management approach. On each su-distributary and on the distributary, the head reaches were to be irrigated during the day time. At night every upstream pipe outlet was closed and guarded by two labourers recruited from tail end villages. A truck and jeep performed night controls to check that all upstream pipe outlets were closed in order to push water to the tail at night. The Irrigation Department concentrated its efforts on the pipe outlets that took water directly from the distributary, and on the sub-distributary offtakes. The remaining outlets in the subdistributaries were left to their users for operation.

This approach suffered from the same problems of bribes and intimidation as the earlier ones. In practice the management was mostly *ad hoc*. When large groups of discontented farmers came to the office, extra controls were installed and the engineers tried to show their commitment. When Irrigation Department officials were outnumbered by farmers at night at a particular point, they shut their eyes and turned their backs. When MLAs requested them to supply water to a particular group of farmers, they tried to do so for some time. Gangmen were bribed on a large scale or forced under physical threat to open gates and keep such things secret from checking officials. During night controls the Irrigation Department jeep first drove a 'warning' round before the situation was actually checked. This was done to give the sleeping labourers who guarded the outlets time to wake up and close the pipe outlet before the arrival of the checking officials. After the check the gates were re-opened. The actions of the Irrigation Department became almost symbolic.

The description of these four phases shows that the pipe outlets and their technical characteristics are both an instrument in the struggle between Irrigation Department officials and farmers over water distribution, as well as an outcome of that interaction. The designs of the pipe outlets have been modified in response to the balance of forces between officials and farmers. The example also shows that using the word 'struggle' is no exaggeration in the context of water distribution.

Photo 8: The ungated outlet

The latest strategy of the Irrigation Department seems to be avoidance of conflicts with cultivators. The overall goal of pipe outlet operation is shifting from the implementation of a reasonably *equitable* water distribution pattern to the execution of a *safe* water distribution policy, with an eye to equitable water distribution when equity can be achieved without risks. A new type of pipe outlet was designed that reflected the situation and the new strategy of the Irrigation Department: the ungated pipe outlet.

The ungated pipe outlet is an open pipe fixed in a head wall of granite stones. This pipe outlet does not have a gate, as this is considered as a waste of goverment money because the farmers will destroy it (see photo 8). The rationing/control aspect was realised in a different way. The offtake field channel was lined and constructed at a high level in order to lower the driving head of the outlet. In this way the Irrigation Department hoped to confront the farmers with a *fait accompli*. The only way to manipulate, besides rigorous destruction of the whole structure, is to construct checks in the distributary or subdistributary, to raise the water level. At the time the field work was done for this chapter, two ungated pipe outlets had been constructed. In 1992 the engineers were also considering the reintroduction of the pen-gate (without padlock). This allows farmers to manipulate the outlets without infliction of damage.

8.5 CONCLUSION: DESIGN, CONSTRUCTION AND WATER CONTROL

In this concluding section I first present a brief summary and some interpretation of the detailed and complex material discussed above. I then move on to draw some more general conclusions on the relation between technological change and state-farmers relations in Indian canal irrigation as exemplified by this case study.

An interpretative summary

Almost from day one the - then British colonial - government was faced with a problem of water control when it undertook to construct large scale irrigation systems in different parts of India. The control of water distribution was a particularly pertinent problem in areas with strong water scarcity. Given the objectives of colonial rule, the government designed the irrigation systems in dry areas to spread water thinly over large numbers of villages and farmers. It thus created the problem that the government canal managers needed to ration irrigation water. After failed efforts to organise water distribution through the invisible hand of the market with the aid of modular outlets, the government resorted to proportional and rotational water distribution with semi-modules in North India (*warabandi*) and to prescription of cropping patterns (localisation) and the use of pipe outlets in interior South India. This shows that in different times and places different forms of water control evolved as a response to the problems encountered on the canals.

In each of the three responses discussed there is a close link between the institutional and the technical dimension of water control. In the 'invisible hand' mode of water distribution, modular outlets that allow stable volumetric delivery are required. Though technically feasible modular outlets were designed in India, volumetric delivery and pricing was never successfully introduced. This had to do with 1) opposition of farmers, and 2) the nature of the land revenue system. The effort failed through institutional factors.

In a rotational mode of water distribution that seeks to distribute water proportionally to land holding, and with fluctuating water levels in the rivers and canals, semi-modules are the appropriate structure. They distribute surpluses and shortages equitably. Semi-modules also reduce the management tasks of the government, as they are 'automatic'. Proportionality is only achieved however, when there are institutions within the government bureaucracy that guarantee the execution of rotation schedules over distributaries that maintain water levels close to full supply conditions, and institutions at outlet command area level that achieve equitable distribution in the outlet command area.

In the protective irrigation systems of interior South India, where localisation defines the mode of land use planning and water distribution, semi-modules would also have been a logical choice. The reasons for the adoption of pipe outlets are related to low demand for water in existing 'irrigated dry' systems in this region, no scarcity of water in the 'wet' systems, and perhaps the strong tradition of local management in 'wet' irrigation, which implied limited government exposure to field and outlet level water distribution practices. There were no incentives for engineers to abandon the use of pipe outlets. It is however surprising that the use of pipe outlets continued even when water distribution problems proliferated through increased demand, and consequently scarcity. The Tungabhadra Left Bank Canal may be seen as a case where the objective of a wide spread of irrigation water was not achieved through both institutional and technical factors.

A close look at the design and construction of pipe outlet structures in the Tungabhadra Left Bank Canal revealed further linkages between the technical and the institutional dimensions of water control. Technological trajectories not only exist at the level of large regions of a subcontinent, but also at the level of single systems and single canals.

What I find striking - because it came unexpected - is the variation in the details of pipe outlet design and construction in the Tungabhadra Left Bank Canal. This variation is easily overlooked, and has been overlooked so far, by outside observers. Almost all the variation has to do with the contestation of water control by government managers and farmers.

The two main variables in the design and construction of the pipe outlets are:
1) the presence and type of the gate (including locking arrangements), and
2) the sturdiness of the structure in which the gate and pipe are fixed.

There are pipe outlets without gates, with pen-gates and with thread-gates. The precision with which discharge through the pipe can be regulated increases in this order. There are gates without locks, with padlocks and with spring-locks, the latter with or without a protection-box around it. These signify different relations between government managers and water users. No locks either means abundance of water and no relation between government and water users, or such dominance of water users that the government no longer tries to regulate flow through locking the gates. The successful use of padlocks assumes strong control of the government management, as they do not allow adjustment without destruction of the lock. They seem to have been used only in a transition phase from the original unlocked pen-gates to spring-locked thread-gates. The spring-locks require two keys for manipulation (and three in case a box is added), but these two keys can easily be copied locally. They therefore allow manipulation without damage, though farmers sometimes damage the structures to facilitate manipulation. The spring-lock is thus a suitable device in control-through-bargaining situations between government managers and water users. It allows day-to-day adjustment of gate settings in response to changes in demand. The design also allows a division of management responsibilities between day and night, between government officials and farmers respectively, without damage to the structure, while the possibility of regulation is maintained.

The second variable, sturdiness of the structure in which the gate is embedded, exhibits a variation of at least 4 types. Gate structures fixed in vertical pipes as found in distributary 97 is the first. Together with the second, stone-and-mortar-with-visible-gate type, it dates from the early stages of the canals, when sturdiness was not a question. When demand, scarcity and the manipulation of structures by farmers increased more solid structures were tried. The major change was to shift from stone-and-mortar to concrete, but leave the structure unchanged, that is the gate visible. This third type is now widely used. An additional change was to locate the gate in the middle of a concrete structure, to make it less accessible. This fourth 'bunker' type was found in subdistributary D24/9. These developments are an answer to a problem with which the 19th century engineers also tried to deal: how to make a structure tamper-proof?

The variation, and its geographical spread, are the product of the history of water distribution practices in the particular canals where we find them, and from the balance of forces between government managers and farmers, and the forms of organisation and routines that have resulted from that. The resources of the different actors engaged in this social interaction may depend on external and contingent factors like the political party in power, non-water related factors that determine access to Irrigation Department offices and to other parts of the administration (like the Revenue Department and the legal system), and the social relations of the water users in the command area. The outcomes of interaction also depend, as this chapter and the previous illustrate, on the personal ambitions and capacities of the actors involved. Irrigation Department engineers can be 'smart' managers or not, committed or not, good technicians or not, and not in every distributary a 'body' of water users is formed.

What kind of generalisations are possible on the basis of these empirical findings? Many of the factors mentioned above are interdependent in complex ways, and depend on other, contingent external factors. I therefore think there is not much scope for an effort to develop a general theory of factors that shape the technical features of pipe outlets. There is no fixed pattern of evolution of these technical forms. The emergence in 1992 of the ungated outlet in distributary 97 illustrates this. Regular spatial patterns do emerge, as shown in the examples of spatial distribution in sub-distributary D24/9 and distributary 93, but the type of regularity differs from canal to canal. Each of these regular patterns can be understood by the identification of factors relevant to that particular case, and the way they articulate.

However, some tentative generalisation is possible at a different level. The case study can also be read as an example of the relation between technological change and state-farmers relations. More than firm statements the case allows a number of questions to be raised on this larger theme, which can be considered as an agenda for further research.

The state, farmers and technological change

I start with the observation that local level engineers (mostly Assistant Engineers overseeing (part of) a distributary canal) are quite innovative in their adaptation of the design of pipe outlets to changing conditions. At the same time however there is no sign of similar innovativeness with regard to the type of outlet structure. The use of *pipe* outlets is unquestioned. The problems in water management have not generated an internal debate in the engineering community on this particular design element, which, as this chapter has shown, is the crucial, and highly problematic, point of contact between farmers and the government management. How can this be explained?

A first point is that irrigation engineers seem to be more interested in invention than adaptation. Their professional interest is aroused much more by the invention and deployment of *new* technologies than by making work and adaptation of *existing* technologies to changes in circumstances.

Historically this is clear from the intensity of Indian irrigation engineering debate and experimentation in the early decades of the 20th century. The hydraulic and engineering disciplines were undergoing strong development in that period, and many inventions were made. For outlet structures the starting point of this period lies around 1900. At a conference in Simla in 1904 several proposals for new devices were discussed (The Irrigation Conference Simla 1904, 1905; also see Kennedy, 1906).[38] After this systematic experimentation took place in field research stations and laboratories. This resulted in a series of technical papers (see for example Crump, 1922; Inglis, 1928a&b; Inglis and Joglekar, 1940). Crump's semi-module and Gibb's module reached a stage of development in the 1920s and 1930s that allowed use in real irrigation situations. As noted above, the semi-modular outlet became the dominant artefact in North India. The debate and experimentation came to a closure in the 1930s and 1940s, after which only smaller adaptations took place that did not change the hydraulic principles of the devices (see for example Bharadwaj, 1949).

Then followed a period in which the design standards for the existing outlet structures became standard designs. For any canal structure (outlet, drop, flume) that needs to be constructed, a standard form and procedure is available. These were used in the design of the Tungabhadra Left Bank Canal, as well as, at present, with any repair work. They can also be found in the irrigation engineering textbooks. Design and construction of canal level artefacts have been highly routinised.[39]

What does arouse the professional interest of irrigation engineers is the 'high tech' frontier of irrigation engineering. Examples of this are modern sprinkler and drip irrigation technologies, and different kinds of modelling that involve the use of computers. In general, the large and more spectacular civil works like dams are found more appealing than the mundane artefacts at the canal level. This predilection is also evident in the strong interest to receive training at prestigious technical irrigation faculties, particularly in the United States.[40]

Another illustration of the same point is the research focus of the Karnataka Engineering Research Station. When I visited the hydraulics department of this institution in 1996 I was informed that their research focused on the design of spillways for dams. Between the 1930s and 1960s there was attention for outlet structures and measuring devices, as evident from the publications quoted in section 8.2, but in the 1990s this was no longer there. As in other places of the world, outlet structures and measuring devices have become known structures, available, on the shelf as it were, when required (see Bos, 1978).

What has not developed is a recognised professional interest in the day-to-day business of making designed artefacts work in practice, and the technological innovation associated with this. The adaptive work of local level engineers described in this chapter is not documented and detailed and prolonged field work was required to be able to recognise it. The engineers themselves hardly saw their work from the perspective described in this chapter. They usually described it as choices forced on them by the difficult circumstances of water

[38] For other design elements important developments also took place in this period. For a technical discussion of dam/weir and canal design in North India see Brown (1983/84).

[39] I suspect that in the training of irrigation engineers students are mainly taught to master these design routines, and that little emphasis is given to the choice between different designs. I have not investigated training curricula in detail, so this is a tentative observation.

[40] As noted above, British engineers were sent to Spain, Italy and France in the 19th century to collect ideas for new technologies. Around the turn of the century American and Australian engineers visited India (Wilson, 1903; Deakin, 1893). The newly independent Indian government sent some its engineers to the United States (and Italy and Yugoslavia) for the same purpose (Sain, 1957).

management, and initially were often hesitant to discuss it because they had diverged from the standard designs.

It can be noted in this respect that Indian irrigation engineers have virtually no formal training in the agricultural and institutional dimensions of irrigation management (see Chambers, 1988). In addition it is important to note that the designs of outlets and other lower level structures are mostly made by lower level and therefore often junior irrigation engineers. Their designs need the approval of higher level officers. The hierarchical structure of authority of the Irrigation Department does not create an incentive for innovativeness; it does create a strong bias to keep to standard designs. To propose something else than a pipe outlet would spark a lot of debate, and would put an individual engineer on the spot. Also, the introduction of a new type of outlet requires at least a distributary level approach. In most cases this exceeds the domain of the field level engineer. The response of local engineers seems to have been to take the institutional constraints as given and try to work within the margins that canal-level implementation allows. The degree of innovativeness that has been discussed in this chapter is therefore perhaps quite remarkable.[41)]

The second point I want to raise concerns the interaction of irrigation engineers and farmers with regard to design and construction. The pipe outlets case study at first glance seems to be a classical example of the social (re)construction of a technical artefact. Different actors, notably farmers and Irrigation Department staff negotiate and renegotiate the technical characteristics of the device. However, farmers and irrigation staff hardly meet each other in this process of remodelling, and hardly ever directly discuss the desirable features of the structures. Farmers inflict damage on/remodel the outlet structures during the night or at other moments that no Irrigation Department staff is present. The staff registers the damage/remodelling and decides whether it should be repaired, and when, with or without changes in the design characteristics. After this is done a new round starts. Sometimes farmers make direct requests to the Irrigation Department to change outlets, for example when they think the pipe is installed below bed level, but these occasions are relatively rare. There are very few encounters at this interface (Long, 1989).

What this means is that there is no formal or informal platform for the negotiation of technological innovations. Possibilities for a meaningful discussion between farmers and irrigation staff and among different groups of farmers, are more or less ruled out because of the lack of such a platform. Mahbub and Gulhati's hope that farmers would use the knowledge contained in their book to check whether the government managers provide sufficient water to their outlets therefore must remain an idle hope. Particularly those who do not get their share of the water have few possibilities to make their voice heard in such a way that it makes a difference, because there is no structured participation of water users in the technical decision-making of the Irrigation Department.

To explain the absence of institutions for participation in design activities reference can be made to some of the same issues that were discussed above: the routinisation of irrigation design, the scope of the training of engineers, and the hierarchical organisation of the Irrigation Department, where accountability relations are upwards to superiors rather than

---

[41)] The design and estimate of a new pipe outlet structure or one that needs to be repaired has to be sent upwards in the Irrigation Department hierarchy for approval. But the design and estimate do not specify the exact type of gate to be used nor the mode of construction and construction material. The generality of the design and estimate create a space for adaptation to local conditions. Decisions on the precise construction characteristics can thus be made by Section Officers (see Bolding, 1992:100-105).

downwards to water users (also see chapter 7). In addition there is, on the farmers' side, the diversity of interests between headenders and tailenders, or more generally the problem of social differentiation. The same mechanisms that help to reproduce unequal water distribution at the outlet and distributary levels (see chapters 6 and 7) are likely to hamper the introduction of more democratic forms of technological change.

9

CHANGING TABLES

Institutional transformation in main canal management

This chapter discusses changes in the organisation of water distribution in the Tungabhadra Left Bank main canal between 1980 and 1992. I describe two attempts to change main canal water distribution routines. Firstly I look at an attempt generated at the policy level to change main canal water distribution through and by the Command Area Development Authority (CADA) (section 9.2). Secondly, and more elaborately, I discuss how the day-to-day and year-to-year happenings in the command area induced institutional change in main canal management during a severe water crisis (section 9.3). This is preceded by a description of the inequality of water distribution at main canal level (section 9.1).

In the concluding section 9.4 I first discuss the relevance of the water control framework for the analysis of main canal management. I briefly summarise how water distribution at main canal level is politically contested, and how the technical, organisational and socio-economic/political dimensions of water control are related at this level. After that I discuss at greater length a number of specific conclusions that can be drawn from the main canal case study. The overall theme is what the case can teach us about irrigation policy for management reform. I argue for the adoption of a 'policy as process' perspective instead of the current 'policy as prescription' model. The former implies locally-specific policies, with more participatory policy formulation and more adaptive policy implementation.

Finally, the chapter as a whole has two more general, and more mundane, objectives. Firstly it means to be a contribution to the very limited set of analyses of main canal distribution practices in South Asian irrigation. Detailed studies of irrigation water distribution practices at the level of the main canal are even rarer than those at distributary and outlet level. As a result we know much better what is *not* happening in main canal management - management as planned - than what *is* happening.

Secondly, the chapter tries to sketch a more refined picture of the workings of the Irrigation Department than the popular images of rent-seeking and anarchy on the canals tend to suggest (also see chapter 7). It identifies a more complex set of difficulties in the realisation of more equitable water distribution than these common pejorative qualifications of main canal management allow. The chapter sketches some of the contours and limitations of the knowledgeability and capability of the Irrigation Department staff as central actors in main canal management.

9.1 INTRODUCTION

In this introductory section I give the background information for the main story of the chapter. It includes a description of unequal water distribution at main canal level, the emergence of water scarcity and a distribution problem around 1980, and the importance of the opening and closure dates of the canal.

Unequal distribution at main canal level

In 1991-92 water distribution in the Tungabhadra Left Bank main canal was unequal, though how unequal is a matter of perspective. The main canal is divided into four Canal Divisions for its management (see figure 3.1 in chapter 3). Table 9.1 gives the water use in each of these Divisions, going from head to tail. I have taken a two-week period in February/March 1992 for the calculation of the average discharges at the dam site and the borders of the Divisions. In this part of the agricultural year water stress is not extreme, but because it is in the *rabi* season, all water will certainly be used (in contrast to a period like November or December for example), and there was no rain (as was the case in the *kharif* season).

Table 9.1 shows a head-tail pattern in the distribution of water along the main canal. Somewhat surprisingly perhaps, actual distribution is not extremely skewed when compared with the planned distribution as per the localised cropping pattern. The Irrigation Department manages to keep the water distribution reasonably close to the pattern as planned through localisation.[1)]

But this is not how farmers look at the matter. For farmers localisation has become an irrelevant factor in their crop choice (see chapters 3, 6 and 7). Farmers throughout the command desire to practise intensive irrigation. If we consider the spread of the water over the four Divisions in relation to the irrigable command area in these Divisions, a much higher degree of inequality emerges. The water use per acre of command area is 2.2 times in the head end Division than in the tail end Division. It is this perception of inequality that underlies the water users' attitude toards the Irrigation Department's main canal management.

The emergence of scarcity and a distribution problem

The pattern of unequal, head-tail water distribution in the main canal was not always a problem. In the initial decades of the Left Bank Canal's existence there was surplus water at the level of the system as a whole. Table 9.2 shows the total water drawals from the reservoir for Left Bank Canal irrigation. It can be deduced from the table that in the 1960s the main canal did not have to run at full capacity. Till the mid-1970s 'bonus crops' were

---

[1)] The relatively higher water use in the second Division as compared to the First Division in proportion to the localisation pattern has to do with the much larger area localised for rice and sugarcane in the First Division (40998 *versus* 5861 acres). Several aspects of inequality are not visible in this table. In an overall analysis allowance would have to be made for the fact that part of the supply to the tail end comes in periods when it is not needed. This happens when the release at the dam site is insufficiently reduced in comparison to lowering demand (at harvest time for example). Another factor that accentuates the head-tail pattern is that the supply to the tail end covers a shorter period of the year. The tail end has to wait longer before the water arrives when the canal is opened or the discharge increased, and the water supply shrinks and stops earlier when the canal is closed or discharge reduced (the latter because upstream users try to draw the maximum when closure nears). This can easily make a difference of two weeks of water supply per year. The last exacerbating factor is that the supply to the tail end division is more variable than that to the upstream divisions.

Table 9.1: Water use in the four Canal Divisions of the Tungabhadra Left Bank Canal between 18.2.92 and 2.3.92

	Water use in a Division (average discharge 'consumed') (in cusecs) (a)	*Actual water use as a proportion of planned water use according to the localisation pattern*	*Actual water use in proportion to the size of the Division's command area* (b)
First Canal Division (head end)	986	104%	141%
Second Canal Division	1140	115%	103%
Third Canal Division	939	91%	92%
Fourth Canal Division (tail end)	456	80%	64%

a) This is the difference between average discharge in the main canal at the head and at the tail of the Division; average release at the dam site was 3541 cusecs. Based on gauge register and gauge table Irrigation Department.
b) The total localised area was taken as the command area. For Division one to four these are 119246, 188688, 173861 and 120903 acres respectively

allowed in the summer season. A last indication of the existence of a surplus situation in the early phases of the canal's existence, is that in discussions on the length of the summer canal closure period during the 1970s, it was considered whether this should be 20 days or a month (GOKAR/PD, 1976; CADA/TBP, 1979). These periods look extremely short in the present circumstances.[2)]

[2)] This does not mean there were no management problems in the main canal. The major main canal management problem in this period was the occurrence of breaches (see GOKAR, n.d.) These breaches could cause serious water shortages for particular areas, depending on at which point in the canal they occurred, how long they took to repair, and what moment in the season it was. The breaches were a serious risk factor in irrigated agriculture, that caused insecurity of the water supply. In the 1970s the breach problem started to be remedied. The problem was identified to lie in the faulty construction of the main canal, particularly the unsatisfactory way in which the consolidation of the canal banks had been done. To remedy the problem, a programme of 'outer' and 'inner strengthening works' was designed, which is still in progress. Breaches are by no means fully a thing of the past, but reportedly the situation has improved. However, the Irrigation Department is also commonly accused by farmers of letting breaches occur and enlarge themselves by not promptly stopping water supply, in order to attract repair and maintenance funds. I am unable to judge the truth of this accusation. Breaches have distributional effects, but are not caused by distributional factors. Therefore, the implications of breaches are left aside.

Table 9.2: Total water drawals by the Tungabhadra Left Bank Canal, 1961-62 to 1991-92

Year	*Total drawal (in TMCft)*					*Year*	*Total drawal (in TMCft)*		
	(a)	(b)	(c)	(d)	(e)		(c)	(d)	(e)
1961-62	38.809					1979-80		85	88.868
1962-63	41.839					1980-81		89	88.086
1963-64	56.683					1981-82		77	80.21
1964-65	61.688					1982-83		80	80.938
1965-66	67.655					1983-84		81	80.828
1966-67	70.828		71.59			1984-85			76.209
1967-68	63.193		62.66			1985-86			74.855
1968-69	77.443					1986-87	82.298		83.604
1969-70		74.250				1987-88	64.740		65.046
1970-71		75.380				1988-89			69.74
1971-72		75.380				1989-90			73.958
1972-73		63.020			76.438	1990-91			75.857
1973-74		67.83			87.463	1991-92			77.278
1974-75		67.67		67	82.028	1992-93			70.924
1975-76				78	94.932	1993-94			80.431
1976-77			73.38	75	74.548	1994-95			73.322
1977-78			85.79	85	85.885	1995-96			70.516
1978-79				88	85.927				

TMcft. = Thousand Million cubic feet
a) GOI/KWDT/MYDK-15 (1970)
b) GOKAR/PD (1976:116)
c) Gauge registers Irrigation Department, data collected in 1991-92
d) Jurriëns and Landstra (1990:table 13)
e) Gauge registers Irrigation Department, data collected in 1997

The present problem of insufficient supply to the tail end divisions with maximum main canal release, has emerged around 1980 and has intensified since then. Table 9.2 shows that for a long time the Left Bank Canal's total yearly drawals from the reservoir increased.[3] This increase seems to have taken care of the increase in demand for water that was caused by ongoing land development for irrigation in the command area and the intensification of irrigation. In the course of the 1970s total drawals started to exceed 80 TMCft. and from then the increase stopped. In fact, there seems to be a decrease after 1980-81. The limit that was reached was the maximum discharge capacity of the main canal.[4] In addition, the level of use that was reached in the Left Bank Canal and, presumably, in other canals that draw water from the Tungabhadra reservoir, led to the exhaustion of the reservoir earlier in the

[3] Data from different sources and collected at different times from the same source are given in table 9.2 to indicate the reliability of the total drawals figures.

[4] A factor that complicates the interpretation of the total drawals figures is that the discharge capacity of (parts of) the main canal increased during the 1980s through the outer and inner strengthening works programme. The main canal is still unable to carry its design discharge of 4100 cusecs. The maximum drawal from the reservoir is about 3500 cusecs. It can be noted that the Left Bank Canal has never drawn its full share as allocated in the Krishna Water Disputes Tribunal's Award (see chapter 4).

year than before. This necessitated earlier canal closures, which automatically led to lower total drawals.[5]

I conclude from these figures and data collected through interviews that from approximately 1980 water distribution in the main canal has been a zero-sum game. The phenomenon of the relocation of water use to upstream reaches that was described in chapters 5 and 7 for the distributary level, also started to occur at main canal level from this year.[6]

Canal opening and closure

Before I enter into a discussion of the attempts to change main canal management once it had become an issue, it is useful to explain in some detail the relevance of the opening and closure dates of the canal. The opening and closure of the canal refers to the following three elements.

1) The opening date at the beginning of the agricultural year (somewhere around June).
2) The closure date at the end of the year (in the period March-May).[7]
3) The question of a closure period, and its length, halfway during the agricultural year (in November-December).

The agronomic importance of an early opening date of the canal (at the start of the agricultural year) is that in this way (supplementary) irrigation is possible in the optimal sowing period of the rainfed/irrigated dry crops. It also allows early sowing and transplantation of rice. Late sowing leads to yield reduction. A further advantage of an early start of irrigation is that a second irrigated crop does not extend into the hot summer season that starts from March, but that irrigation can be stopped in February. This reduces the total yearly water requirement and, by implication, would allow spread of the available water over a larger area.

---

[5] Whether the siltation of the reservoir has been a factor of significance in this process is difficult to judge. That it will become so at some point in the future is certain.

[6] I consider 1980 to be a reasonably accurate, though necessarily approximate date because it was independently mentioned by different actors (farmers, officials, journalists) in different parts of the command area as the year when problems started. For example, farmers in the last distributary, distributary 106 (real number) reported that since 1980 their distributary has gone out of irrigation. It is very difficult, and very labour-intensive, to quantify the process described above more precisely. First, the required data on discharges, cropping patterns, irrigation efficiencies and other relevant factors are not all very reliable or simply do not exist. Furthermore, the figure of total drawals per year black-boxes a complex pattern of variation of demand and supply over time and space. There are 87 distributaries, each with a different history of the development of water use, which have affected main canal water management in different ways. And there are yearly variations in the quantity and timing of rainfall in the canal command area and in the catchment area of the reservoir. Also, variations in the cropping pattern occur caused by non-water factors like crop prices and pests. Demand for water increased, but not along a smooth curve, and the supply of water that was possible (and its timing) varied from year to year. There is thus not one single year in which demand and supply met. We are documenting the relocation process in greater detail at both distributary and main canal levels in subsequent research.

[7] Actually, there is not one single closure date for the full main canal. The sugarcane growers in the first reach of the main canal upto Mile 36 are entitled to receive water into the month of May. This section of the canal is closed only in May. The discussion below refers to the closure date of the part of the main canal downstream from Mile 36. The struggle over the water release period for the sugarcane growers is in itself an interesting episode in the political contestation of main canal management, which involves a lot of legal action, but I leave it aside here.

The closure date at the end of the season is important for the irrigation of a second crop. As discussed in chapter 4 the original design of the scheme did not envisage any double cropping, that is two consecutive crops on the same piece of land. Irrigation was primarily meant to support the rainfed cropping calender, with cultivation of *kharif* and *rabi* crops on different plots. A release period of 8 months is sufficient for this cropping pattern.[8] However, for farmers who had invested in the development of their lands and took the opportunity to cultivate two irrigated crops on their new plots, an opening period of the canal of 8 months is insufficient for full maturation of the rice crop.[9]

It is around the second rice crop that a lot of the struggle regarding the closure date revolves. The quicker depletion of the reservoir during the year, caused by the expansion and intensification of irrigation, started to affect the second (rice) crop. It pushed back the closure date to a moment earlier in the year. The full depletion of the reservoir in the *rabi* season under pressure of rice farmers also affects the start of the irrigation season in the following year. As a result there is no carry-over storage at the end of the agricultural year. Carry-over storage can be used for a timely start of irrigation in case the monsoon rains in the catchment (and inflows into the reservoir) start late. In the present situation the start of the irrigation fully depends on the timing of the monsoon rains in the catchment.

The closure period halfway the agricultural year has to do with the second rice crop as well. One of the main aims of a closure in November-December is to curb rice cultivation in the second season. Closure makes it impossible to raise rice nurseries, when it is well timed and sufficiently long.[10] Another aspect of mid-year closure is that it saves water in a period with low demand for water because temperatures are low and many crops have been harvested.

After having presented this background information I can now proceed to discuss the first attempt to change the pattern of unequal distribution at main canal level. This involves the introduction of a new actor in water distribution. Apart from farmers, Irrigation Department staff and politicians, the Command Area Development Authority plays a role.

9.2 CADA AND WARABANDI: A NEW PLAYER AND A NEW GAME

This section describes the fate of the efforts to change the organisation of water distribution in canal irrigation systems through the establishment of Command Area Development Authorities. I focus on the events in the Tungabhadra Left Bank Canal command area, but situate the account in the overall Command Area Development effort. The story conveys how a policy conceived at the Central Government level was translated and transformed during its long journey to implementation at the system and canal level.

---

[8] This 8 months release period has been introduced in later projects in Karnataka like the Malaprabha and Upper Krishna Project.

[9] Particularly in case farmers choose to cultivate long duration rice varieties like *Sona Masuri*, instead of shorter duration varieties like IR-64 or Emergency.

[10] Farmers can get around this by ponding water in rice plots before the canal closes, by storage of water in farm ponds, or by starting nurseries along the natural drains or the river by means of lift irrigation.

The establishment of CADAs

In 1973 the Central Government issued instructions to the States to establish Command Area Development Authorities for its irrigation schemes (see GOI/MOI/CAD and water management division, 1984 for the orders with regard to Command Area Development). The establishment of Command Area Development Authorities in India was the result of the recommendations of the Irrigation Commission and the National Commission on Agriculture (GOI/MOIP, 1972, GOI/National Commission on Agriculture, 1973).[11] These commissions had noted and investigated - among other things - the underutilisation of large scale irrigation systems. Better management to remedy underutilisation was, and is, considered as a major contribution to the resolution of the food crisis and an important contribution to agricultural growth in general (GOI/PC, 1992).[12] Command Area Development Authorities were presented as the suitable institution to undertake such remedial action (see Box 9.1 for the establishment of CADAs in Karnataka).

Command Area Development Authorities were intended to be interdisciplinary institutions that integrated and had authority over the line departments that worked in the irrigation system concerned.

> The Command Area Development Authority would be responsible for water utilisation and integrated area development in the irrigation command, including modernisation of the distribution system, the provision of drainage and the maintenance and operation of both the distribution and drainage systems. (D.O. No.F.11-9/73-CAD, dated 1st September 1973, from Secretary, Union Ministry of Agriculture to State Chief Secretaries, on Setting up of CAD Authorities-Objectives, Jurisdiction, Constitution and Powers etc., in: GOI/MOI/CAD and Water Management Division, 1984:20)

This was a vast mandate, which included main canal management. The institutional status and position of Command Area Development Authorities differs somewhat from State to State, but nowhere did they get the position as envisaged in this quotation. In practice the Command Area Development programme focused on the physical activities of field channel construction, 'on farm development' and the introduction of rotational water distribution below the outlet (see for example Hart, 1978; Pant and Verma, 1983; Wade, 1982b).

I highlight two important, and related, reasons for this development. The first is the way the problem of underutilisation that the CADAs were supposed to solve was defined. The second is the active resistance to the establishment of a coordination authority by particularly the Irrigation Department, which stood to lose control over its full domain.

In the first identification of the underutilisation and management problem, policy makers located the cause of this problem at the farm and outlet level: farmers did not construct field channels and field drains, they did not level their lands, and if they did they tended to waste water.

> As is well known it is the management of water in the commands of major and minor projects which offers the greatest scope for improved production. These commands represent about 50% of our total irrigation potential and suffer from a number of

[11] The Command Area Development (CAD) programme of which the establishment of CADAs was an element, was strongly supported by organisations like the World Bank and USAID. The programme was funded by the Central Government.

[12] The (under)utilisation rate of irrigation systems is usually expressed as the ratio between the total area irrigated in a system and the total area made suitable for irrigation by the Irrigation Department. However, it can also be expressed as the ratio of actual water use and projected water use, for example. For a technical discussion of the concept of (under)utilisation, see Mitra (1986).

Box 9.1 CADAs in Karnataka

Karnataka's response to the Command Area Development Authority initiative was slow. It took till 1980 before the Karnataka Command Areas Development Act (Act No.6 of 1980) was accepted, which arranged the legal framework for Command Area Development Authorities. In the mid 1970s, following the Central Government instructions, CADAs were established, but it seems only in the form of CADA Boards, without an executive institution attached to it. Such a Board also existed for the Tungabhadra project. The command area development work was carried out through the line departments, as it had been before. The Karnataka Command Area Development Authorities were 'revitalised' in 1979-80 (CADA/TBP, 1986:15) within the legal framework of the new Karnataka Command Area Development Act. The Tungabhadra CADA was constituted as a statutory body on 11 December 1979. For the Tungabhadra Project a CADA-like setup was in place already before the Command Area Development programme started. In the 1950s and 1960s the developmental activities in the Tungabhadra command area were coordinated by the Divisional Commissioner of Gulbarga Division, of which Raichur District was part, who was the *ex-officio* Administrator of the Tungabhadra Project. A Deputy Administrator (who was Additional Deputy Commissioner under the Revenue Department) was based in Munirabad, the dam site. There was also the Tungabhadra Advisory Board (TAB) with 8 non-official members, and a Project Working Group of which all the departmental heads were members (GOMYS, 1957-58; GOI/PC/PEO, 1965). The Administrator and Deputy Administrator were both IAS (Indian Administrative Service) officers, that is, high level government officials. There was thus a clear effort to come to an overall development process in the command area of the Tungabhadra project from an early date. The new CADA structure combined the authority of the earlier Administrator with the tasks of the Project Working Group. The present ICC (Irrigation Consultative Committee) is a very similar body to the TAB. Also in terms of practical work, there was not much new: in the 1950s the Hyderabad Government already decided to construct field channels and not to leave this to farmers. What was new was the effort to create an institution that had far reaching authority over the technical departments that worked in the command area, and the location of the coordination authority outside the Revenue Department. Some people have told me that the organisation of the Tungabhadra project served as the model for the Command Area Development policy. I have been unable to verify this statement.

> deficiencies, the most important of which are the lack of adequate delivery systems which should reach upto the farmers' fields, the lack of proper land-shaping and levelling of fields, the absence of drainage, where necessary, as well as such other factors as the proper timing of water supplies and the avoidance of wastage through seepage, etc. The lack of infrastructural support in such matters as extension, demonstrations adequate communications, marketing facilities, scientific crop planning and the supply of inputs, such as, credit, fertilisers, pesticides, machinery, seeds etc. are also important matters. The shortage of power, and recently of diesel in the case of areas commanded by minor irrigation also needs to be looked into urgently.(D.O. No.F.11-9/73-CAD, dated 19th May 1973, from Union Minister of Agriculture to Chief Ministers of States, on Command Area Development-Concepts and Organisation Pattern, in: GOI/MOI/CAD and Water Management Division, 1984:1-2)

A similar relegation of water management problems to the outlet level command area level occurred when in 1980 a policy was adopted to introduce the much acclaimed North Indian *warabandi* system of water distribution in all Indian canal irrigation system.[13] The features of *warabandi* as a system of rotational (weekly) water distribution at distributary and outlet level, with water allocation to plots on a time/acre basis were explained in chapters 3 and 8. In an important policy workshop organised by the Administrative Staff College of India (ASCI), in Hyderabad in April 1980, the following definition of *warabandi* was agreed upon for the purposes of the Command Area Development policy.

> Several viewpoints on Warabandi were discussed, taking into account the different systems existing in the country, such as Osrabandi, Shejpali and the Phad systems. Finally, a common view emerged as reflected in the following definition:
> "Warabandi is a system of equitable water distribution by turns according to predetermined schedule specifying the day, time and duration of supply to each irrigator in proportion to land holdings in the outlet command." (Singh, 1981:46)

A similar perception existed at the Tungabhadra project level. When the Chief Engineer Tungabhadra Project was invited in 1980 by the CADA Administrator[14] to comment on the implementability of *warabandi* in the project, he described *warabandi* as follows in his reply.

> Here it is to be pointed out that [the] Command Area Development Authority is in charge of water management below the outlet and since [the] warabandi system essentially deals with distribution of water under each outlet, the work of implementing warabandi system on an experimental basis in the beginning and later extending it to the entire [command area] will have to be responsibility of Command Area Development Authorities.

Neither in the workshop definition, nor in the Chief Engineer's description is there any reference to the main system management element of *warabandi* (proportional distribution over outlets by maintaining full supply levels in distributary canals by systematic on/off rotation of these canals). The definitions only refer to water distribution over farmers within the outlet command. On its journey from North to South India and in the step from policy to practice, some elements of the *warabandi* model disappeared.

It is not the case that views that emphasised the importance of main system management were not voiced. In the same workshop referred to above it was noted that on the basis of experiments with the introduction of *warabandi* undertaken in the 1970s,

> it was soon realised that the main canal system must behave in a disciplined manner discharging sufficient quantity of water at the required supply level. Undependability of canal supplies made Warabandi a meaningless exercise. (Singh, 1981:1)[15]

Within the borders of Karnataka there was documented experience with rotation at distributary level, particularly in Bhadra Project, Tunga anicut and Malaprabha Project. The Chief Engineer Tungabhadra Project chose to disregard this experience, though it was part of the available documentation. The introduction of *warabandi* fully focused on the outlet level. It involved the design of rotation schedules for these outlets and, later, the establishment of outlet-level Water Users Associations.

---

[13] It was the Fifth Conference of State Irrigation Ministers, held in Bangalore in December 1980, which decided that *warabandi* should be introduced in all major systems in India. The first experiments in Karnataka with the *warabandi* system took place in the Hemavathy and Harangi commands in 1981-82 (Govindaiah, 1989).

[14] The Administrator is the head of the executive part of the CADA. There is also a CADA Board which governs the CADA. It is headed by a Chairman. The chairmanship is a political appointment. It is often held by former MPs or MLAs or other politically active persons.

[15] Also see Wade and Chambers (1980) for an elaborate discussion of main system management as the gap in irrigation intervention.

The absence of a main system component in the CADA water management programmes can be explained by the second reason mentioned above: the resistance of the Irrigation Department to the creation of a coordinating institution. This can be well illustrated with the Tungabhadra Left Bank Canal case.

CADA and warabandi in the Tungabhadra Left Bank Canal

The *warabandi* concept arrived in the Tungabhadra Left Bank Canal in 1979-80. In 1979 *warabandi* received its first mention and advocacy in the report of the Tungabhadra Ryots Grievances Committee, chaired by the executive head of the CADA, the Administrator (CADA/TBP, 1979). In March 1980 the CADA Administrator sent a report on a 1970s *warabandi* experiment in another Indian State to the Irrigation Department's Superintending Engineers, Executive Engineers and Assistant Executive Engineers. It was accompanied by the question what the Irrigation Department's opinion was on the implementability of *warabandi* in the Tungabhadra project, and what was already happening in this regard. Also, the recommendations of the Hyderabad workshop of April 1980 were distributed and the Chief Engineer Tungabhadra Project was asked to send his comments to the Secretary to Government (Irrigation).[16]

The Chief Engineer quoted above had already located both the area and responsibility for implementing *warabandi* outside the Irrigation Department's domain. He continued to explain his position more explicitly as follows.[17]

> The suggestion of the workshop that wing of Irrigation Department concerning operation and maintenance should be brought under Command Area Development Authority, cannot be accepted. Command Area Development Authority is responsible, for management below the outlet point with the coordination of other departments. Since it is a statutory body, Command Area Development Authority should have its own staff or get it from concerned departments on deputation. The centr[al] works of maintenance of main canal and distributaries including the outlet structures and supplying correct discharge at the outlet point should be with the Irrigation Department and the Irrigation Department should not be made subordinate to the Command Area Development Authority. Here it is to be stated that a separate Engineering wing has already been provided under CADA and hence no further action is necessary to transfer any section of the Irrigation Department under CADA.

But the political push to implement the new *warabandi* policy was strong. In January 1981 the Central Government issued a notice following a meeting of irrigation ministers the month before, to implement *warabandi* on a pilot scale in at least two distributaries in each scheme. The Irrigation Department was forced to engage in its implementation.

---

[16] This instruction to report to the Secretary to Government (Irrigation) exemplifies the relationship between the Chief Engineer and the CADA Administrator. The CADA Administrator is higher in rank than the Chief Engineer, but in many cases the Chief Engineer does not accept that authority. The CADA Administrator has to get support from the politico-administrative boss of the Chief Engineer, that is the Secretary to Government (Irrigation). Another issue here is that CADA Administrators initially were IAS (Indian Administrative Service) officers, while the Irrigation Department argued that they should be engineers. There is also ongoing discussion whether the Secretaries to Government in the Irrigation Department should come from the engineering cadre or be IAS officers. One element of the difficult relationship between the Irrigation Department and the CADAs is the more general animosity between 'technocrats' and 'bureaucrats' (see for example *Deccan Herald*, 7.11.88 and *The Hindu*, 14.1.90).

[17] See letter No. CE/TBP/PLN/Warabandi/TA7/80-81/7758/2 of 23.10.80.

The CADA Administrator's request to select suitable distributaries for *warabandi* pilot schemes was sent down the Irrigation Department hierarchy in the system. The answer that came back was that no suitable distributaries existed. The reason that no suitable pilot canals could be found is that the CADA irrigation engineer who wrote the request for selection had put rather stringent technical conditions for the pilot distributaries. These conditions were that there should be control/measurement devices (like V-notches) in the pipe outlets, that all cross drainage works should be in working condition, and that soil and cadastral maps should be available. One wonders why the CADA irrigation engineer, deputed from the Irrigation Department, should put a condition like a measuring device at pipe outlet level, as this was never even planned to be a design element of the Tungabhadra system. Whatever may have been the reason, this and the other conditions made it very easy for the Irrigation Department to claim non-implementability.

However, other factors than protection of its own territory may also have played a role in the attitude of the Irrigation Department. The Chief Engineer of the Tungabhadra project also informed the CADA Administrator, that it would be very difficult to implement *warabandi*.

> It is learnt from them [the Executive Engineers, PPM] that whereas the tail-enders of distributaries, where water supply is very unsatisfactory are very enthusiastic about warabandi system which ensures equitable distribution of water on the basis of land holding, the irrigators at higher reaches where gross indiscipline, such as unauthorised irrigation and violation of cropping pattern is prevalent, are not agreeing for any new method of irrigation, such as warabandi, to be introduced, since naturally it will end the indiscipline by which they are now benefitted. It is, therefore very difficult to introduce warabandi system unless the irrigators under the entire distributary agree for introducing such a system.

As discussed in chapter 7, the Irrigation Department in interaction with farmers had developed rotation systems at distributary level in several distributaries, which created some regularity in the distribution schedules in these canals, even when these were highly unequal. It is understandable that the Irrigation Department was not very keen on others to come and - in their view - upset these routines. It knew very well that implementation of *warabandi* on a serious scale would require the confrontation of inequality problems at distributary and main canal level.

The administrative ping-pong game between the Irrigation Department and the Command Area Development Authority was concluded in 1982 after the Secretary to Government (Irrigation) sent the instruction to introduce *warabandi* to the Chief Engineer of the Tungabhadra Project directly in September 1981. *Warabandi* then acquired the meaning it would keep to the end of the decade. In the Tungabhadra Left Bank Canal the concept had the following elements.

1) At the *outlet* level the introduction of rotational water supply completely became a Command Area Development Authority activity. This effort was necessarily on a very small scale because the CADA hardly had any presence at field level. The implementation of *warabandi* at outlet level therefore met with very little success. The same is true for the establishment of Water Users Associations which during the 1980s were increasingly seen as important for successfully introducing *warabandi*. In the places where the policy was formally implemented (according to the CADA annual reports) it seems mainly to have been a paper exercise. For example, the 1986-87 annual report of CADA Tungabhadra Project mentions the introduction of *warabandi* and the establishment of a Water Users Association in a particular outlet

in a subdistributary investigated in this research project. In 1991-92 not a trace could be found of either, and also there was no sediment in the farmers' memory.[18] When a CADA official in the middle reach of the system in 1992 showed me a list of about 80 officially established Water Users Associations, and I asked about their status, he replied that "it only takes the stroke of a pen to abolish them". The *warabandi* signboard with the rotation schedules painted on them were standing in his office unused. The Tungabhadra project is no exception to the rule that water users associations created in a top-down administrative manner generally have a short life.

2) At the *distributary* level, *warabandi* in the larger distributaries came to mean a rotation system over subdistributaries and pipe outlets, as discussed in the chapter 7. These rotations had often emerged earlier than the formal introduction of *warabandi*. *Warabandi* became a label for something that already existed. During the 1980s orders to introduce *warabandi* in the bigger distributaries were routinely issued in times of increased scarcity and conflict. The Irrigation Department did not hurry to pass these orders down the hierarchy.

3) At the *main canal* level, the Tungabhadra CADA in November 1982 issued a circular to introduce an on/off system for smaller distributaries. Small and very small distributaries were supposed to be closed for one or two days a week to push more water to the tail end of the main canal. This was thus an effort by the Command Area Development Authority to do something about unequal water distribution in the main canal. This document, though formally in force and regularly referred to in times of crisis, practically led a sleeping existence till the end of the decade. I have found no evidence of actual implementation of the rotation of the smaller distributaries in the main canal in the 1982-88 period.[19]

It may be concluded from the foregoing that the Tungabhadra Project Irrigation Department effectively neutralised the possible influence of the Command Area Development Authority on main system management in the first ten years after the CADA was established. The CADA was allocated a space in the pipe outlet command area, where the Irrigation Department itself did not work. The fact that the CADA staff consisted of staff deputed from other departments, including the Irrigation Department will not have made the execution of the authority formally given to the CADA easier. Because of the weakness of the CADAs in number of staff, the CADA remained extremely dependent on the Irrigation Department for the implementation of anything to do with water distribution. The effort to improve the Irrigation Department's irrigation management practices through the Command Area Development policy failed without ever having a serious chance of success.

However, the story of the Command Area Development Authority's role in main canal management does not fully end here. The main canal on/off system circular became a resource in the process of change in main canal management in 1988-90. This change was generated from within the system itself, to which events I now turn.

---

[18] Personal communication Kees van Straaten, 1992.

[19] But I can't claim to have seen all possible evidence.

9.3 GETTING THE GAUGES RIGHT

Despite many conferences and workshops, the establishment of new institutions, and pilot programmes not much changed in the actual management practices in the canal irrigation systems during the 1980s. In this period the Tungabhadra Left Bank Canal witnessed a proliferation of main canal management problems as a result of increasing water scarcity (see section 9.1). These problems escalated in the years 1988-1989 and 1989-90. The escalation induced some institutional changes in main canal management which in my evaluation have improved it, and have perhaps created a small basis for further change. In this section I discuss how the events in these two years unrolled.

Gauge and discharge tables

The process of change in main canal management that took place in the period 1988-1990 can be summarised in two gauge and discharge tables.[20] These are tables that list the water levels and the related flows at different points along the main canal. When the level at one point is known, the corresponding levels (the proportionate gauges) at other points of the canal can be read from the table. The main canal is divided into four sections, managed by different Canal Divisions of the Irrigation Department. Each of these Divisions is headed by an Executive Engineer (EE) who is the senior officer for water management in the Division (see figure 3.1 for an organigram of the Irrigation Department in the Tungabhadra Left Bank Canal).

The important gauge points, that is points for measurement of water levels, are those at the borders of the Divisions. These are the gauges at Mile 0, Mile 47, Mile 69 and Mile 104. In every division a gauge book or gauge register is kept, in which the gauges at the border points are noted hourly. The communication of these figures is done through the canal telephone network, that links the offices with the gauge locations along the canal.

With the gauge and discharge table in hand an Executive Engineer can determine the water level he is entitled to receive by looking at the gauges in the upstream divisions. He can also read off the gauge he has to maintain at the downstream exit point of his division, to pass on to the next division. The activity of main canal management is thus basically the process of getting the gauges right, and the gauge and discharge table is a crucial instrument for this.[21]

The mode of calculation of the gauge and discharge table is extremely important. Particularly important is the relative position of the columns, that is which level at Mile X is seen to be proportionate to the level at Mile Y. When we look at the table in use in the Left Bank Canal in 1988 (see table 9.3), this table was calculated on the basis of the localisation pattern: the protective cropping pattern sanctioned by the government. Up to 1988 the Irrigation Department formally used this table for main canal management. However, because of the actual cropping pattern, with large areas of rice in the head end divisions, this table had little practical value. The real management of the main canal took place on the basis of indents prepared by the Executive Engineers of the different divisions,

---

[20] The expression 'gauge and discharge table' is derived from the heading above one of the tables and used because it is more informative than the term 'working table' normally used by the Irrigation Department engineers.

[21] Because the Left Bank Canal has been designed as a supply oriented continuous flow system, without cross regulators water levels are and can be the main piece of information for canal management.

Table 9.3: Old gauge and discharge table for Tungabhadra Left Bank Canal

Close to dam		Mile 47		Mile 69		Mile 104	
Depth (feet)	Discharge (cusecs)	*Depth (feet)*	Discharge (cusecs)	*Depth (feet)*	Discharge (cusecs)	*Depth (feet)*	Discharge (cusecs)
11.55	3826	*12.10*	2776	*9.95*	1716	*6.90*	620
11.45	3800	*12.10*	2774	*9.85*	1710	*6.85*	608
11.35	3750	*12.00*	2734	*9.75*	1688	*6.80*	600
11.25	3700	*11.90*	2701	*9.70*	1665	*6.75*	592
11.20	3650	*11.80*	2665	*9.65*	1643	*6.70*	584
11.15	3600	*11.70*	2628	*9.60*	1620	*6.65*	576
11.05	3550	*11.60*	2592	*9.45*	1598	*6.60*	568
10.95	3500	*11.50*	2555	*9.40*	1575	*6.55*	560
10.85	3450	*11.40*	2519	*9.35*	1553	*6.50*	552
10.75	3400	*11.30*	2482	*9.30*	1530	*6.45*	544
10.65	3350	*11.20*	2446	*9.20*	1508	*6.40*	536
10.55	3300	*11.10*	2409	*9.10*	1485	*6.35*	528
10.45	3250	*11.00*	2373	*9.05*	1463	*6.30*	520
10.35	3200	*10.90*	2336	*8.95*	1440	*6.25*	512
10.30	3150	*10.80*	2300	*8.85*	1418	*6.20*	504
10.20	3100	*10.70*	2263	*8.80*	1395	*6.15*	496
10.10	3050	*10.60*	2227	*8.75*	1373	*6.10*	488
10.00	3000	*10.50*	2190	*8.65*	1350	*6.05*	480
9.90	2950	*10.40*	2154	*8.55*	1328	*6.00*	472
9.80	2900	*10.30*	2117	*8.45*	1305	*5.95*	464
9.70	2850	*10.20*	2080	*8.40*	1283	*5.90*	456
9.60	2800	*10.10*	2044	*8.35*	1260	*5.85*	448
9.50	2750	*10.05*	2008	*8.25*	1238	*5.80*	440
9.40	2700	*9.95*	1971	*8.15*	1215	*5.75*	432
9.30	2650	*9.85*	1935	*8.05*	1195	*5.70*	424
9.20	2600	*9.75*	1898	*7.95*	1170	*5.65*	416
9.10	2550	*9.65*	1862	*7.85*	1148	*5.60*	408
9.00	2500	*9.60*	1825	*7.80*	1125	*5.55*	400
8.85	2450	*9.55*	1789	*7.70*	1103	*5.45*	392
8.75	2400	*9.45*	1752	*7.65*	1080	*5.40*	384
8.65	2350	*9.35*	1716	*7.55*	1058	*5.35*	376
8.55	2300	*9.25*	1679	*7.45*	1035	*5.30*	368
8.45	2250	*9.15*	1643	*7.35*	1013	*5.25*	360
8.35	2200	*9.10*	1606	*7.25*	990	*5.15*	352
8.25	2150	*9.05*	1570	*7.15*	968	*5.10*	344
8.10	2100	*8.95*	1533	*7.05*	945	*5.00*	336
8.00	2050	*8.85*	1497	*7.00*	923	*4.95*	328
7.90	2000	*8.75*	1460	*6.85*	900	*4.90*	320
7.85	1950	*8.65*	1424	*6.75*	878	*4.85*	312
7.75	1900	*8.55*	1387	*6.65*	855	*4.75*	304
7.55	1850	*8.45*	1351	*6.55*	833	*4.70*	296
7.45	1800	*8.35*	1314	*6.45*	810	*4.65*	288
7.30	1750	*8.25*	1278	*6.35*	788	*4.55*	280
7.15	1700	*8.15*	1241	*6.25*	765	*4.45*	272
7.05	1650	*8.05*	1205	*6.15*	743	*4.40*	264
6.95	1600	*7.90*	1168	*6.05*	720	*4.35*	256
6.80	1550	*7.80*	1132	*5.95*	698	*4.25*	248
6.75	1500	*7.65*	1095	*5.85*	675	*4.20*	240

Table 9.4: New gauge and discharge table for Tungabhadra Left Bank Canal

Mile 47		Mile 69		Mile 104	
Depth (feet)	Discharge (cusecs)	*Depth (feet)*	Discharge (cusecs)	*Depth (feet)*	Discharge (cusecs)
11.60	2592.00	*9.00*	1455.31	*6.15*	476.50
11.55	2573.00	*8.95*	1440.33	*6.00*	469.00
11.50	2555.00	*8.90*	1425.35	*5.95*	461.50
11.45	2537.00	*8.80*	1397.73	*5.80*	439.00
11.40	2519.00	*8.75*	1383.58	*5.700*	425.00
11.375	2516.00	*8.73*	1376.51	*5.675*	421.50
11.350	2513.00	*8.70*	1369.44	*5.650*	418.00
11.325	2510.00	*8.675*	1362.45	*5.625*	414.50
11.300	2507.00	*8.650*	1355.46	*5.600*	411.00
11.275	2496.25	*8.625*	1348.48	*5.575*	407.50
11.250	2485.50	*8.600*	1341.49	*5.550*	404.00
11.225	2474.75	*8.575*	1334.45	*5.525*	400.50
11.200	2464.00	*8.550*	1327.41	*5.500*	397.00
11.175	2452.50	*8.525*	1320.43	*5.475*	393.75
11.150	2441.00	*8.500*	1313.45	*5.450*	390.50
11.125	2430.50	*8.475*	1306.53	*5.425*	387.25
11.100	2420.00	*8.450*	1299.60	*5.400*	384.00
11.075	2409.00	*8.425*	1292.68	*5.375*	380.75
11.050	2398.00	*8.400*	1285.75	*5.350*	377.50
11.025	2387.00	*8.375*	1279.01	*5.325*	374.25
11.000	2376.00	*8.350*	1272.27	*5.300*	371.00
10.975	2366.63	*8.325*	1265.54	*5.275*	367.75
10.975	2357.25	*8.300*	1258.80	*5.25*	364.50
10.850	2319.75	*8.200*	1231.78	*5.15*	352.00
10.75	2282.25	*8.100*	1205.09	*5.05*	340.00
10.65	2244.75	*8.00*	1178.74	*4.95*	327.00

which reflected actual cropping patterns.[22] The allocations to the divisions were thus regularly renegotiated within the Irrigation Department.[23] From these allocations were derived particular relations between the gauge levels at different points in the canal, which varied from occasion to occasion.

In 1990 a different gauge and discharge table came into use (see table 9.4). In this table the downstream columns have been shifted upwards. This means that a lower water level is now seen to be corresponding to a particular upstream level than before. The new gauge and discharge table can be seen as an institutional consolidation of the already existing unequal water distribution pattern in the main canal. The change of tables might be interpreted as a defeat of the tailenders, and a defeat of the irrigation administration, by the head end rice farmers. Finally, one might analyse, the actual unequal pattern of water distribution and the rice dominated cropping pattern related to it, have received some sort of institutional

[22] Within limits imposed by the distributary canal capacities.

[23] The frequency of meetings of the Executive Engineers on the indents varied with the degree of water scarcity and concomitant level of conflict on the canal.

sanction.[24] This sentiment was indeed expressed by irrigation officials when they described the new table to me as being 'unscientific'. Unscientific is the code word for politically mediated or enforced. However, if we take a closer look at the social process that produced this change of tables, a different interpretation than defeat emerges.

Main canal management in 1988-89

The 1988-89 irrigation season started badly. In the first week of July 1988 the lowest levels of the Tungabhadra reservoir in 35 years were recorded. Only a very small amount of drinking water for Raichur town, the district capital located at the tail end of the canal, could be released into the Left Bank Canal, but no water for irrigation purposes. In the course of July inflows into the reservoir increased, but in the beginning of August there was a breach in the main canal, because of which the full canal had to be closed for a week. By the end of August reservoir levels were higher than the previous year, but the damage had been done: the start of the irrigation season had been delayed, a delay that would automatically affect the sowing dates for the second irrigation season. This implied that the second irrigation season would extend further into the hot summer season of March and April, when water is short and the canal is scheduled to be closed.

In September and October 1988 there were the usual scarcity problems, as this is both the peak period for crops like rice, and the overlap period of the rainfed cropping seasons (see chapter 7). In the tail end region of the main canal processions were organised to protest against headenders who took too much water, and Irrigation Department officials started night controls on the distributaries and main canal with police protection. But, experience had taught that the real problematic season would be the second season, particularly the months of February, March and April. In anticipation of the problems in the months to come, the Irrigation Department launched an administrative effort to avoid them. In November 1988 it was already clear that a limited quantity of water would be available for the second season because of the poor reservoir situation, which, according to the Chief Engineer, would not be sufficient even for 'irrigated dry' crops. Lower officials were instructed to announce this in all villages through loudspeakers, and press statements were released. In November the Irrigation Consultative Committee (ICC, see above) decided to close the Left Bank Canal between 25 November and 15 December (and thus limit rice cultivation in the *rabi* season). However, the decision was reversed in the same month under pressure of appeals from farmers and legislators.[25] In December 1988 the Irrigation Department distributed notices that only 'irrigated dry' crops should be grown. In the same month canal officials were instructed to introduce *warabandi* as per the 1982 CADA notification. In January 1989 the gauge and discharge table based on the localisation pattern was sent to all Executive

[24] Though the new gauge and discharge table was prepared on the instruction of the Chief Engineer, it does not seem to be a fully public document. When I asked for a gauge and discharge table in the Irrigation Department office near the dam in spring 1992, I was given the old table based on the localisation pattern, and the same thing happened to us, unasked, in 1997.

[25] In the previous year, 1987-1988 a canal closure in November/December had been implemented for the first time (from 22 November to 13 December there was no discharge into the main canal that year). In 1987-88 the water situation and the timing of the crops must have been more favourable than in 1988-89 because no extreme things seems to have happened in that year. However, Anagol wrote in 1969 that "the canal which used to be closed for one month during December in the past is now proposed to be closed during May." (Anagol, 1969:A116) There may thus have been November/December closures in the earlier history of the canal.

Engineers.[26] But, neither the notices, the gauge and discharge table, nor the efforts to introduce an on/off system at main canal level were very successful. A lot of rice was grown in the second season, and with the increasing temperature in February and March, the Left Bank Canal area also got heated up socially and politically.

The issue was, as usual, the closure date of the main canal. The Left Bank Canal was scheduled to be closed for at least two months, April and May, for repairs and because of lack of water in the reservoir. The decision making on the closure date of the canal takes place in the Irrigation Consultative Committee. This body is chaired and convened by the CADA Administrator, and has members from the Irrigation Department and other technical departments, the district administration (Deputy and Assistant Commissioners), and the Members of the Legislative Assembly (MLAs) from the command area. Farmers are not independently represented on the committee.

The committee usually finds it very difficult, as already suggested by the cancellation of the November/December closure, not to yield to short term pressures exerted on it, but to look at the long term planning and problems. Another example of this is that in December 1988 the ICC decided on a canal closure on 20 April when it saw that reservoir levels were higher than the previous year, but it ignored the low inflows that would made the date unrealistic. As a result, the ICC soon had to correct the decision. From February 1989 the reservoir levels were lower than in any other year in the period 1982-83 to 1991-92. By the end of February 1989 the ICC had to prepone the closure date to 23 March, in view of the reservoir situation.

As a further response to scarcity, orders to introduce *warabandi* in the bigger distributaries were issued once again in the first week of March. By this time the agitation of farmers over water shortage in the tail end areas had reached such an intensity that on 8 March a Prohibitory Order was clamped on the dam site by the government. As a response to the agitation it was decided on 10 March to postpone the closure of the canal till the end of March, notwithstanding the fact that by 10 March the reservoir had reached the level that is normally taken as the minimum level for the start of releases at the beginning of the season.

In the month of March a frantic succession of meetings of farmer leaders, irrigation officials, district administrators, MLAs, cabinet ministers, and finally the Chief Minister of the State took place. At one point the MLAs of the opposition party threatened to resign if the closure date was not postponed. Hunger strikes were undertaken, irrigation officials locked up in their offices for days surrounded by farmers, roads were blocked, and shopkeepers in the district headquarters called a *bandh* (a strike) in support of farmer demands. Police firing during riots was reported, but denied by the police.

On 20 March the government decided to release water from the upstream Bhadra reservoir to supplement supply in the Left Bank Canal, but this took some days to arrive and was equivalent to 6 days full canal supply only. From 23 March an on/off system was implemented in the main canal. For 1 week all distributaries in the first half of the main canal were to be closed, in the second week all distributaries in the second half of the main canal would stay dry. To implement this, prohibitory orders were promulgated for the main canal area. One head end MLA was reported to have posted on a distributary gate with a

---

[26] Because the localised cropping patterns are different in the *kharif* and *rabi* seasons, the gauge and discharge table should be different for the two seasons. However, the table used is an approximate average of the two seasons. There is some suggestion that the gauge and discharge table based on the localisation pattern was prepared for the first time in 1988, but this is not certain.

group of women and children to prevent closure of the distributary in the on/off rotation. The situation was so chaotic that this rotation is very unlikely to have been implemented.[27]

The water from the upstream reservoir arrived on 29 March and the discharge into the Left Bank Canal was increased. The first half of the main canal consumed the larger part of the available water. Early April most of the rice was nearing the harvesting stage. From 8 April the discharge in the Left Bank Canal slowly went down to zero, and stopped completely on 21 April.

Main canal management in 1989-90

The dramatic events of *rabi* 1989 created institutional and political space for new approaches to the problem of water management in the Left Bank Canal. There was a clear concern on the government side to avoid similar problems in the future, and a High Power Committee was appointed to make proposals to achieve this. From the farming community there were calls for abolishing the localisation policy: let the government supply a fixed amount of water to farmers, and leave crop choice to cultivators is what they suggested.[28] Suggestions were put forward to construct a balancing reservoir in the tail end section of the main canal, and to create a separate administrative division for checking the gauges in the main canal. Tail end farmers argued for a shift of the closure period from May to December, to curb rice cultivation in the *rabi* season. *Zilla Parishad*[29] members called for decentralisation of the management of irrigation and to bring it under the umbrella of that body. And, the State government adopted a different management style for some time, as we shall see below. At the same time there was an effort by the Irrigation Department to get magisterial powers in water management, through a change in the Irrigation Act.

Many of the proposals and ideas put forward in this period were not new in themselves, but now there was an opening to try to get them accepted. After the events of the 1989-90 agricultural year, some of the changes got consolidated and others got (re-)shelved.

The 1989-90 agricultural year was inaugurated with a number of meetings in which the proposals of the High Power Commitee were accepted as the guideline for water management. These meetings were attended by high level government officials like the Development Commissioner and relevant Secretaries to Government. This political commitment to implement a different approach was soon overtaken by events.

Like the previous year, the irrigation had a difficult start. There were two breaches halfway along the main canal early in the year. Soon after this, the recommendation of the High Power Committee to implement an on/off system in the main canal got strongly opposed by farmers, and was not implemented.

In September protest started against the decided closure of the main canal from 15 November to 10 December. In the same month it was decided to postpone the closure till 1 December, but to reduce the discharge in the period before the closure. The latter was not

[27] Also the discharge data for the main canal at the division boundaries give no indication of this rotation. Closure of the distributaries on the upstream half of main canal should have led to significantly higher discharges in the downstream half of main canal. These did not occur according to the Irrigation Department register (data collected in 1997 by R. Doraiswamy).

[28] In May 1989 President's rule was instituted in the State and the parliament dissolved. There were therefore no MLAs to fill the seats in the ICC. Farmers movements argued that they could become ICC members. They did not succeed to get such participation, but were relatively directly involved for a period of about 6 months.

[29] The elected District Council.

implemented. A new decision was taken to close the main canal from 1 to 25 December. Attached to that was the decision that the summer closure would be on 15 March. Farmer opposition to the November/December closure increased, but the Irrigation Department still (almost fully) closed the main canal from 1 December.

Right after the canal was closed farmers appealed to the newly appointed Chief Minister of the State.[30)] The government agreed to re-open the canal on 10 December, with the summer closure set at 10 March (3 months release), under the condition that farmers promised not to grow rice in the *rabi* season. This promise was made by farmer leaders and MLAs. The December closure as recommended by the High Power Committee, thus half survived.

After having observed that rice nurseries still came up in the Left Bank Canal, the government put an ultimatum to remove them within 48 hours, and threatened to close the Left Bank Canal if this did not happen. This move brought the difference of interest between head end farmers and tail end farmers out in the open and on the political agenda. Tail end farmers started to write memoranda against head end rice farmers.

On midnight 24 December the main canal was closed because the rice nurseries had not been removed by the cultivators. However, this closure not only caused problems for rice farmers, but also for non-rice farmers.[31)] Widespread agitation started, and the head end/tail end conflict of interest disappeared again.

On 30 December a Superintending Engineer and an Executive Engineer were assaulted and wounded by farmers in the tail end area of the main canal. In an emergency meeting chaired by the Deputy Commissioner on 31 December, it was decided to re-open the canal on 1 January. However, on that day 300 engineers took mass casual leave in protest against the molesting of their colleagues, and the canal remained closed. The engineers put forward a series of demands, which included magisterial powers to Irrigation Department officials to address violations of the cropping pattern and water management rules. After some high level meetings, water was released into the canal on 5 January.

But, the government did not yet give up its battle against the rice nurseries. On 11 January an ordinance was issued by the government that announced the destruction of rice nurseries. For this purpose a number of platoons of armed police were deployed. Not more than 10 ha of nurseries actually got destroyed. The Chief Minister had to call off the destruction drive after two days because of fierce opposition.[32)] Herewith another recommendation of the High Power Committee, to abolish rice cultivation in *rabi* through legislation, had floundered.

In January the Irrigation Ministry also announced that the carry-over storage of 8 TMCft., scheduled to be used for early sowing in the 1990-91 season, and another High Power Committee recommendation, would be used to alleviate tail end problems in the current season. In the course of the *rabi* season the closure date of the main canal got postponed till 10 April amidst the usual turmoil.

One way to read these events is to see them as the ultimate administrative effort to implement protective irrigation, in at least the *rabi* season. It is an ultimate effort because

---

30) Elections were held in November, so the MLAs were 'back in business' as well.

31) Farmers with a *rabi* crop sown in October required water in December/January as the crop then is in a crucial phase. Farmers planning/cultivating a second irrigated dry crop wanted to sow in this period or give the first irrigation.

32) Including MLAs who blocked roads, and women and children who slept on roads to the rice fields when the squads tried to work at night.

it is personally overseen by the Irrigation Minister and the Chief Minister. It is administrative because of its emphasis, finally, on legislation and its strict implementation. Drama is added through the effort to implement the law by force. However, the administrative effort must yield to the rice interest.

> [The] paddy growing ayacutdars' lobby is very powerful economically and politically and all the Governments in the past, whether Congress(I) or Janata Dal have yielded to [its] pressures. (Raichur District Zilla Parishad president, quoted in *Deccan Herald*, 31.1.90)

The adoption of a new discharge table for the main canal in the beginning on the 1990-91 season, can in this interpretation be seen as the closing piece of the victory of the rice lobby, and the last nail in the coffin of protective irrigation. This reading is certainly partly true, but some positive effects of the events became visible in the years that followed this dramatic episode.

The consolidation of change

Some of the ideas put forward in the 1988-90 period did get consolidated in the following years. I list and discuss the changes that took place.

The closure of the main canal in November/December has not become a permanent feature of main canal management, but it the idea had some effect for some years. In 1992-93 there was a reduced discharge into the main canal between (approximately) 21 November and 9 December 1992. In 1993-94 this was a longer period, between (approximately) 22 November and 24 December 1993. In 1994-95 there actually was a closure, for one week in December 1994, but no reduced discharges before or after it. In 1995-96 there was no reduced discharge or closure in the November/December period. And lastly, in 1996-97 there was a breach in the main canal near the dam, which caused several weeks of canal closure in September/October 1996. There was no closure or reduced discharge in November/December 1996 as a consequence.[33] The practice thus seems to have been watered down.

The idea of the balancing reservoir became a sanctioned project in 1992 during a visit of -another- Chief Minister to the district. A politician from the tail end area of the Left Bank Canal had become CADA chairman by 1992, and in that capacity convinced the government of the need for the balancing reservoir project. The construction is scheduled to be completed by the end of 1997.

The sources of support for the balancing reservoir idea were complex. For the Irrigation Department it will relieve, at least in theory, the tensions in water management in the tail end section of the main canal, because it creates a two week buffer capacity. This can make supply more regular and rotation systems more feasible, and bridge periods of acute water shortage. Another Irrigation Department interest was undoubtedly that any new construction activity was welcome because it is what engineers like to do most. It may also appeal to the engineers' desire for technical solutions to social problems. For the politician/CADA chairman there was, apart from concern about the problems as such, the reproduction of support in his base area, necessary for his further political career. For the Chief Minister and the Irrigation Minister similar considerations applied. All these factors are always there, but it requires particular circumstances (a crisis) and particular actors (an ambitious tail end politician/CADA chairman and a Chief Minister who needs to distribute favours) to knit them together and produce a concrete project, as happened in this case.

---

[33] Discharge data for these years were collected in 1997 by R. Doraiswamy.

The on/off water distribution proposed by the High Power Committee survived to some extent. It got its major application in the fourth division of the Left Bank Canal. From October 1989 a rotation system was introduced in the fourth division in which half of the distributaries are closed for a week while the other half receives the full discharge. From *rabi* 1990 the system worked reasonably well, and in 1997 we could observe that it had been continuously practised since then. According to both farmers and irrigation department officials this has measurably improved the situation in this section of the main canal.

In 1991-92 considerable land development activity could be observed in the tail end region of the main canal. This was probably a reflection of improved water availability and improved predictability of water supply, through the rotation, because of favourable rains and as a result of the change in main canal management generally. Obviously, land development will create a higher demand for water, and therefore the relaxation in water management problems may be shortlived. On the other hand, new vested interests in more equitable water distribution in the main canal are created in this way.

The rotation system as described in the CADA circular from 1982 was also implemented in the first three Canal Divisions. This increased and stabilised the supply to the Fourth Canal Division, and made the implementation of the on/off system in that division possible.[34)] The effort to get the gauges right as described in the new gauge and discharge table was reasonably successful. This fact is generally attributed to the efforts of a committed Executive and later Superintending Engineer based in the tail end Division.[35)] In October 1988 an inspection report was produced by this officer that clearly documented the excess water use in the Second and Third Divisions.[36)] The inspection was followed by a series of meetings that finally resulted in the new gauge table, the implementation of the on/off system in the Fourth Division and the main canal rotation as outlined in the 1982 CADA circular.

Maintenance of the gauges at the Division borders requires active intervention of higher level officials in the work of their subordinates. The gauges and rotation systems are more or less maintained through a monitoring and intervention process involving an intense flow of express telegrams, urgent telephone messages and letters between the Division offices and with the Superintending Engineer's and Chief Engineer's offices. A sample of the resulting interactions is given in Box 9.2.

To conclude, my interpretation of the changes in main canal management that I just described, is that the new gauge table for the main canal that was produced in 1990 created

---

34) That the upstream distributaries were actually closed can be observed in the gauge registers kept in the Division offices, by looking at the daily distributary discharges recorded for each distributary. The evidence is too voluminous to present here. The increase in discharge can be derived from the same data.

35) When, in 1992, I asked a third division engineer about the engineer that introduced the rotation in the fourth division he replied that "the tail enders consider him as their god".

36) What is unusual is that the Executive Engineer of the Fourth Division undertook the inspection (with assistance from staff of the Superintending Engineer's office). This means that the inspector directly checked the performance of colleagues who occupied the same level in the hierarchy. The inpection did not include the First Division, which comes under a different Superintending Engineer. The creation of a separate Subdivision (under control of the Executive Engineer of the Second Division, and thereby the Superintending Engineer of the three downstream Divisions) to operate the distributary offtakes in the First Division failed. First Division officers referred all problems in their distributaries to this Subdivision. It received insufficient backing and was abolished in 1992.

Box 9.2: Extracts from internal communication in the Irrigation Department on main canal management

The Chief Engineer in presence of all the officers of [the Left Bank Canal] fixed the gauges to be maintained during last Kharif 1990 as under. (...) Therefore all Executive Engineers are requested to see that water management is done smoothly by adopting rotation system of water supply in the distributaries. The Executive Engineer [Fourth Division] is also requested to arrange to adopt weekly 'on & off' system of irrigation in the main canal as per last year to have smooth water management upto tail-end. (Letter SE to EEs Second, Third and Fourth Divisions, July 1991)

I therefore request you to please insist all the concerned staff to move on the canal, distributaries upto tail end areas daily and watch the daily movement and diaries of your staff. You can also move along with them, frequently, so that, problems can be easened at your end only. The fortnight diaries of Assistant Executive Engineers from July 1991 onwards may also be submitted to this office along with your spot checks for verification. (Letter SE to EE Fourth Division, August 1991)

The gauge at Mile 104 at 5 p.m. is 4.85 ft. The gauges at Mile 104 are fluctuating and causing difficulties to this Division in maintenance of irrigation management. Therefore you are requested to maintain 6.30 ft. gauge at Mile 104 constantly. Failure to maintain the required gauge on your part will lead to law and order situation for which you alone will be responsible. The situation is most critical and explosive in this Division command area. I request you will realise the gravity of the situation and extend your cooperation in proper maintenance of the gauge. Please acknowledge the receipt of this message. (Urgent telephone message of EE Fourth Division to EE Third Division, August 1991)

[Following excess drawal by one distributary.] This sort of management is far from satisfactory. You have to curb such tendency on the part of concerned. Let me know what your Sectional Officers were doing. The explanation of concerned should be submitted to this office to take further action. If this tendency is not stopped, it will be difficult for undersigned to remain as a mere spectator. Action should be taken to close all distributaries as agreed upon during lower rotation is in progress. (Letter EE Fourth Division to an AEE, August 1991)

Today at 1.00 p.m. gauge at Mile 104 is 5.15. Next irrigation management rotation system collapsed around chaotic conditions. Myself, Assistant Executive Engineer staff not in position to attend irrigation management duties. Jeeps are being stopped on roads. Unruly mobs not permitting to move. Life miserable. Living under continuous threat. None to rescue. (Express telegram EE Fourth Division to CE, September 1991)

It is impressed on all concerned that based on net available discharge with reference to gauges at Mile 104, it is to be equitably distributed without affecting interest of any ryots at any distributary. Necessary regulation chart at various depth of flow at Mile 104 is herewith enclosed for ready reference. Any violation will be viewed with displeasure and will be reported to higher authorities. (Letter EE Fourth Division to AEEs Fourth Division, September 1991)

Even after my hours together convincing to them, and persuasion stating that to allow the water to the tailend areas the rotation system is a must for this Division. But they were not ready to hear or accept the same. The situation was very critical and they talked in all types of nonsense and abusing words and their intention is to manhandle the undersigned in his own chamber. (...) In view of the above, to provide adequate water to tailend atchkat under lower rotation, protection of District Armed Police to avoid tampering of head sluices and illegal opening etc. (Letter EE Fourth Division to SE, September 1991)

You are hereby directed to arrange for staff for patrolling round the clock (..). The necessary trucks, van, and Police protection may be taken during the patrolling period. (Letter EE Fourth Division to an AEE, September 1991)

Irrigation management has become uncontrollable even with Police assistance (...) Ryots are agitating, staff is reluctant to [work] under above situation. (Express telegram EE Fourth Division to CE, September 1991)

It appears that present Executive Engineer [Third Division] is not in a mood to maintain 6.2 foot gauge. Due to lack of action situation is becoming grim. Kindly intervene. (Express

The on/off water distribution proposed by the High Power Committee survived to some extent. It got its major application in the fourth division of the Left Bank Canal. From October 1989 a rotation system was introduced in the fourth division in which half of the distributaries are closed for a week while the other half receives the full discharge. From *rabi* 1990 the system worked reasonably well, and in 1997 we could observe that it had been continuously practised since then. According to both farmers and irrigation department officials this has measurably improved the situation in this section of the main canal.

In 1991-92 considerable land development activity could be observed in the tail end region of the main canal. This was probably a reflection of improved water availability and improved predictability of water supply, through the rotation, because of favourable rains and as a result of the change in main canal management generally. Obviously, land development will create a higher demand for water, and therefore the relaxation in water management problems may be shortlived. On the other hand, new vested interests in more equitable water distribution in the main canal are created in this way.

The rotation system as described in the CADA circular from 1982 was also implemented in the first three Canal Divisions. This increased and stabilised the supply to the Fourth Canal Division, and made the implementation of the on/off system in that division possible.[34)] The effort to get the gauges right as described in the new gauge and discharge table was reasonably successful. This fact is generally attributed to the efforts of a committed Executive and later Superintending Engineer based in the tail end Division.[35)] In October 1988 an inspection report was produced by this officer that clearly documented the excess water use in the Second and Third Divisions.[36)] The inspection was followed by a series of meetings that finally resulted in the new gauge table, the implementation of the on/off system in the Fourth Division and the main canal rotation as outlined in the 1982 CADA circular.

Maintenance of the gauges at the Division borders requires active intervention of higher level officials in the work of their subordinates. The gauges and rotation systems are more or less maintained through a monitoring and intervention process involving an intense flow of express telegrams, urgent telephone messages and letters between the Division offices and with the Superintending Engineer's and Chief Engineer's offices. A sample of the resulting interactions is given in Box 9.2.

To conclude, my interpretation of the changes in main canal management that I just described, is that the new gauge table for the main canal that was produced in 1990 created

---

34) That the upstream distributaries were actually closed can be observed in the gauge registers kept in the Division offices, by looking at the daily distributary discharges recorded for each distributary. The evidence is too voluminous to present here. The increase in discharge can be derived from the same data.

35) When, in 1992, I asked a third division engineer about the engineer that introduced the rotation in the fourth division he replied that "the tail enders consider him as their god".

36) What is unusual is that the Executive Engineer of the Fourth Division undertook the inspection (with assistance from staff of the Superintending Engineer's office). This means that the inspector directly checked the performance of colleagues who occupied the same level in the hierarchy. The inpection did not include the First Division, which comes under a different Superintending Engineer. The creation of a separate Subdivision (under control of the Executive Engineer of the Second Division, and thereby the Superintending Engineer of the three downstream Divisions) to operate the distributary offtakes in the First Division failed. First Division officers referred all problems in their distributaries to this Subdivision. It received insufficient backing and was abolished in 1992.

Box 9.2: Extracts from internal communication in the Irrigation Department on main canal management

The Chief Engineer in presence of all the officers of [the Left Bank Canal] fixed the gauges to be maintained during last Kharif 1990 as under. (...) Therefore all Executive Engineers are requested to see that water management is done smoothly by adopting rotation system of water supply in the distributaries. The Executive Engineer [Fourth Division] is also requested to arrange to adopt weekly 'on & off' system of irrigation in the main canal as per last year to have smooth water management upto tail-end. (Letter SE to EEs Second, Third and Fourth Divisions, July 1991)

I therefore request you to please insist all the concerned staff to move on the canal, distributaries upto tail end areas daily and watch the daily movement and diaries of your staff. You can also move along with them, frequently, so that, problems can be easened at your end only. The fortnight diaries of Assistant Executive Engineers from July 1991 onwards may also be submitted to this office along with your spot checks for verification. (Letter SE to EE Fourth Division, August 1991)

The gauge at Mile 104 at 5 p.m. is 4.85 ft. The gauges at Mile 104 are fluctuating and causing difficulties to this Division in maintenance of irrigation management. Therefore you are requested to maintain 6.30 ft. gauge at Mile 104 constantly. Failure to maintain the required gauge on your part will lead to law and order situation for which you alone will be responsible. The situation is most critical and explosive in this Division command area. I request you will realise the gravity of the situation and extend your cooperation in proper maintenance of the gauge. Please acknowledge the receipt of this message. (Urgent telephone message of EE Fourth Division to EE Third Division, August 1991)

[Following excess drawal by one distributary.] This sort of management is far from satisfactory. You have to curb such tendency on the part of concerned. Let me know what your Sectional Officers were doing. The explanation of concerned should be submitted to this office to take further action. If this tendency is not stopped, it will be difficult for undersigned to remain as a mere spectator. Action should be taken to close all distributaries as agreed upon during lower rotation is in progress. (Letter EE Fourth Division to an AEE, August 1991)

Today at 1.00 p.m. gauge at Mile 104 is 5.15. Next irrigation management rotation system collapsed around chaotic conditions. Myself, Assistant Executive Engineer staff not in position to attend irrigation management duties. Jeeps are being stopped on roads. Unruly mobs not permitting to move. Life miserable. Living under continuous threat. None to rescue. (Express telegram EE Fourth Division to CE, September 1991)

It is impressed on all concerned that based on net available discharge with reference to gauges at Mile 104, it is to be equitably distributed without affecting interest of any ryots at any distributary. Necessary regulation chart at various depth of flow at Mile 104 is herewith enclosed for ready reference. Any violation will be viewed with displeasure and will be reported to higher authorities. (Letter EE Fourth Division to AEEs Fourth Division, September 1991)

Even after my hours together convincing to them, and persuasion stating that to allow the water to the tailend areas the rotation system is a must for this Division. But they were not ready to hear or accept the same. The situation was very critical and they talked in all types of nonsense and abusing words and their intention is to manhandle the undersigned in his own chamber. (...) In view of the above, to provide adequate water to tailend atchkat under lower rotation, protection of District Armed Police to avoid tampering of head sluices and illegal opening etc. (Letter EE Fourth Division to SE, September 1991)

You are hereby directed to arrange for staff for patrolling round the clock (..). The necessary trucks, van, and Police protection may be taken during the patrolling period. (Letter EE Fourth Division to an AEE, September 1991)

Irrigation management has become uncontrollable even with Police assistance (...) Ryots are agitating, staff is reluctant to [work] under above situation. (Express telegram EE Fourth Division to CE, September 1991)

It appears that present Executive Engineer [Third Division] is not in a mood to maintain 6.2 feet gauge. Due to lack of action situation is becoming grim. Kindly intervene. (Express telegram EE Fourth Division to CE).

a more realistic base for the internal negotiation of water distribution among divisions in the Irrigation Department. The earlier table, based on the localisation pattern, was so far removed from the actual releases to the tail end section of the canal, that it served no practical purpose. As a result, there was no firm ground for compromising on proportionate gauges, and these had to be renegotiated time and again. The new table has provided a new institutional form (a new set of operational rules) within which main canal management can take place. It seems to produce better and more stable results. Problems in water distribution have not gone away, but the social interaction around it within the Irrigation Department seems to be more productive than before.

This positive judgement must however be a tentative judgement. The first years following the introduction have not been characterised by great overall water scarcity. An important weakness of the system is that the feedback or sanction mechanism for non-adherence is the authority of the Superintending Engineers and Chief Engineer towards Executive Engineers only. A lot thus depends on the personal qualities of and the pressures put on the two Superintending Engineers and the single Chief Engineer. Accountability relations in the Irrigation Department have remained one-sided. The Command Area Development Authority and Irrigation Consultative Committee are, as discussed, only partially able to establish an accountability mechanism *vis à vis* the Irrigation Department as a whole. The new management routine thus remains to be tested.

9.4 CONCLUSION

The events and developments discussed above allow a number of general observations and conclusions regarding the dynamics of main canal management in the Tungabhadra Left Bank Canal and other protective irrigation systems. I first summarise, briefly, the relevance of the water control concept (see chapter 2) for the understanding of main canal management. After that I discuss, at greater length, the substantive conclusions that can be drawn from the case study.

Water control: political contestation

At main canal level water distribution became an issue from around 1980. The gradually increasing demand for water at main canal level could no longer be met by an increase of the supply from the reservoir, and water scarcity came to be felt. The occurrence of water scarcity induced the articulation of new forms of social interaction at main canal level. Other people than the formally responsible Irrigation Department officials started to get involved in it too. Officials of the Command Area Development Authority were added to the distributary level set of actors - farmers, Irrigation Department officials and MLAs. Occasionally, senior government officials and politicians up to and including the State's Chief Minister were forced to actively engage in conflict resolution and crisis management. Sections of the government like the judiciary and the police were more actively, or better put, more dramatically involved at the main canal level than at the distributary level. Part of the bargaining on water distribution has been institutionalised in the Irrigation Consultative Committee at project level, in which officials and non-officials (MLAs) have seats.

In the years 1988-89 and 1989-90 new negotiation practices between the Canal Divisions responsible for water distribution in the main canal were established. These changes within the Irrigation Department apparatus were interpreted as a relatively successful effort to constitute a more reliable and less conflictuous (but still unequal) mode of main canal water distribution. This institutional change did not come easy however. Formal policy efforts by the Command Area Development Authority to reform main canal management in earlier years had failed. It required the escalation of water distribution problems at main canal level to a situation where extreme measures like the issue of prohibitory orders for the dam and main canal area had to be taken, to create the space and impetus for the institutional change within the Irrigation Department.

That water distribution at main canal level is a political process, in the narrow as well as the broad sense of that term, and heavily contested, should be evident from this.

Water control: multi-dimensionality

The gauge and discharge tables for the main canal, which gave the chapter its title, vividly illustrate the intimate relations of the three dimensions of water control. The tables are technical instruments, which structure main canal management routines and express the balance of political, economic and administrative power in the command area. The new gauge and discharge table for the main canal that was put into use in 1990 and which departs from the old table based on the localisation pattern, both enables and constrains the reproduction of unequal water distribution. It institutionalises inequality by attaching numbers to the skewed distribution of the available water supply over the four Canal Divisions. At the same time it has provided a basis for implementation of a more reliable and stable, and higher water supply to the tail end Canal Division, at least in the first years after its introduction. Another example of the relationship between the technical and the social dimensions of main canal management is the phenomenon already observed in previous chapters, that it is the nature of conflicts in water distribution to pass over even if you don't do anything about them. They have by their nature time limits: farmers may press for more water to sow their crops, but a certain moment it is too late to sow, and the problem disappears; farmers may press for water to mature their crops, but if they don't get it, the crop eventually dies, and the problem, in a cynical way, solves itself. For this reason, an important strategy of Irrigation Department officials is to find means to get over the shortage period, the duration of which they know is by nature limited. The ultimate way to do this is to find extra water for this period, as happened in 1988-89 by the release of water from the Bhadra system, and in 1989-90 by not using the carry-over storage for its intended purpose. Another way is the introduction of tightly controlled rotation systems for a short period, as was also done in the period described above. This phenomenon may explain why main canal management looks like an 'adhocracy'[37] or totally chaotic, with strong pejorative connotations, in the eyes of some observers. The fact of the matter is that many problems can be solved by *ad hoc* measures because they are *ad hoc* problems. That not everyone is happy with the situation that causes the occurrence of these *ad hoc* problems, is another matter.[38] The case discussed suggests that considerable escalation and mounting of pressure on the Irrigation Department and other actors is necessary before the routine of *ad hoc* problem solving develops into more systematic routines that can to some extent prevent the occurrence of these problems.[39]

---

[37] The term is taken from Nijman (1993).

[38] In this sense the problems are structural, because they appear time and again. But, from the perspective of an individual engineer, it may rain more next year and he may be transfered.

[39] What I implicitly suggest here is a kind of balancing of the various costs and benefits of different management alternatives by Irrigation Department officials. I don't think it is possible or useful to (continued...)

Other examples of sociotechnical relationships can be found in the chapter, but this should suffice to make the general point of the multi-dimensionality of water control at the main canal level. I now proceed to draw more specific conclusions from the material presented in this chapter.

Policy as prescription, policy as process

The chapter contrasted two attempts to change main canal water management routines. One was a national policy initiative that reached the command area through the CADA. The other was grounded in events as these developed in the command area.[40)]

The CADA-based initiative for water management reform is a clear example of what Mackintosh calls the 'policy as prescription' model of planned intervention by government agencies (Mackintosh, 1992).[41)] Two of the main features of the prescriptive model are a standardised approach and a top-down legalistic bias. The Command Area Development programme provides a good example of this.

A striking characteristic of the Command Area Development approach is its degree of standardisation. The Command Area Development policy was conceived at the central government level, influenced by national and international policy makers and advisors. The State governments made only limited adaptations to the central government model, certainly as far as system-level activities like on farm development, *warabandi*, and the establishment of Water Users Associations were concerned. The Command Area Development policy was a standard policy recipe or formula derived from the existing body of knowledge, experience and opinion on canal irrigation, and experimentation with some of the policy's elements in a number of irrigation systems. It was intended to be implemented in all canal irrigation systems in a similar fashion.

The second outstanding characteristic of the Command Area Development policy is that its recommendations have a highly directive character. Put differently, the policy has a strong bias towards bringing about change through legislation and its (correct) implementation. The government tells farmers and irrigation officials what to do and how to do it in an Act, rules, procedures, bye-laws and other instructions. It also defines the legal machinery of fines and other punishments to control non-adherence to the policy prescriptions, particularly as far as

---

[39)](*...continued*)
try to measure these costs and benefits very precisely (as for example rational choice theorists might want to do). More interesting, because it provides more insights into the dynamics of main canal management and more concrete entries for intervention and change, is the question how and why the costs and benefits are differently perceived/felt by different officials within the department. This suggests an area of research usually described as the issue of the 'motivation of managers' (Chambers, 1988: chapter 9), or 'management styles' as mentioned in chapter 7. My analysis of main canal management suggests that this issue is not only linked to institutional constraints, conditions and incentives, but also to the nature of the water distribution problem itself.

[40)] A recent government attempt to improve main system management has been the National Water Management Programme (NWMP) (Berkoff, 1988). In the distributaries where it was implemented in the Tungabhadra system it has left no noticeable impact on the management of these canals. Activities were limited to physical interventions, mainly repair od structures and lining.

[41)] Mackintosh describes 'policy as prescription' as follows. It "proposes appropriate government policy for development, based on a set of assumptions about the benevolence of government. It is largely ahistorical. Typical question: What public services should the government provide?" (Mackintosh, 1992:4, box 2).

farmers are concerned. There typically is a strong law and order element in this type of approach to reform (also see CADA/TBP, 1979 for example).

Though the Command Area Development policy was based on an interpretation of existing experience, documentation and opinion on water management problems in different canal irrigation systems, the policy remained external to the irrigation systems in which it was to be implemented. With this I mean to say that the implementation process was not structured in such a way that learning from local factors would be possible, in order to shape the policy to system-specific problems and circumstances.[42)]

In the Tungabhadra Left Bank Canal the pressure of circumstances has forced the occurrence of some locally specific discussion on water management reform. The Ryots Grievances Committee report (CADA/TBP, 1979) which immediately preceded the implementation of the Command Area Development programme in the Tungabhadra Left Bank Canal, might, in a positive interpretation, be considered as a system-specific problem identification that involved farmer participation. The committee collected almost 3000 representations of farmers, and held a series of public hearings on the basis of them. The committee does make (or rather repeats) one important locally-specific recommendation and that is to replace the Left Bank system of localisation with the Right Bank localisation in blocks with similar crops, to be irrigated for one season and closed (cemented) for the other season (see chapter 3).

However, participation remained at the level of consultation and the committee's work cannot be regarded as a conscious attempt to design a locally specific approach in the context of the overall Command Area Development policy.[43)] It recommends the implementation of the CAD policy in an equally prescriptive way as the Command Area Development policy makers themselves. It contains no suggestions to try a more adaptive mode of policy implementation.

The events in the Tungabhadra Left Bank Canal command area in the years 1988-1990 were presented as a contrast to the Command Area Development policy implementation effort. These events were interpreted as the occurrence of institutional change in response to the main canal management problems as these actually occurred in the command area. A new policy for main canal management emerged in the social process of the negotiation of water distribution by the different actors concerned. This course of events exhibits some of the characteristics of what Mackintosh calls the 'policy as process' model of change (Mackintosh, 1992).[44)]

In this case the design of the policy was not a planned and methodologically thought-through effort at reform, but an unplanned and methodologically unreflected process of making the best of the circumstances by trying to seize the opportunities that the situation created. Nevertheless, it contains an important lesson for the design of better planned

---

[42)] The quality of the analysis on which the policy was based may also be questioned, as suggested in the chapter, but my point here is about the mode of implementation. Incomplete analysis can be remedied when a learning process is part of the approach to implementation.

[43)] This can be derived from the terms of reference of the Committee that are included in the report, and from how the report is written in general.

[44)] Mackintosh describes 'policy as process' as follows. It "seeks to explain the actions of public institutions, governmental and non-governmental, and their effects, as outcomes of social processes. It takes a historical and evolutionary approach. Typical question: How can non-governmental action improve public service provision?" (Mackintosh, 1992:4, box 2) interventions. This lesson is that efforts at management reform need to be grounded, both in analysis and strategy, in existing, locally specific management practices and social reality.

I conclude that policies for irrigation reform, including main canal management reform, should be conceived and implemented in a different manner than the 'policy as prescription' model that has been used so far. A stronger process orientation, that is more participatory policy conception and more adaptive policy implementation, is certainly not a sufficient condition for success, but it is, so I want to argue, a necessary one. Starting from detailed insight in local circumstances, histories and processes to identify existing spaces and strategic actors for reform seems to be an advisable approach. In the final analysis it are those directly involved in irrigation management, particularly farmers and Irrigation Department staff, who have to carry a changed *modus operandi*, and not the relatively distant policy reform initiators. To start change from the lived experience of those directly involved therefore seems the logical thing to do.

Two additional conclusions that can be drawn from the main canal case study that are relevant to the discussion above are 1) that there is no dearth of ideas for change, and 2) that these ideas can potentially be mobilised in crisis situations.

During the escalation of water management problems in 1988-89 and 1989-90 many ideas surfaced for changing the existing organisational structure of (main) canal management. As mentioned above, many of these ideas were not new. The proposal to construct balancing reservoirs was already included in the 1934 project report. The introduction of the block system of localisation as practised in the Right Bank Canal and the idea of wholesaling water to farmers by volume had also existed for decades.

What is important is when and how some of these ideas can be mobilised more effectively. The case study above clearly shows that crisis situations are occasions when such ideas are brought forward by the different actors concerned. In crises existing certainties and relationships are questioned and in flux, and this creates space for more drastic change than when things are relatively quiet on the waterfront.[45] Most of the ideas that surface quickly go under again after the crisis is over. Some reach the stage of implementation on a trial basis but may be stopped
by farmers action. This was the fate of the block system of localisation for example, for which farmers got a stay order in the Karnataka High Court. Some ideas do stick, like the change in the gauge tables. It is this process of getting ideas on the reform-agenda and consolidating them in new institutional and technical structures which is, in my view, the essence of policy making and implementation.

This view implies a recognition that behind ideas lie interests of different groups of people, and that the mobilisation of ideas means the mobilisation of people. Depending on the force different groups are able to generate, policy and practice change in different

---

[45] The Tungabhadra case study perhaps also suggests that particular conditions of state governance create space for change. A factor in the 1988-1990 events seems to have been the dissolution of the State parliament and Governor's rule after that in the period May-November 1989, and the fact that a newly elected government had to deal with the crisis emerging from December 1989. The situation of Governor's rule seems to have allowed quick and firm decisions on the policy changes to be implemented, and the new government seems to have tried to use its fresh electoral mandate to confront the rice interest more radically than had been tried before (for a similar analysis of opportunities for change with newly elected governments in the India-Bangladesh negotiations on the Ganges river water, see Crow, Lindquist and Wilson, 1995). More detailed research would be required to make stronger statements on this issue.

directions. Policy formulation and implementation are contested, like water distribution, and involve strategic political behaviour to create and utilise spaces for change.

At the level of day-to-day practices those involved in irrigation policy formulation and implementation usually recognise, and adopt, such a perspective. However, at the level of ideology policy practitioners usually express the view that policies should perhaps be defined politically, but implemented rigorously and rationally, or as engineers like to say, scientifically and without political interference. This gap between what should be and what is has so far not generated a fundamental rethinking of the 'policy as prescription' model in the field of canal irrigation. Which movements for change are taking place in Karnataka is elaborated in the next chapter.

10

BACK TO THE FUTURE

An agenda for management reform in protective irrigation

In part II of the Spielberg and Zemeckis' cinematic trilogy *Back to the future* the scientist Doc Emmett Brown, inventor of a time machine, proclaims that "the intent here is to gain a clearer perception of humanity, where we've been, where we're going, the pitfalls and the possibilities, the perils and the promiss, perhaps even an answer to that universal question: why?" His efforts to gain wisdom in past, present and future involve great havoc and drama. Whether his ambition is fulfilled remains uncertain, but in true Hollywood style the heros live happily ever after.

In the real world it is - of course - impossible to change the past, and our capacity to shape the future is heavily constrained. Whether all water users and other actors involved in the havoc and drama in the Tungabhadra Left Bank Canal will live happily ever after can be the subject of serious concern. But even if we can't travel in time, we can travel in our minds. How we understand the present and the past influences the future that we try to build. It is to that theme that this concluding chapter returns: how to shape the future of protective irrigation.

Canal irrigation is not the heartland of progressive politics. Despite passionate arguments about its potential to secure the livelihoods of not only the relatively well-to-do green revolution farmers, but also of small peasants and agricultural labourers (Chambers, 1994), canal irrigation has not caught the imagination of environmental, anti-poverty and other progressive social movements. Canal irrigation has mainly been criticised for its negative social and ecological effects and the technocratic megalomania of its advocates. Whatever the merits and importance of this critique, it leaves the problems in existing large-scale canal irrigation unaddressed (for exceptions, see below).

Canal irrigation has been the birthplace of other social movements however. The *Karnataka Rajya Raita Sangha* (KRRS, Karnataka State Farmers Movement) was formed in the resistance of farmers against the introduction of betterment levy in the Ghataprabha and Malaprabha irrigation systems (see Nadkarni, 1987:84-100). The KRRS is one of the new farmers movements in India (Brass, 1995), which to a large extent focus on tax, price and subsidy issues. It also has a strong anti-corruption profile. The KRRS uses populist images of the rural/urban divide, and positions 'the farmers' against 'the state' and other actors. As a result it has hardly addressed distributional issues within the category of 'the farmers' (for discussion see Nadkarni, 1987; Krishnarajulu, 1989; Assadi, 1995; also see chapter 3).

In government policy the approach to canal irrigation has consistently been of the prescriptive kind. In the past decades, a lot of time and energy has been spent on the design of new laws, policies and programmes at the international, national and State level. However, these reform initiatives were largely neutralised on their way from top to bottom. A major example is the Command Area Development programme, as was discussed in chapter 9. It seems to have achieved a considerable part of its physical targets, but it has been virtually powerless in terms of irrigation management reform.

Canal irrigation policy also has a large *déjà vu* content. Those who read the *Report of the Indian Irrigation Commission (1901-03)* will recognise that many reform proposals have been in discussion for the last hundred years. But, as it seems, without much of an effect. For those who want to act and don't want to wait (Chambers, 1988) the situation in canal irrigation is not the most stimulating of environments. Cynicism is a not uncommon sentiment among irrigation professionals and observers of the canal irrigation scene.

In my first effort to come to grips with actually existing protective irrigation, I characterised the situation in these systems as a deadlock, where none of the parties involved could fully get what they wanted, and none of them was in a position to force substantive change, while disaster was on the horizon (Mollinga, 1992). Throughout this research project I have tried to investigate whether the gloomy picture of the policy and public action environment of canal irrigation sketched above is too simplified, and I have attempted to identify entry points for breaking the deadlock.

The focus in the concluding chapter is - therefore - on possibilities for management reform in protective irrigation. I discuss this topic in four different ways.

In section 10.1 I identify constraints and opportunities for management reform on the basis of the analysis of water distribution practices in the preceding chapters. I argue that a more diversified and hopeful picture of the dynamics of canal irrigation is warranted than suggested by notions like cynicism, *déjà vu*, and deadlock (and more substantive ones like rent-seeking). This section is also a summary answer to the central research question of the book.

In section 10.2 I look at different perspectives on management reform in protective irrigation. I discuss the different grounds that have been and are given for the - generally acknowledged - need of that reform, and outline the policy instruments related to these different grounds. I argue that management reform approaches need to move away from a sectoral 'canals and irrigation water' focus, and need to be part of a broader perspective on integrated water resources management, rural development and ecological sustainability. I briefly discuss an example of such a more comprehensive approach.

In section 10.3 I focus on the process dimension of the formulation and implementation of reform policies, by looking at recent developments in Karnataka. The main argument is that the policy process that is now designing 'participatory irrigation management' programmes, should be much more 'participatory' itself. There is a lack of a well articulated public demand for policy change, and no efforts to involve the different interest groups in the policy process.

In the last section, 10.4, I return to the world of research. I conclude the chapter and the book with an outline of a research agenda that could support management reform initiatives. I focus on three issues that I consider of particular importance. These are canal irrigation technology and its design process, the politics of irrigation, and the rights and entitlements structure with regard to water use and distribution.

10.1 CONTESTED WATER CONTROL IN THE TUNGABHADRA LEFT BANK CANAL: CONSTRAINTS AND OPPORTUNITIES FOR MANAGEMENT REFORM

In this section I identify constraints and opportunities for management reform in protective irrigation. This discussion is based on the analysis of water distribution practices in the Tungabhadra Left Bank Canal in the preceding chapters.

I first identify a set of constraints for management reform by looking at the overall structure of water control in the Tungabhadra Left Bank Canal. I discuss the social relationships that shape management practices. These are the relationship between farmers and Irrigation Department officials, the position of politicians in resource distribution, and the characteristics of the agrarian structure. I also discuss how the technical infrastructure shapes water control.

After that I shift attention to the opportunities for management reform that can be derived from the Tungabhadra Left Bank Canal case study. These can be identified by looking at the day-to-day water distribution practices. The actual situation is more dynamic than a 'structural' picture might suggest. I discuss the potential for self-governance, the negotiation of rule systems between farmers and the Irrigation Department, and the scope for institutional and technological learning within the Irrigation Department.

The discussion of constraints and opportunities for management reform is simultaneously the formulation of the answer to the central research question of the book. That went as follows (see chapter 2).

> *How do the pattern of commoditisation, the form of state regulation and the characteristics of the technical infrastructure shape, and how are they in turn shaped by, the forms of organisation of water distribution in the Tungabhadra Left Bank Canal irrigation system?*

The management reform focus implies that not all empirical findings and conceptual points are summarised. For these I refer to the earlier chapters.

Constraints: the structure of water control

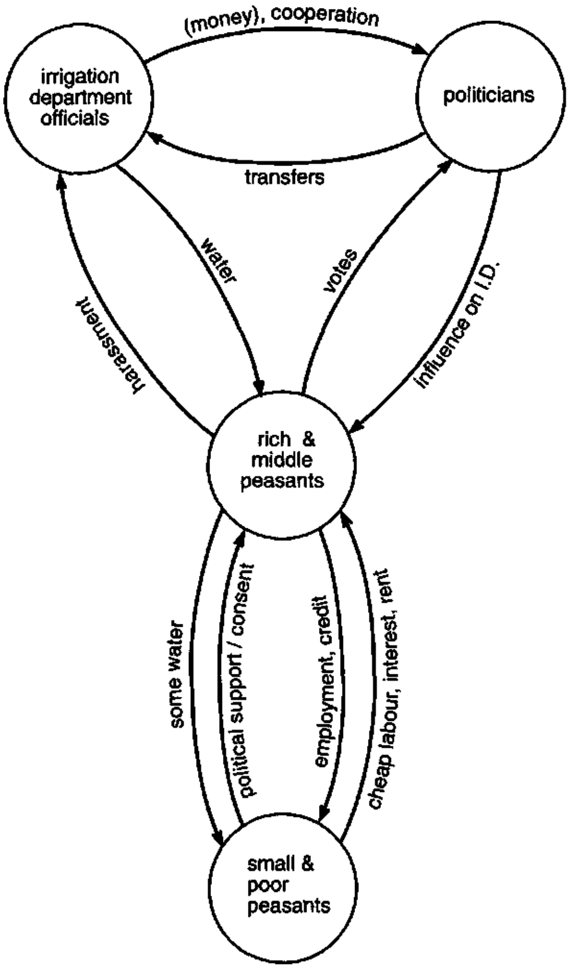
The theory of protective irrigation contains a very simple water management model. In this model there are only two actors involved in water distribution, farmers and Irrigation Department officials, and their relationship is one sided: water is to be supplied to the farmers by the officials. This book has shown that the actual situation is far more complex. A more realistic, though still simplified, model of the social relationships that shape day-to-day water management in the Tungabhadra Left Bank Canal is given in box 10.1.

Regulation 1: farmer-Irrigation Department relations

The model in box 10.1 shows that the relation between farmers and Irrigation Department officials is not one-sided. Water is scarce and some farmers appropriate shares larger than their protective entitlement. This implies extensive involvement of farmers in main system management, which involves intensive interaction between farmers and Irrigation Department officials around unequal distribution of the resource.

The involvement of farmers in water distribution takes direct and indirect forms (see particularly chapters 7 and 8). Direct involvement means self-management of the infrastructure, particularly the distributary canal infrastructure, by water users. It includes the adjustment of gates, the 'remodelling' of outlet structures, the creation of obstructions in some canals and outlets, and the removal of these in others, and the guarding of canal

Box 10.1: The structure of water control in the Tungabhadra Left Bank Canal



sections, either by individual farmers, groups of farmers or labourers hired by farmers for this purpose. These activities are concentrated during the night time, but some parts of the command area are completely self-managed by farmers.

Indirect involvement consists of the exertion of pressure on the Irrigation Department to supply sufficient water at the right time. Different techniques are used. These include written or personal representations of farmers to Irrigation Department officials, demonstrations (road and railway blocks, surrounding officials' houses, and other stratagems), the payment of larger or smaller sums of money to irrigation officials, and physical threats.

The Irrigation Department bureaucracy is characterised by a top-down hierarchical structure of operation.[1] A structural property that is important for water distribution practices is that there are no practical formal accountability mechanisms between water users and irrigation officials. Farmers in principle have the possibility to go to court to contest management decisions of the Irrigation Department, but this is an ineffective mechanism for structuring water distribution. The most farmers are able to achieve in this way is the paralysis of the legal efforts at regulation of water distribution by the Irrigation Department (see chapters 3 and 7). There are no fora for joint decision making, or even consultation, of farmers and irrigation officials on either management or design issues.[2] The Irrigation Consultative Committee at project level is only a partial exception. It is mostly relevant in situations of extreme water crises. Farmers are not directly represented in it (see chapter 9).

The lack of institutions for joint management, and for the design of joint management, constitutes the first constraint for management reform.

Regulation 2: politicians and resource distribution

The second addition to the management model of protective water is that more actors are involved in water distribution than farmers and Irrigation Department officials alone. The third important party are politicians, particularly MLAs. The role of MLAs in their constituencies was decribed as that of resource brokers. Water may, under particular conditions, be an important resource for a politician to engage with (see chapters 3 and 7). Politicians can influence the management decisions of Irrigation Department officials through their influence on the transfers of these government officials.

The relation between politicians and officials is two sided as well. The literature suggests that officials have to pay politicians for keeping good relations with them. This money is supposedly generated through bribes paid by contractors and farmers (see Wade, 1982a). The contractor side of this argument is confirmed by the limited evidence that I have collected on this. However, I do not think that the collection of bribes by Irrigation Department officials is very important in water distribution. I have found examples of it, but in the water distribution domain it is not the structuring relationship between the farmers and Irrigation Department officials.

The relationship between politicians and farmers is an electoral one. An MLA needs votes to secure his or her re-election, and votes are secured by channelling resources to voters. Farmers exchange their electoral support for the politician's influence on the resource managers, the Irrigation Department.

The lack of accountability relationships between farmers and the Irrigation Department is filled in by the political process. Via politicians farmers create an indirect mechanism to negotiate water distribution with the Irrigation Department.[3] The constitution of this

---

[1] I have left the Command Area Development Authority out of the figure in box 10.1 because of its limited influence on water distribution. However, this is a simplification, particularly with regard to main canal management (see chapter 9).

[2] In the conceptual terms of rule-making: there are no institutionalised fora for operational, collective choice, and constitutional rule making (see chapter 6).

[3] I call this relationship a mechanism rather than an institution. It is an institution in the broad sense of that term: a regular and repeated pattern of behaviour, but it has a low degree of consolidation. It occurs only under some conditions, which are locally specific, and it doesn't have any 'formal' dimension like, for example, rules of conduct agreed upon by those involved. I have discussed it under the heading of 'forms of organisation' in chapter 7, but perhaps it would be more accurate to describe it as a 'form of organising'.

mechanism is possible because of the influence that politicians have on the administration, as discussed above. There clearly is no separation of legislative and executive powers (and judicial powers for that matter). However, the access to political influence is as unequal as that to irrigation water. The constituency-based political system implies that a politician has to please as many categories of voters as possible, but the dependencies inherent to the agrarian structure make that a politician should certainly not displease the powerful among them.

This undemocratic political configuration is the second constraint for management reform.

Commoditisation and the agrarian structure

The third amendment to the protective management model is that the category of 'farmers' needs to be unpacked to be able to understand water distribution practices and unequal distribution properly (see chapters 5 and 6 particularly).

The agrarian structure is characterised by strong social differentiation of agrarian producers as a result of the commoditisation process that accompanied the development of irrigated agriculture. The introduction of irrigation has led to the emergence of a group of head end farmers in the command area who could establish and expand a water-intensive and highly commoditised farming system through excess appropriation of water. This process was induced by well-endowed migrant farmers from the coastal areas of Andhra Pradesh who acquired land in favourable locations in the command area to start a rice-based farming system. Others followed suit. What has emerged is a class-related geographical pattern of water and land distribution, which roughly follows the head-tail locational pattern. Mechanisms for further land concentration in favourable locations include the purchase of land on the land market, land transfers through dowries, and strategic provision of loans with land as the collateral (see chapter 5). Apart from location other factors that influence the geography of social differentiation are the history of settlement and the design characteristics of the canal infrastructure (see chapters 5 and 7).

The 'economically and politically sound' farmers, the rich peasants, and to a lesser extent the middle peasants, dominate the interactions with Irrigation Department officials and politicians. Small and poor peasants depend on them to secure water supply when the quantity and/or timing of the supply by the Irrigation Department is unsatisfactory.

This relation of dependency is in some respects similar to that between politicians and rich and middle peasants. Particularly rich peasants act as local leaders in a much broader sense than only with regard to water distribution. Also they have to reproduce their support base even when they are not elected leaders. The acquisition of extra resources like water is one way to reproduce their social and political capital.

Another part of the relationship between the two groups of farmers is more straightforwardly economic. Rich and middle peasants supply credit and employment to many small and poor peasants. The configuration of relations between different categories of farmers explains the unequal but relatively conflict-poor water distribution at outlet command area level. Because water rights are unclearly defined, small and poor peasants cannot openly contest unequal distribution (see chapter 5 and the discussion below on self-governance).

The socio-geographical dimensions of the differentiation of agrarian producers are the third constraint for management reform.

Technology

The last structural factor that I want to discuss, and which is not visible in the model in box 10.1, is the role of the technical infrastructure in shaping water management practices. One aspect of that role was already referred to above in the discussion of the geography of social differentiation. The layout of the canal infrastructure is the grid on which the spatial pattern of class-related land and water distribution is made and remade.

Technical features of the system that were found to be of particular importance were the following two (see particularly chapters 4 and 8).

1) The combination of supply-orientation of the canal design, its continuous flow character, the size of the system, and the absence of cross regulators and/or intermediate storage make the system technically very difficult to manage. More precisely, it makes management that has to deal with demand for water that exceeds supply, and management that wants or needs to respond to changes in demand for water, very difficult, and practically speaking, impossible.

At main canal level the Irrigation Department tries to deal with this situation by keeping the proportional distribution over the canal divisions constant, but the limitations of this are clearly felt in the tail end division (see chapter 9). The Irrigation Department also tries to stabilise the releases into the distributaries. This is not too difficult in the head end distributaries, where design capacity limits the maximum supply. Further downstream the distributary releases are the subject of negotiation with and intervention by farmers.

The main terrain of management interactions is the distributary canal system however (see chapter 7). Apart from the rotation schedules discussed above, different pseudo-calculated rules have been negotiated between irrigation officials and farmers on gate openings and water levels. Where subdistributary canals exist their design capacities are an important factor in the spread of irrigation water over the command area.

2) The choice of non-modular pipe outlet structures to supply water to outlet command areas enhances these problems (see chapters 4 and 8). These devices are extremely difficult to regulate with any precision. Moreover, they have been over-dimensioned, for reasons that are not fully clear. This makes excess appropriation of water technically very simple. The pipe outlet structure is therefore a strategic point of control in the system. Many of the farmer-farmer and farmer-irrigation official interactions take place around this structure. As a result the structures are subject to a continuous cycle of manipulation, damage, destruction, repair, rebuilding and redesign. The variation in the characteristics of the pipe outlet artefacts expresses the balance of power between farmers and between farmers and the Irrigation Department in water distribution, just like the precise characteristics of the rotation schedules express this balance.

These technical features of the Tungabhadra Left Bank Canal system constitute the fourth constraint for management reform.

Opportunities: starting points for change in everyday practice

The picture of water control in the Tungabhadra Left Bank Canal sketched above is inevitably a simplified picture. The flavour of the relationships lies in their detail, and in the variations on the general theme described. For these I refer to the earlier chapters. More importantly, the picture is also incomplete. The interaction of the different actors within an evolving social structure has produced particular forms of organisation that institutionally consolidate the relationships of these actors. These forms of organisation are not static but dynamic, and apart from constraints also provide opportunities for management reform. Also the technical infrastructure has not been a static, given factor, but has exhibited some dynamism. This points to another entry point for change.

Self-governance capacity
The examples of rule making and implementation at outlet command area level given in chapter 6 and at subdistributary level in chapter 7 show that indeed water users are knowledgeable and capable actors (see chapter 2 for this concept). They show that supply-side rules for water distribution are made, sometimes in great detail, and always with the equity concept of irrigation time per acre incorporated in them. However, from an equity perspective the weak point are the processes that constitute the demand for water. In chapter 5 it was shown that small and poor peasants in the tail end anticipate unequal distribution in their crop choice. They plant less water-intensive and less remunerative crops because they know they are unable to gain the upper hand, or at least an equal hand, in confrontations with rich and middle peasants in the head end. Nevertheless, and this is the first opportunity for management reform, it seems to me that there is substantial potential for an increased level of self-governance by farmers.

Joint rule-making and implementation
At distributary level rotation schedules were the main form of organisation discussed. They were analysed as jointly constituted by farmers and irrigation officials, and as an expression of the balance of power between head enders and tail enders as well as that between farmers and Irrigation Department staff. I have argued that the distributary level rotation schedules signify a different relationship between water users and the state than that portrayed in the increasingly dominant rent-seeking perspective. There the image is one of a relation dominated by bribe payments, reinforced with political lobby activities, leading to anarchy on the canals. I interpret the Tungabhadra Left Bank Canal situation more positively. I consider the rotation schedules as the emergent properties of conflicting interests, and as institutions that, despite the inequalities inherent in them, provide a better starting point for the renegotiation of water distribution than the 'syndrome of anarchy' perceived elsewhere. This is the second opportunity for management reform.

Institutional and technical learning in the Irrigation Department
Forms of organisation internal to the Irrigation Department were discussed in chapter 9 with regard to main canal management. I showed how in the severe water crisis in the period 1988-1990 the Irrigation Department adapted the procedures for main canal management. It designed a new gauge table for main canal management, which gave the water levels to be maintained at the divisional borders with particular releases from the reservoir. This new gauge table diverged from the old, localisation based table. It institutionalised inequality in water distribution at main canal level, but at the same time provided a more realistic basis for the negotiation of water distribution at this level.[4] The example shows that even under the very difficult circumstances prevalent in the Tungabhadra Left Bank Canal some degree of institutional learning and development was possible. I interpret this as another, third, opportunity for management reform.

It was observed (see chapter 8) that there was considerable technical creativity of the engineers at the distributary canal level with regard to pipe outlet structure design. However this creativity is muzzled by a hierarchical structure of authority and by the absence of fora

[4] Part of the change was the introduction of rotation over distributaries in the tail end division of the main canal, and regular weekly closure of smaller distributaries in the other divisions to push water to the tail end.

for the discussion of the technical features of the system between farmers and irrigation engineers. In addition, the professional orientation in the irrigation engineering community is not toward the small-scale day-to-day problems of existing technologies, but towards the creation of new, large-scale and more spectacular structures. Nevertheless, I conclude that the technical professionalism of engineers provides a fourth entry point for management reform, because that reform creates technical challenges.

Conclusion

The cynicism with regard to irrigation reform that I referred to in the introduction of this chapter finds part of its rationale in the overwhelming nature of the constraints outlined above. Restructuring the state-farmers relationship, redefinition of the role of politicians, changing the agrarian structure and an overhaul of the technical infrastructure seem to be impossible tasks to accomplish. And indeed, it would be naive to underestimate the importance of these conditions of impossibility.

However, such general and structuralist views can overlook opportunities for change and reform. The detailed analysis of water distribution practices in this book which was summarised above, shows that there is considerable diversity and dynamism within the overall structure. There is capacity for self-governance by farmers, there is joint rule making and implementation by farmers and Irrigation Department staff mediated by politicians, there is institutional change within the Irrigation Department, and there is technical creativity of engineers.

In the introductory chapter of the book I stated that a larger number of 'grounded' studies on management practices in canal irrigation might provide a more realistic basis for debates on reform. I hope to have shown that the basis for that realism is provided by an understanding of the contested nature of water control and the interrelation of its different dimensions (see chapter 2 for these theoretical starting points). Apart from allowing an analysis of why things are as they are, contestation implies room to manoeuvre and multidimensionality implies that changes in one aspect may induce or facilitate changes in other aspects. This is not intended to sound overly optimistic. But unless it is assumed that dramatic structural changes are in the offing, strategic analysis of present conditions to identify entry points for change will have to be the basis of reform initiatives in canal irrigation.

10.2 REFORM PERSPECTIVES FOR PROTECTIVE IRRIGATION

The discussion above identified constraints and opportunities for management reform in protective irrigation. It implicitly assumed the need for such reform. This need is recognised by almost all actors involved in protective irrigation management. Even most head-end water users would, I suspect, acknowledge it.[5]

However, the need for management reform can be argued on a variety of grounds. These different grounds represent different perspectives on what the problem in protective irrigation is. Different problem formulations in their turn imply different policy instruments to achieve reform. Below I briefly summarise the different problem definitions and the policy

[5] Reasons for this expectation are the conflictuous nature of present management and the potential to reduce - in neo-institutional economics terms - transaction costs also for this group.

instruments associated with them and indicate which role they play in policy debates in Karnataka. Towards the end of the summary review I question, paradoxically, the focus on water and its management in discussions on water management reform. To conclude I give my own perspective on the matter.

Manage as planned

The first perspective on management reform in protective irrigation starts from the observation that protective irrigation systems are not used as planned. This itself can be considered sufficient reason to advocate reform. Reform in this perspective means taking measures that guarantee that the systems *are* used as planned. This position implies no reflection on the model of protective irrigation as such, but addresses either design and technical or planning and implementation deficiencies.

In the 1990s this technocratic view of management reform seems, at the policy level, no longer to be held by many people. It was however the dominant policy view in the early decades of the Tungabhadra Left Bank Canal's existence (see the discussions on the best cropping pattern referred to in chapter 3 for example). The perspective does define part of the attitude of many irrigation engineers working in the systems. Many of them feel that when politicians would not 'interfere' in management, and farmers would be 'educated' and follow the rules of 'scientific management', the system could be operated as planned. However, the same engineers realise that this 'if only' position is not very helpful in day-to-day management and in thinking about possibilities for change.

The policy instruments associated with this perspective typically are a combination of upgrading of the technical infrastructure, the enforcement of farmer discipline (adherence to the rules) by legal action and if necessary police action, and extension activities towards and training of farmers (see for example Madarkal, 1968; *Tungabhadra Project*, 1970; UAS, 1973; CADA/TBP, 1979). When engineers formulate proposals for change they usually include magisterial powers for irrigation officials, and good transport and communication facilities as elements of the strategy to be adopted. Box 10.2 gives a letter signed by 21 Section Officers which was written in the context of a public discussion organised by CADA in 1992, in which they formulated their reform management perspective (also see Ahmed, n.d.).

The economic benefits of protective irrigation

The second perspective on the need for management reform is an economic argument about the maximisation of the overall economic benefits of irrigation (also see Chambers, 1994 on 'production thinking'). It has been argued, given that water is scarce relative to land, that a strategy to maximise the production per unit of water gives higher total economic returns than a strategy to maximise production per unit of land (see Dhawan, 1989; Rath and Mitra, 1989).[6] It has also been argued that the labour requirement of the crops grown with a unit of water, under protective irrigation is higher for most 'irrigated dry' crops than for sugarcane and similar to that of rice (Rath and Mitra, 1989; Bolding, Mollinga and van Straaten, 1995:footnote 32).

There is also a counter argument. The direct production achieved with irrigation is a rather limited basis for economic evaluation. A more comprehensive analysis would also look at the second order economic effects of irrigation. One example is the effect of agricultural growth

---

[6] The total production may be expressed in total calory content or total value of the crops.

Box 10.2: A Section Officers' perspective on management reform

To: the Chief Engineer/Date: May 1992/Subject: Problems of Section Officers engaged in water management- Regarding
Sir,

We, the following section officers engaged in water management of Distributaries, request your kindself to consider the problems briefed below.

1) The cropping pattern localised in the distributaries has become 'the talk of the town' in the state. Hence, separate kharif and rabi blocks pipe-outlet wise to be re-organised and got approved by the Government for efficient water management (as in the case of high level canal).

2) The Irrigation Department is unable to control the un-authorised and outside localisation development. The prevention of the same is to be implemented with a separate staff of Revenue, Police and Irrigation Departments. Collection of water rate and penalty collection to be entrusted to Irrigation Department.

3) With the existing rotation system, it is difficult to push water to tail end. Avoiding all the hurdles in closing and controlling PO's and subdistributaries with great struggle, the tail end ayacutdars are feeded *three days in a week. When any ayacutdars in the Upper reach manhandled the staff, there is nobody* to help.

Now it is intended to adopt on & off system. Basic impression of ayacutdars is not for this procedure. With 50 ricemills in Gangavathi Taluka and with a strong Paddy Growers lobby, is our Irrigation Department capable of adopting 'on &off' which directly influences the plantation of paddy and sugarcane. The adoption of this procedure, to be taken after caraful change in cropping pattern, mass meeting among the ayacutdars and strong protection to the field staff.

4) The political interference of MLAs, MPs, ZP (Zilla Parishad) members and Ryot Sangha pressurise the unauthorised operation of POs and subdistributaries, which directly affects the water management. The operation of sluices should be free from such pressure. This point is to be clarified with political leaders.

5) The contractors. Now, the Section Officers are facing difficulty to extract work from the contractors. Either they bring political pressure or official pressure or even blackmail us with our personal matters. Hence, we request our Higher Officers to use the Clause of Black-listing of contractors who misbehave and violate the Agreement executed. To safe-guard the interest of government work, the Executive Engineer should check measure the works exceeding Rs.15,000 invariably.

6. Police squad for ID. A separate police force is required for maintaining law & order in implementing the Rotation and New Systems introduced. Even, we find difficult to stop the ayacutdars damaging the structures in front of us. Police requires witness, for which the local people are not ready. Hence, a permanent separate police squad is required.

7. Fresh appointments of gangmen, sowdies, work inspectors and Irrigation Inspectors to be done urgently. The sanctioned strength pattern to be revised practically and necessary job opportunities to be increased to meet the demand of ayacutdars.

8. Proper communication system is required and quick operation of sluices both on main canal and distributaries. Preferably wireless system as in UKP (Upper Krishna Project) is required.

9. Sufficient trainings regarding management in the Institutions like KERS KRSagara and WALMI Dharwad to be conducted and each Section Officer to be deputed compulsorily.

10. Regular grants allotted to each Division is equal to the payment wages of staff. For works separate additional grant is requested every year to government. This may be avoided by impressing the government the actual requirement of grants for canal maintenance works.

11. The I.D. has ayacut roads maintained at Rs.1000/- per kilometer for annual maintenance. It is requested to increase AME cost to Rs.6000/- per km to meet present hike in prices. It is pity that our I.D. is unable to get either HKDB (Hyderabad-Karnataka Development Board) funds or other development funds for the roads. We are facing difficulty to answer the questions of ayacutdars and MLAs to maintain the roads fit for vehicle movement. This may be viewed seriously.

12. T.A. admissable per month for each Section Officer and below is not sufficient to meet the vehicle expenditure like petrol, oil, repairs, etc. This may be increased to keeping in view the petrol rate and the jurisdiction of the Section Officer and below.

13. Sufficient survey instruments, machineries like Zerox copiers, computers, well conditioned Tipper, lorries and all Diesel Jeeps to be made available in each Division. To attend emergency works like breaches, bongas and night water management, the present vehicles are not in good condition. O&M subdivisions are not capable of repairing the vehicles quickly and many vehicles are kept idle for want of repairs.

The above points are for your kind consideration. Sir, with good faith, we have envisaged the above to implement as soon as possible. Thanking you, Sir,

Yours faithfully <21 Section Officers>

on the input, output and processing business sectors, in terms of economic growth and employment generation. These may be expected to be larger in the case of 'productive irrigation' than for protective irrigation.[7] The overall benefits (and poverty alleviation effects) of 'productive irrigation' may thus be larger than those of protective irrigation.[8]

A problem with the evaluation of these different views is that the data base for it is extremely small. To my knowledge the references given exhaust the material available that directly addresses this issue. Moreover, apart from the quantitative question, which is complicated enough, there is a qualitative question on the type of agrarian change that a government or any other agent desires to promote. In this different factors than growth and employment effects may play a role (also see the discussion of equity and sustainability below).

In the maximisation of benefits perspective, the problem to be solved is the contradiction between the government objective to spread water and maximise production per unit of water, and the farmer's objective to maximise production per unit of land (see chapter 3). The policy instruments logically associated with this perspective, with private ownership of land taken as given, would be price and market regulation in favour of 'irrigated dry' crops.

On the whole however, the policy emphasis is exactly the reverse. Rice, together with wheat, is an essential commodity in the government's Public Distribution System (PDS), which intends to guarantee a base supply of foodgrains (and other commodities) to poor households. This involves support prices and procurement by the government of these foodgrains (see Mooij, 1996). The existence of the PDS system is one factor that explains the attractiveness of rice cultivation as against other foodgrains. To my knowledge considerations of water management reform have not played an important role in decision making on agricultural prices and marketing policies.

Perverse incentive structures

The third perspective on the need for management reform in protective irrigation focuses on the incentive structure for water use and its management. The common denominators of the problem definition in this perspective are inefficiency and low performance. There are several strands in the argument about incentive structures, efficiency and performance.

One strand is that the State governments can no longer continue to finance the operation and maintenance of the canal irrigation systems in the way that they do now. The systems are under-financed, and management quality suffers from this. Cost recovery from the farmers is a must to manage the systems better in the future, so goes the argument (*Report of the Committee on Pricing of Irrigation Water*, 1992/1994:2.2 and 3.3; Svendsen, 1991; Svendsen and Gulati, 1994; World Bank, 1991).

This argument may be combined with the hope or assumption that higher payments for water will induce farmers to use it more efficiently. Advocacy of volumetric pricing is therefore often part of the argument.[9] It is however very doubtful whether water prices can

---

[7] For example in the case of the emergence of cooperative sugar factories (see Attwood, 1993).

[8] A limitation of Rath and Mitra's argument that is relevant in this respect is that they do not distinguish between family labour and wage labour in their estimation of labour required for crop cultivation. For the overall economic effect it is important whether irrigation mainly generates self-employment for farming households or wage employment for agricultural labourers.

[9] Calls for volumetric pricing go back at least 100 years (see chapters 3 and 8). Scattered calls for it can be traced in later periods. One example is Azeemuddin (1947) who preferred volumetric (continued...)

be increased to such a level that they will influence farmers' decisions on the quantity of water use (see R. Bhatia, 1992 for a critical review of the arguments; also see Oorthuizen and Kloezen, 1995 for general discussion).

Financially autonomous irrigation agencies are another element of this line of thought (*Report of the Committee on Pricing of Irrigation Water*, 4.5; also see Merrey, 1995 for general discussion). Then the focus is on accountability relations: the management institution's survival depends on the payments made by farmers, and farmers need to pay to get a service. It is argued, in my view very plausibly, that financial relations can be a very strong mechanism in the creation of stronger and more balanced accountability mechanisms between managers and users.[10)]

However, the ability to pay and withhold payment is not distributed equally over different categories of farmers, and therefore a financial perspective on accountability may be insufficient to address accountability and distribution issues within the community of water users.

Yet another strand of the financial reform argument focuses on rent seeking activities by the bureaucracy, that is corruption. Because water is a scarce resource that in India's canal irrigation systems is priced far below its economic value, system managers can capitalise on their control over the distribution system and extract illegal payments from farmers. In this way a vested interest on the management side is created in uncertainty of water supply and generally in poor management as compared to the formal distribution policy (Repetto, 1986; Wade, 1982a).

Some people believe that rent-seeking can only be eradicated by pricing water at its economic value (and thus remove the rent's economic base) or by the removal of water scarcity. The most radical reform proposal in this respect has been forwarded in Burns (1993). This author proposes to eradicate rent seeking activities by the removal of water scarcity. He suggests to define and physically concentrate a group of core water users who receive sufficient water also under conditions of drought, and who pay water charges that cover operation and maintenance costs. The non-core part of the system will only receive the surplus water after the core area has taken its share. This implies zero supply in situations of drought.

Less radical reform strategies would favour financially autonomous irrigation agencies with increased water charges to cover at least operation and maintenance cost, and would argue that through increased accountability the management performance of the managing institutions would be improved and rent-seeking reduced.

The Tungabhadra Left Bank Canal case suggests that rent-seeking may, in some cases, not be the major issue in water distribution, at least not in the direct sense that bribe payments are the dominant mechanism in resource distribution (see chapter 7). It thus fundamentally

---

[9)](...continued)
delivery and pricing in new projects in Hyderabad State, but he feared that the Indian farmer was not 'advanced' enough for this. Instead he argued for a betterment levy, and to avoid wastage he wanted payment per watering or per crop.

[10)] The first effort with a financially autonomous irrigation agency in Karnataka, the Krishna Bhagya Jala Nigam Limited (Nigam for short) does not seem to be very promising. It should be noted that this company was primarily established to attract investment funds for the construction of the Upper Krishna Project (*Times of India*, 20 March 1995), that the staff of the Nigam is deputed from government agencies, and that the government has guaranteed the returns to the shareholders' investments.

questions whether the rent-seeking argument can be the basis for water management reform proposals. However, acceptance of the rent-seeking argumentis not a condition for the recognition of the importance of financial incentive structures.

Equity

The fourth perspective on the need for management reform in protective irrigation focuses on the equity issue. It argues that unequal water distribution and unequal spread of the benefits of irrigation (either regionally or over categories of people) is unacceptable. In chapter 3 I analysed how concerns of famine prevention and social stability lay at the basis of the concept of protective irrigation, and how these have been taken up in the post Independence development discourse. Poverty alleviation, the regional spread of development efforts and resources, and the reproduction of the state's legitimacy are arguments that can be used in favour of protective irrigation. For tailenders equity is also a highly relevant argument. To them it is not clear why others should get a larger share of the water.[11)]

Equity has become a prominent element in the irrigation policy discourse since the first wave of national and international management reform debate in the 1970s and 1980s. The policy initiative in which equity objectives have been most prominent is the organisation of water users in water users associations at outlet command area level as part of the Command Area Development (CAD) programme in the 1970s and 1980s (see chapter 9 and below). Its resonance with the populist nature of the Indian polity should be evident (see chapter 3). However, or maybe because of this, the equity objective has not been operationalised very clearly. Noticeable about the Indian irrigation management reform debate is that the issues of water rights reform and/or land rights reform have hardly been taken up (see Chambers, 1994). Such reforms would directly affect the entitlement structure with regard to water, and thus very directly confront equity issues. It is undoubtedly true that in the Indian context these are very difficult avenues for change, particularly in canal irrigation. However, when equity is a central concern or stated objective, more discussion on strategies to achieve it would be warranted.[12)]

Democratisation

A fifth argument for management reform in protective irrigation focuses on the democratisation dimension of decentralisation. Advocacy of decentralisation is often associated with equity, efficiency and cost recovery objectives. In those approaches decentralisation serves as an instrument to achieve other objectives. Decentralisation can also be an argument in its own right. In such a perspective the political dimensions of decentralisation are emphasised. It is seen as a way to institutionalise more democratic and more localised forms of development policy making, planning and implementation.[13)]

[11)] A continuation of the present management practices in the Tungabhadra Left Bank Canal is likely to lead to slow but steady further concentration of water use in head end regions at outlet, distributary and main canal level. That this process is ongoing at main canal and distributary level is suggested by our fieldwork in 1996-97 in a larger number of distributaries spread over the Tungabhadra Left Bank Canal command area.

[12)] There are examples of delinking water rights and land rights for example, but these have not been able to put the property rights issue on the canal irrigation policy agenda. Also see footnote 46.

[13)] This can be further illustrated with Meinzen-Dick's discussion of the terminology and policy trends in the debates on the devolution of irrigation management (Meinzen-Dick, 1996). She gives (continued...)

Democratisation might be considered a particularly relevant issue in Karnataka, because Karnataka has a relatively strong tradition of decentralised governance (for discussion see Aziz, Nelson and Babu, 1996). However, to my knowledge this perspective on decentralisation does not play an important role in discussion on irrigation policy in the State.[14)]

The main policy instruments associated with this perspective would be the creation of a multi-tier system of federated water users association, or other organisations, to which real powers would be devolved (rather than being an extension of the government bureaucracy). Even when this structure could be created an important question would be whether and how the possibilities for more constructive and balanced negotiation of water resource distribution would be captured.[15)]

An important, but in my view underemphasised, dimension of decentralisation (whether it is advocated from political or more instrumental perspectives) is the technology required to make instititutional decentralisation possible. Put differently, how can supply-oriented large canal systems be decentralised hydraulically? I have argued that the present technical infrastructure of the Tungabhadra Left Bank Canal is not particularly suitable for the regulation of scarcity distribution and flexible types of management (see section 10.1).[16)]

Ecological sustainability

A sixth argument for management reform has to do with the ecological effects of large scale irrigation systems. Over the last two decades these have been heavily criticised for their negative environmental impact (Dhawan, 1990; Singh, 1997). When we look at existing canal irrigation systems, the ecological critique concerns two main issues: *(i)* waterlogging and

---

[13)](...continued)
the following definitions. "Decentralization attempts to improve the management of natural and fiscal resources by moving both decision-making authority and payment responsibility to lower levels of government (...) Privatization refers to the transfer of ownership of resources from the public sector to groups or individuals (including for-profit firms). Participation and democratization seek the involvement of citizens affected by programs, for social goals of empowering local people as well as goals of improving program performance. Within the irrigation sector, irrigation management transfer (IMT) or turnover generally refer to programs that shift responsibility and authority from the state to non-governmental bodies (...) --a 'rolling back the boundaries of the state'. (...) Participatory irigation management (PIM) refers to programs that seek to increase farmer's direct involvement in system management--either as a complement or substitute for the state role. (...) Either approach leads to some form of joint management of irrigation systems, with the state responsible for more tasks at higher levels of the system, and farmers' organizations responsible for more at lower levels (...)." (*ibid.*:2-3)

[14)] The only instance I know in the Tungabhadra Left Bank Canal was referred to in chapter 9. In 1989-90 the elected District Council (*Zilla Parishad*) president called for putting irrigation management under the control of that and lower bodies.

[15)] For an example of a multi-tier organisational structure of Water Users Associations see Shanmugham (1991) on the Lower Bhavani project in Tamil Nadu.

[16)] The most comprehensive attempt at the re-design of a large scale canal irrigation system that I know is Paranjape and Joy (1995). It refers to the Sardar Sarovar Project in Gujarat, and one of its most original features is the combination of large scale canal irrigation with local watershed management. Also see the discussion below.

salinisation, and *(ii)* the negative environmental effects of high external input agriculture (for discussion of these issues, see for example Shiva, 1988 and Nanda, 1991).[17]

The solution of both issues involves management reform. Waterlogging and salinisation are related to poor maintenance of canal infrastructure, the absence or poor state of drainage, overirrigation and other factors. In many cases waterlogging and salinisation can be controlled by proper management practices in operation and maintenance.[18]

The control or prevention of the negative environmental impact of high external input agriculture (with regard to soil fertility, health, pollution and ecological diversity) requires changes in farming system management. These are partly related to irrigation management. For example, water availability influences crop choice and the occurrence of pests and diseases, and the double cropping that reservoir-fed canal irrigation allows reduces fallow periods, which negatively affects nutrient balances.[19]

The policy instruments associated with this argument for reform are the same as in the previous reform perspectives and depend on how one thinks that 'good water management' can be accomplished. For the stimulation of ecological agricultural practices separate policy instruments are required.

Towards a comprehensive view

The different reform perspectives outlined above are associated with different concepts of development and different 'political projects'. The 'manage as planned' and 'economic benefits' perspective are both associated with strong concepts of planned development by the state, with technocratic and meritocratic overtones. It was dominant in the first decades after Independence, but is now under question.

The 'perverse incentive structures' perspective is associated with the neo-liberal development programme, which emphasises a reduced role of state institutions, and the introduction of the market mechanism. It is on the rise, though more so at the level of policy discourse than policy practice. The importance of water pricing and the potential benefits of contractual arrangements for water delivery are also increasingly acknowledged by people who do not subscribe to the neo-liberal development programme.

The 'equity', 'democratisation' and 'ecological sustainability' perspectives could be seen as the progressive agenda for canal irrigation reform. They have appeared in the order that they were discussed. Though the situation varies from State to State, I would like to argue that this progressive agenda has not or insufficiently translated into a coherent concept or

---

[17] Much of the environmental critique is directed against the construction of new projects, like the Sardar Sarovar project referred to above. Additional issues like the submergence of agricultural land, forest and settlements with the related displacement of people, then occur.

[18] Also in this case the problems and their solutions are locally specific. For example the situation in an alluvial plain like Haryana (North India) with some parts located in a basin from which drainage is impossible, and a gradual import of salts by irrigation water (see Jacobs, de Jong, Mollinga and Bastiaanssen, 1997), is totally different from a situation like the Tungabhadra Left Bank Canal, with considerable relief and in principle sufficient drainage capacity, and the salts being mainly resident salts which are mobilised by irrigation (see *Report of the external review*, 1997). Improved drainage, which is part of the solution in both cases, has received comparatively little attention in India.

[19] The NGO AME (Agriculture Man Ecology) has documented the effects of intensive irrigation on soil fertility in the Tungabhadra Left Bank Canal. A presentation of their results in December 1997 (in Bangalore and Munirabad) showed that the situation is worrying. I did not have access to the final report of their work at the time of writing this chapter.

approach at the level of management reform discourse and practice. Only the equity concept has been incorporated in the official Indian canal irrigation policy discourse in a visible way. The ecological issue is mainly seen as a problem. The initiatives that have been taken in this regard by governmental and non-governmental organisations have remained rather localised and isolated.[20]

However, there is change in this respect. On the basis of experiments with (canal) irrigation development and reform that have been done in the States of Maharashtra and Gujarat, and the opposition to the Sardar Sarovar project, a more comprehensive formulation of a progressive agenda for canal irrigation reform has been undertaken. I refer to the approach that has been published under the title 'banking on biomass' (see Paranjape and Joy, 1995; Datye, 1997). I briefly discuss the main elements of the approach, to suggest along which lines progressive theory and practice regarding canal irrigation might be developed.[21]

The first element of the approach can be derived from the following quotation.

> It is generally found that in watershed development schemes local groups as well as development administration tend to concentrate on the *in situ* measures to the exclusion of water source development for water application. On the other hand irrigation projects give scant attention to local resource management and exogenous water is seen not as supplement to primary ecosystem productivity that it should be but as a substitute for it. The need is to integrate them both within a coherent perspective. (Datye, 1997:57)

The dichotomy between rainfed agriculture and (canal) irrigated agriculture needs to be transcended. In this approach the sustainable (in Datye's terms regenerative) management of local resources should be a precondition for the availability and use of 'exogenous water' like that provided by a canal irrigation system. Such an integrated approach to water resources development can lead to substantial increases in resource use efficiency.[22]

The second element of the approach refers to the social dimensions of sustainable resource use. It can be derived from the following quotation.

> Equitable access to water necessary for ensuring livelihood needs to be treated on par with employment guarantee and the right to work as part of the larger right to an adequate livelihood. (...) water necessary for drinking and domestic use, for regeneration and for the livelihood component including special measures for the disadvantaged sections represents a priority claim on water resources in the area, and

---

[20] It is significant that most publications that could be classified under the 'progressive agenda' are case studies of local initiatives and experiments (see for example Singh, 1991; Sivamohan and Scott, 1994). There is hardly a more generalised debate. Maloney and Raju (1994) and Ambler (1994) could be considered as exceptions. More significant is that in canal irrigation there is to my knowledge no example of local initiatives and experiments that have developed into a broader movement, like, for example and as comparison, the well recharge movements in Gujarat (see Shah, 1997).

[21] For the summary below I made use of Linden Vincent's discussion notes on the paper based on the *Banking on biomass* book (Datye *et al.*, 1997). The paper and notes were presented during the IDPAD (Indo-Dutch Programme on Alternatives in Development) 'Managing water scarcity: experiences and prospects' conference in Amersfoort, the Netherlands in October 1997.

[22] The author claims that "by the integration of external sources of irrigation water with 'local' water harnessed from the watersheds and conserved *in situ*, it is possible to raise the productivity level of total available water for productive use to levels three times that of 'external' irrigation water." (Datye, 1997:142) These and other statements are backed up by empirical evidence and calculations on the basis of existing technologies.

> only after these claims have been met can the water be available for commercial use. The policy is to ensure a minimum livelihood for all and to regulate all resources necessary for this, and leave the rest of the resources to be freely utilised by the enterprising. (*ibid.*:58)

The approach defines a basic water right for all, and delinks water rights from land rights. In strategic terms the approach wants to allocate 'new water', that is water that has become available through efficiency gains and ecosystem development, to the resource poor. The approach is a positive-sum variant of hydraulic property creation (Coward, 1986a&b). Those who have (collectively) invested in the generation of new resources by optimising existing resource use, gain rights in these new resources.[23]

The third element is the ecological sustainability-with-growth element. Characteristic of the approach is that it not only advocates ecologically sound techniques for agricultural production, but conceptualises agriculture as a system of 'regenerative biomass production' that provides the bio-energy not only for sustainable agriculture but also for dispersed industrialisation.[24] The production strategy emphasises production of crops that can serve as the inputs for small industries, like tree crops. The approach wants to 'move beyond subsistence' and wants to provide an agricultural *cum* industrial perspective of sustainable growth.[25] Part of the approach is an argument for non-subsidised prices for external inputs in agriculture, subsidies that help the detrimental effects of high external input agriculture to pertain. The approach proposes the (gradual) removal of subsidies on electric power and the introduction of a progressive tariff system, volumetric water supply and cost recovery, while price support for coarse grains is advocated.

The fourth element is the methodological one. There is a strong emphasis on decentralised and interactive planning and decision-making, including an emphasis on elements like people's science, participatory technology development, and resource literacy.[26] However,

---

[23] The authors recognise that the acceptability of equitable access to water is a "most troublesome point" (Datye, 1997:130), but several examples are cited where this has been achieved in practice. The general finding in the cases reported is "that where access to water resource is seen to come about clearly through collective action, and where there are no previous entrenched water rights, farmers are not averse to equitable sharing arrangements." (*ibid.*:132) In terms of social reform the approach chooses to move away from a primary focus on land reform as a precondition for agrarian change. "The alternative paradigm presented here suggests another route -- that of augmenting the subsistence base by harnessing and generating new productive assets and ensuring access to them in the course of development in building up common resource pools through the development of wastelands and water, and by a policy of tying availability of public funds with the conditionalities of creating rights and access for the rural poor to the common pool resources of water and biomass. Combined with an overall improvement in the availability of water and efficiency of water use along with increased productivity of land and water, conflicts can be minimised though, of course, not entirely eliminated." (*ibid.*:261) This aspect of the approach is likely to spark a lot of discussion, particularly from a gender perspective. For the importance of control over land for gender equality see Agarwal (1998). Also see NEDA (1997).

[24] The publications referred to contain descriptions and calculations of biomass based power generation, in relation to the power required for lift irrigation that is part of the agricultural system for example. In general, the approach also emphasises the use of local materials, for example in canal lining and weir and small dam construction (see Gore, 1998).

[25] In this respect it goes one step further than approaches like those described in Chambers, Saxena and Shah (1989) for example, though many of the individual elements are similar. There is also a greater emphasis on the technological prerequisites in Datye *et al.*'s approach.

[26] The publications referred to do not discuss these methodologies in detail. For more elaborate treatment see for example Chambers, Saxena and Shah (1989), Shah (n.d).

despite the statement that "the policy framework and implementation of the post-Independence programme in the water, energy and infrastructure sectors lack all the components of the policy frame proposed here." (*ibid.*:266), the publications contain no description of a strategy to achieve the policy reform and/or broad-based social activism that is necessary to create more favourable conditions for large(r)-scale implementation of the approach.

Elements of Datye *et al.'s* approach can certainly be questioned, and some of these questions have been hinted at above. However, it makes an in my view highly original attempt to combine the concepts of integrated water resources management, ecologically sustainable agriculture, agro-industrial growth, equity/poverty alleviation/social security and decentralisation/democratisation. It broadens the Indian debate on canal irrigation reform in the following way.

1) It situates canal irrigation reform in a broader rural development strategy, and doesn't look at canal irrigation as a self-contained phenomenon.[27]
2) It links canal irrigation development and watershed development (it takes an integrated water resources management perspective), and links this to decentralised and democratic forms of planning and decision making.
3) It emphasises the importance of water rights (and property rights in resources in general) as central for a development strategy that targets the resource poor.
4) It gives detailed attention to the technological dimensions of the development strategy.

Conclusion

The main conclusion that I draw from this review of irrigation management reform perspectives is not only that there are good reasons to advocate reform in protective irrigation, but also that, in contrast to what some observers think (see Burns, 1993), these reforms are not impossible to achieve.

The difficult question to be answered remains "what the conditions [are] in which a group of people will voluntarily subscribe to a rule of restrained access to irrigation water?" (Wade, 1988b:489) The discussion of Datye *et al.*'s approach suggests that this problem can be addressed, but that it should not be addressed in the context of canal irrigation management alone. The problem should be situated in a broader approach that looks at the role of water in rural development, and employs strategies that address water rights issues and moves beyond subsistence and agriculture.

Interesting about Datye *et al.*'s approach is also that it incorporates elements of several of the other reform perspectives: an emphasis on productivity growth, employment cration, resource use efficiency, and non-subsidised pricing. This implies that it can possibly speak to the concerns of a number of different political constituencies. The major strategic question it seems to me, is how an approach along lines like Datye *et al.*'s can be linked to the concerns of these different constituencies, and linked with, be taken up by, or develop into wider movements for social transformation. This is discussed in some more detail below after looking at the process dimensions of the irrigation policy (reform) process in Karnataka.

---

[27] It can also be noticed that Datye *et al.*'s approach incorporates some of the opportunities for reform identified in section 10.1, most prominently the self-governance and technological creativity elements.

10.3 THE IMPORTANCE OF PROCESS: THE PIM REFORM INITIATIVE IN KARNATAKA

In this section I shift focus from what should happen to what is happening at the level of policy reform. I discuss the recent policy reform process in the State of Karnataka that aims to introduce the concept of Participatory Irrigation Management (PIM) in canal irrigation.[28)]

In Karnataka a reformulation of irrigation policy is in the making that may signify a qualitative departure from earlier approaches to management reform. In October 1995 the Government of Karnataka appointed an Expert Committee to "study the requirement of amendments to relevant Acts and Rules for constitution of CAD [Command Area Development] Boards, State CAD Council and Farmers Associations." (Government Order ID 35 CAM 95 of 27.10.1995) The main assignment of the Expert Committee was to prepare proposals for the implementation of Participatory Irrigation Management (PIM).[29)] The core elements of the Committee's proposals, published in an interim report in May 1996, were the following (*Interim Report*, 1996).[30)]

1) The establishment of contractual relations between the Irrigation Department as a supplier of water and WUAs (Water Users Associations) as buyers of water through volumetric supply and charging, and explicit water rights to be given to WUAs.
2) A much higher degree of self-governance for WUAs than previously considered. This involves, among other things, that powers regarding canal construction and maintenance and the regulation of water supply previously with the Irrigation Department are to be delegated to the WUAs for the area covered by them, that larger units of organisation than the pipe outlet command area are envisaged, that assessment and collection of water fees is to be done by WUAs, and that there will be freedom of crop choice within the WUA area. Federation of WUAs is foreseen.
3) A reorganisation of the CADA (Command Area Development Authority) governing bodies and the Irrigation Consultative Committee, to increase participation of water users representatives.

In June 1996 a High Level Working Group was appointed to initiate action on the recommendations of the Expert Committee. Mid-1997, when this section was drafted, the proposals for amendments to the relevant Acts and Rules and implementation of a PIM programme through pilot projects were very close to formal acceptance, but were not yet confirmed fully at Cabinet and Parliament level. The discussion below may therefore run ahead of events.

I interpret these proposals as a qualitative break with the past because some of the basic characteristics of irrigation management are rethought.[31)] Payment for water is related to

---

[28)] The concept is popularised at the international and national level by the PIM programme of the Economic Development Institute (EDI) of the Worldbank, and the INPIM (International Network for Participatory Irrigation Management), an NGO established under the patronage of the EDI. In India there is also a national INPIM chapter, registered as an NGO. The present policy reform process in Karnataka has partly been induced by the national level PIM concept, but also has its own dynamics (see below). On PIM, see the *INPIM Newsletter*.

[29)] Also see Government Order ID 137 CAM 95 (P) of 13 March 1996 that reconstitutes the Committee and adds terms of reference to this effect.

[30)] The final report was published in 1997 and contained few changes. I refer to the interim report because my copy of the final report was stolen.

[31)] In this respect developments in Karnataka are in line with those in other States. For a review of such efforts, see Raju (1997).

the quantum used, the powers of the Irrigation Department are reduced and those of water users increased, and localisation is officially abandoned, but replaced with a different system of water rights. There are many ifs and buts in the concrete operationalisation of these proposals, but these are not the focus of my attention in this discussion.[32] I want to zoom in on the *process* of policy formulation and implementation.[33]

The policy formulation process

With regard to the process of the formulation of this new policy it is remarkable how few people are involved in it, and how strong the element of contingency seems to be. This can be clarified by looking at where the PIM policy initiative came from. A number of factors have contributed to its existence.

One factor is the pressure for management reform from actors outside the State, notably the Government of India and the World Bank. Mechanisms to influence State policies by these outside agents include policy agreements by conferences of State Ministers at all-India level, the allocation of funds for the CAD programme (which is a central government supported programme), and conditions attached to financial support for the implementation of construction projects and other financial assistance.

The National Water Policy formulated in 1987 which advocates participatory forms of management was accepted by a conference of State Irrigation Ministers. The possibility to levy water charges on a volumetric basis was included in Karnataka law as part of the agreement for World Bank funding for the Upper Krishna Project, a large scale canal irrigation system under construction in north Karnataka.[34] The appointment of the Expert Committee in Karnataka seems to have been triggered by the Government of India's linkage of the continuation of funding for the CAD programme to the implementation of a PIM programme.

In a more general sense, and this is the second factor, there is a constant inflow of ideas on management reform into the State through the actors mentioned above, and through other mechanisms like visits to other parts of India, or countries like Mexico, by senior government officials to study experiments with irrigation management turnover.[35] Also NGOs play a role in the dissemination of knowledge about reform processes and experiments in other States. Finally, numerous conferences and seminars are held on management reform.

Thirdly, to explain how and when such external and general ideas and initiatives are internalised in the State policy process, the most important factor seems to be that a few people who are motivated to carry these ideas forward occupy the right positions at the right moment. The process of the PIM policy formulation seems to take place in a very small

---

[32] It is too early to discuss them in detail because the arrangements finally agreed upon are not yet clear. The details have been negotiated at length and thus contain many compromises. The proposals are more the possible beginning of a new direction to irrigation policy than a full-scale overhaul of the present situation.

[33] The discussion below is based on interviews and discussions in 1996 and 1997 with people involved in the policy process, study of the documentation of the process as far as available to me, and some field observations.

[34] See Karnataka Act No.16 and No.21 of 1995, which amend The Karnataka Irrigation (Levy of betterment contribution and water rate) Act, 1957.

[35] Such study visits in India were undertaken by members of the Expert Committee. A CADA Administrator visited Mexico and wrote a paper on the Mexican model (Ujjankop, 1995).

circle at a high level in the government administration.[36] There is no public debate accompanying it, and there seems to be no organised lobby for it from within the administration, nor from civil society by groups of water users, farmers movements, NGOs or other actors. The policy formulation process for the Participatory Irrigation Management programme thus is highly non-participatory, in the sense that some of the major stakeholders, particularly farmers, are not involved in it.

As a result, the policy initiative in my view is a very fragile initiative. A few unfortunate transfers or replacements may in fact paralyse it. There is a kind of catch-22 situation. Policy changes are required to create space for greater involvement of stakeholders in water management policy making and implementation (at all levels), while such greater involvement is itself a precondition for the creation and particularly the consolidation of that space. The ways out of this situation are 1) to hope that a fortunate constellation of people and ideas lasts long enough to translate the initiative into Acts, Rules, government orders and a sufficient number of experiments to trigger an ongoing process of change, and/or 2) to try to contribute to the emergence of an articulated demand (from the field and the executing institutions) for policy change, that is a bottom-up policy or policy support initiative.

The neighbouring State of Andhra Pradesh may be providing an example of the first way out. Since 1996 a prescriptive process of irrigation reform is implemented in that State with great vigour. The reform process involved the adoption of a new law on participatory irrigation management (the *Andhra Pradesh Farmers' Management of Irrigation Systems Act, 1997*). According to one of its authors, the central elements of the act are the following.

(a) Gives water rights and control of the irrigation systems [to farmers organisations];
(b) Provides for functional and administrative autonomy to the associations;
(c) Makes irrigation department (ID) accountable to the WUAs. The competent authority, who is a person from ID and attached to a group of WUA has to implement the decisions of the WUA;
(d) Enables WUAs to resolve conflicts within themselves;
(e) Attempts to improve the irrigation systems to become more effective as it is to be done by the WUAs only;
(f) Allows access to information to the WUA on scheme operations;
(g) [Allows farmer influence on] preparation of the operational plan and the maintenance;
(h) Provides freedom of cropping pattern to farmers. (Peter, 1998:10)

Elections have been held for more than 12,000 Water Users Associations, and a rehabilitation programme controlled by farmers is being implemented. There will be a three-tiered system of WUA federation in each canal irrigation system (WUA, Distributary Committee, and Apex Committee). A massive media and training programme is part of the

[36] The Expert Committee consisted of the Additional Chief Secretary and Development Commissioner (chairman), an Assistant Professor of the Water and Land Management Institute (WALMI) was the member-convenor, and members included (deputy) Secretaries to Government from different departments (Law, Finance, Cooperation, Planning, Agriculture and Irrigation), some of the CADA Administrators and some CADA Land Development Officers (Engineering). When the Committee was reconstituted in March 1996 some Chief Engineers also became members. An Advisor to the Government on water and irrigation issues also attended the meetings. See Chambers, Saxena and Shah (1989:239-241) on the alienation of policy making from practice, and for proposals to remedy this.

process. The formulation and introduction of the programme was accompanied by intense campaigning within both the ruling and the opposition parties.

The political support for this programme comes from the Chief Minister of the State, and it is one of the elements of the present Andhra Pradesh government's 'new people's movement' *Janmabhoomi*. It is described as a new freedom struggle "to liberate our people from morass and despair, restore the lost values and build an egalitarian society based on the principles of equity and sustainability." (*Janmabhoomi* brochure of Government of Andhra Pradesh, p.4)

The interesting point for the discussion in this chapter is that the Andhra Pradesh case seems to show that it is possible to make canal irrigation reform part of a populist, and Gandhian, political agenda for social transformation. The process of implementation was not longer than one year at the moment this was written, and therefore evaluations of the effectiveness of the programme can not yet be given, but considerable expansion of irrigated area seems to be the result of the devolution of power and resources to WUAs (Peter, 1998:6). The architects of the policy hope to make the process irreversible in a period of 2-3 years. How the programme will attempt to address distributional issues is unclear. Apart from prescription of the constitution of the WUA on a territorial basis, the internal processes in WUAs do not seem to be the major focus of attention. Whether equity and sustainability issues are addressed is therefore a question.

It would be interesting to know the pre-history of to this drastic policy change and vigorous implementation (see Peter, 1998 for the sequence of events once the initiative was taken). There seems to have been a strong element of contingency, that is, some individuals who captured the possibility for such a programme when the opportunity was there.

There are few indications that a similar process might happen in Karnataka, though it is the nature of this type of policy initiative that it is somewhat unpredictable. Therefore a process of coalition-building to create a support basis for a canal irrigation reform agenda seems the only way forward in Karnataka, and perhaps in other places as well (see below for more discussion).

The policy implementation process

The effect of the isolated policy making at the top in Karnataka is that a prescriptive style of implementation can easily persist. This can be illustrated by the way the new PIM initiative was implemented in the Tungabhadra Left Bank Canal.

Mid-1997 the first practical steps were taken to start the implementation of pilot experiments with PIM in Karnataka. A summary of our observation of a field-level meeting on PIM in the Tungabhadra Left Bank Canal command area is given in box 10.3.[37)]

Box 10.3 shows that the prescriptive style of policy implementation was very apparent. Lower level field staff was instructed to bring the PIM message to the farmers in the usual mode of top-down explanation and instruction. While at the level of policy making there is an awareness of the complexities that are part of the process of water users organisation, this awareness does not seem to exist at field level. There was no careful consideration of the unit

[37)] The conclusions drawn from this single observation were confirmed by later visits to other locations where such meetings were held. The fieldwork was done by R. Doraiswamy. For a critical evaluation of attempts to establish water users associations in the Upper Krishna Project, see Patil, Lele and Patil (1992).

Box 10.3: A PIM meeting in a tail end distributary

The Under Secretary to Government Irrigation Department (Command Area Development) in May 1997 issued guidelines for the implementation of PIM on a pilot basis to the Chief Engineers and CADA Administrators of the different projects in the State. As the first step in the implementation of the PIM programme in the Tungabhadra Project (Left Bank and Right Bank) ten pilot villages *cum* command areas were selected. Six of these ten sites had been part of earlier programmes to establish WUAs, and had formally registered WUAs already. Four were new villages/command areas. The selection criteria were, as far as we could ascertain, the size of the command area, and particularly the existence of a 'cooperative attitude' of the farmers. For one case it was reported to us that the village/command area was included on the specific request of the local MLA.

The CADA took swift action and organised meetings in the villages concerned in June and July 1997. We were able to be present at one such a meeting. The village/distributary command area was located in the tail end of the main canal. This was in contradiction with the intention at policy level that sites with not too problematic water supply conditions should be chosen. Furthermore, the meeting took place in the head end village, while the existing association was based in and had a chairman from the tail end village. The meeting place seemed to have been determined by the practical reason of accessibility by jeep. The meeting place was appropriate in so far that most farmers who irrigated in this distributary were from the head end village. The tail end village area hardly received any water. Apart from the chairman only head end farmers, about 20, were present at the meeting.

The farmers had been informed about the meeting a few days earlier. The Irrigation Department officer present at the meeting had heard about it the night before. This was due to the speedy implementation of the higher level instructions by CADA combined with leave of absence of his superior. The meeting was chaired by a CADA officer. Initially the meeting was rather one-directional. The chairman explained the contents of the new policy. It was clear that he was not very well informed about its content. This was hardly his fault because not all the details of the policy were decided at that point of time (one example was the composition of the management board of the new WUA).

The farmers were very quick to notice the problem of the quantity and the stability of water supply from the main canal. The Irrigation Department officer correctly argued that a stable supply could not be delivered because of interventions upstream in the system that his division was unable to influence. The chairman told him to determine a supply that he could guarantee, and thus more or less ignored the issue. The head end farmers had some fear that they would lose water in the new situation, but the head-tail issue was not appreciated and left undiscussed.

A large part of the discussion focussed on the most concrete aspect of the policy: the need to make an estimate of the costs of the necessary technical repairs and improvements of the canal system before the management would be turned over to the farmers. The only concrete result of the meeting was that the chairman told the Irrigation Department officer to prepare such an estimate together with the farmers within a few weeks.

At the end of the meeting we asked whether a copy of the guidelines could be provided to the farmers in Kannada, the State's language. The chairman first reacted by stating that these guidelines were meant for the government officials and that farmers had no need for them. In the second instance he argued that there was a stationery problem in his office. He was clearly totally unprepared for this question. After the meeting we had some discussions with farmers that had attended the meeting, and it was clear that they had only very partially picked up the content of the PIM policy. Self-governance is a novel idea, and it takes time to explain it. However, when after the meeting we asked the CADA officers whether they would return to the village for further explanation and discussion, the answer was negative. They only intended to return at the occasion of a formally called meeting.

Box 10.4: Learning from farmers

Jaska: The irrigation engineer and myself visited this village, in the command area of a large irrigation project Dharoi in Gujarat, India, to find out if the farmers would be interested in PIM.

As soon as the farmers collected I asked the first question, as I always do: "First let me understand what is irrigation system that serves the farm lands of your village." Promptly the irrigation engineer unrolled his maps, three of them, one for each sub-minor. I said it would be difficult to understand the problems of this village if we have to look into 3 maps. In any case I wanted PRA approach to understand the local situation as farmers perceived it. I therefore suggested to prepare an irrigation map of the village. I always carry chart papers and sketch pens with me.

Farmers' first reaction usually is that they do not know how to draw maps. I then take up the pen and make a small round somewhere in the lower middle of the chart paper and tell them if this is the village site (housing area) let me know by which road we reached the village. Somebody would indicate by finger and someone else will take up the pen and draw it. At our prompting, more roads will be drawn and then the canals.

At this stage I found that one leader who was apparently more educated and articulate was speaking on behalf of all and therefore was a barrier to participation by more farmers. I therefore put my finger on a particular minor and asked who are the farmers at the tail end? A farmer raised his hand, I asked him to come forward and explain what was his situation about adequacy of water. He said he never got water! Obviously the leader could not speak on his behalf. Then I asked who else had land served by that canal. More farmers raised their hand and I asked them to come forward. The leader had to make room for them.

Farmer after farmer pointing out the location of his farm, narrated the problems they faced - problem of uneven canal bed, farmers in earlier reaches taking more water than their share, wrong location of outlet, gate in oulet missing etc. The leader only nodding his agreement with views being expressed by the farmers.

The second round of discussion was about PIM and to what extent the benefit that may be obtained from the scheme and whether the responsibility that would devolve on farmers was worth its while. That led to the issue - what needs to be done for rehabilitation of the scheme before turn over was considered between the farmers and the irrigation engineers. When the agreement was reached the issue came up about contribution towards the cost of rehabilitation. According to rough estimate by the irrigation engineer for the rehabilitation as indicated by the farmers may cost around Rs400,000 and expected 10% contribution would mean Rs.40,000.

The first reaction of the farmers is always that they were poor and they cannot raise such large amount. I then entered into discussion about the additional production that would result on account of rehabilitation and due to improvement in the water delivery system when managed by the farmers organisation that will be more sensitive to the changing needs of specific farmers. The rough calculation indicated that the value of additional production would be Rs.120,000 per year. This showed that the farmers would get back more than the amount of their contribution in the first year itself and thereafter they will have the benefit of additional income year after year. One of the farmers has business experience. I asked him "is there any honest business where you get back your investment in less than two years?" The farmers could see the implications of this discussion on cost benefit.

No major decisions can be taken about PIM in a three hours session of initial dialogue. It only prepares the ground for the 2nd, 3rd and the 4th round leading to acceptance of PIM with full understanding of benefits and costs not only of money but of responsibilities.

Source: Shah (n.d.: 4-5)

of organisation or the composition of the water users group in relation to the head-tail water distribution pattern in the distributary concerned. There was no attention to the communication process with farmers, and not a trace of an effort to start a process of joint problem definition and learning from past experience. The problem of reliable supply from the main system was more or less ignored.[38)]

If these events are any indication for how the new PIM policy will be implemented, the worst must be feared for its viability. We should be very careful however not to simply put the blame on the field level staff. The problem is one of general approach. The whole concept of prescriptive policy implementation needs to be questioned. This means that reform of the mode of operation of the government institutions should have a prominent place on the policy agenda.[39)]

That things can be done differently is illustrated in box 10.4, which describes the approach of an NGO working on PIM in Gujarat (also see Gosselink and Thompson, 1997 for a review of the use of participatory approaches in irrigation). However, not all NGOs active in canal irrigation follow such interactive approaches (see van Ommen, 1997 and Buggi, Hulagur and Shivamurthy, 1997 for critiques of NGO activities in Karnataka).

Though NGOs probably have a better record with regard to field level methodologies than government agencies, there are some limitations to their approaches in canal irrigation as well. The major one it seems to me, is the exclusive focus on *local* organisation, of farmers and other water users, at outlet or subdistributary level. This leaves the issues of main system management and institutional reform within the irrigation bureaucracy unaddressed.[40)] One dimension of this is the isolated nature of pilot experiments when undertaken on a relatively small scale (a small number in scattered locations, limited to outlet of subdistributary level), so that cumulative effects cannot occur.[41)] With regard to the role of NGOs in irrigation management reform there seems to be considerable potential to be tapped. However, NGO work should focus more than it seems to be now on building local countervailing power to address the problems located at higher levels of the system and in the policy making and implementing bureaucracy.

[38)] On the positive side it must be observed that the CADA took up the implementation of the PIM initiative with great speed and enthousiasm. A cynical mind would perhaps suggest that this was due more to the possibility of new resource flows than the content of the policy. There was some indirect evidence for this in this particular case. The WUA chairman's role seems to have been that of a middleman with regard to the securing of subsidies for lift irrigation for individual farmers through a CADA programme.

[39)] This issue is under discussion in the policy formulation process, but it is in my view not as prominent as it should be.

[40)] It may happen that NGOs successfully function as a third party (a resource broker, see chapter 3 and 7) that mediates between water users and the Irrigation Department and is able to exert sufficient pressure to improve and stabilise main system water supply during the period that it is active in a particular locality. However, it is sometimes difficult to consolidate this after the NGO leaves the locality. Access to administrative and political circles that NGOs may have to secure water supply, may not easily be taken over by local persons and institutions (but for an exception, see van Ommen, 1997).

[41)] The isolated pilot experiments are partly an artefact of irrigation policy. The Command Area Development programme that has provided funds for WUA formation by NGOs has defined the type and level of experiments to be undertaken in this way (see also chapter 9). The PIM initiative in Karnataka is designed along the same lines, although the unit of organisation is meant to be larger (several hundreds of hectares) than in the Command Area Development approach, where the unit was often the outlet command area (several tens of hectares).

Conclusion

The main conclusion that I draw from this section is that the policy process that is now designing 'participatory irrigation management' initiatives, should itself be more participatory. Interest groups should not only be involved in the local, implementation part of policies and programmes, but also in the process of policy formulation and programme design. Actors who work 'bottom up', like many NGOs, should make this a more prominent part of their approach and partly 'delocalise' their efforts. This could also contribute to the constitution of an articulated field level demand for policy reform.

Bottrall (1992) has formulated this course of action as follows. He argues that

> there could be a possibility of [an irrigation reform] agenda being incorporated into - and thereby reinforcing - broader-based movements for democratic reform. (Bottrall, 1992:245)

He argues that support for a reform agenda for the irrigation sector and bureaucracy might be found in different corners.

> Those currently opposed to the *status quo*, or with good reasons to oppose it, include finance ministries (concerned about IDs' never-ending demands on public funds); politicians and their constituents in regions disadvantaged by present patterns of water development (either through direct damage, as in waterlogged areas, or through long neglect, as in tank areas); environmental action groups; local issue-based groups (such as opponents of state water policies in Maharashtra); and non-agricultural water users, including urban domestic and industrial users, who suffer from the absence of efficient methods of inter-sectoral water allocation. (*ibid.*:244)

To conclude this section I reflect on the type of public action and leadership required to achieve a reform process that also addresses explicitly the issues of equity, democracy and ecological sustainability in local and supro-local resource use practices. The reflection consist of a quotation.

> The primary bottleneck [in superseding the private property interests of landlords and 'waterlords'], as with many other development problems in India, is organizational and political. Even the leftist parties in India, which in a few areas have some history of organizing peasants, are more oriented to price-tax-rent campaigns, limited land redistribution movements, and more recently to recording of rights of tenants and agitation for agricultural wage increases. Seldom is their attention directed toward developing productivity-oriented local cooperative organizations (for water management or for credit and social insurance). Even at the level of slogans the focus is on issues like 'land to the tiller' (and hence a perpetuation of the private property system) and not on the need for building cooperative institutions. It is, of course, far easier to agitate against existing inequality and oppression than to build from the ground up viable community organizations and to sustain them. The latter require a completely different kind of organizational resources and political-entrepreneurial skills which the present leadership of these parties is often ill-equipped to provide. Yet the need remains desperate. (Bardhan, 1984b:219)

What is stated here about the leftist parties can, *mutatis mutandis*, also be applied to other political actors. What I hope to have shown is that a progressive agenda for canal irrigation reform is possible and required. Who will come forward to occupy the political space created by macro-shifts in the Indian economy and polity, and integrate and expand localised efforts into a broader process of public action and institutional reform, is an open question.

10.4 A RESEARCH AGENDA FOR REFORM

The previous sections have tried to bring the 'water control as politically contested resource use' perspective to its logical conclusion with regard to its implications for action. I have questioned conventional concepts of planned intervention (on these see Long and van der Ploeg, 1989), and advocated a process-focused approach and outlined a particular standpoint on the nature of the reform required. In this concluding section I discuss which contributions academic research might make to the further development of this perspective and change processes by the presentation of a research agenda for reform.

I do not want to conclude with a long list of topics and questions that need further investigation. Instead, I briefly describe three thematic areas that in my view deserve more attention, and which need conceptual innovation as well.[42]

Canal irrigation technology and its design process

The first thematic area is that of the canal irrigation technology and its design process. The research started with a concept of technology that wanted to identify the social dimensions of physical artefacts. Particularly chapter 8 shows that this perspective can improve our understanding of water management practices. However, this is little more than a beginning that establishes the possibility of a social perspective on canal irrigation technology. More research on topics like intermediate storage and the choice of outlet structures (in relation to water management and water rights issues and on a comparative basis across the subcontinent) can help to address the technical challenges that irrigation reform is going to present.

With regard to the design process the starting assumption was based on social constructivist analyses of design processes in farmer managed irrigation systems in which NGOs or other irrigation agencies intervened.[43] The finding of that research has been that design processes generally are social processes in which different interests groups interact to negotiate the technical design. Though this was partly confirmed by the analysis of the design process of the Tungabhadra Left Bank Canal (see chapters 4 and 8). The analysis also showed that there is a lot on non-contested, top-down, engineer-dominated design work in canal irrigation, that there are no institutions for discussion and negotiation of design issues by the different interest groups, and that the professional orientation of engineers is not towards field level problems but the 'high tech' frontier of engineering.

I believe that any initiative for reform in canal irrigation, to have a chance of success, requires enrolment of the Irrigation Department engineers that manage the systems. One possible starting point for that enrolment is their technical professional expertise. The

[42] There is a fourth important thematic area, and that is the development of a social or political ecology approach to canal irrigation, at field and farm level as well as higher levels (the latter in relation to integrated water resources management). One of the important topics for research would be farmer responses to waterlogging and salinisation. However, this book does not provide material to elaborate this thematic area, and therefore I only mention it.

[43] Social constructivist analyses have so far hardly been applied to agency managed large scale systems. See chapter 2 for references.

features, history and meaning of that expertise need to be understood much better to be able to rethink it.[44)]

The politics of irrigation

The second thematic area of research that I want to highlight is what might be called the politics of irrigation, or irrigation as a political process. It was mentioned in chapter 7 that one of the weaknesses of this research is that the political networks relevant for water management were not investigated in full detail. Also here the analysis presented is more the identification of a research terrain than a comprehensive statement on the issue. Comparative research on the role of MLAs and other political actors in irrigation management, the intersection of political, administrative and hydraulic boundaries, and the functioning of local political networks would be obvious topics for further research.

Also the internal institutional workings of the irrigation bureaucracy were only partly analysed (see chapter 9). Particularly the coping strategies and styles of management of departmental staff who operate at the interface of the water users and bureaucracy are an important topic.

From a reform perspective these are questions about the forms of and possibilities for institutions in which different interest groups can discuss and negotiate the planning, design and management of the irrigation system.[45)] It is particularly relevant also for the emerging emphasis on integrated water resources management, where ways have to be found to negotiate the allocation and management of water with different functions and values.

Rights and entitlements

The third thematic area is that of the conditions for resource access and use. It includes the 'interlinked entitlements' situation with regard to canal irrigation water that was identified in chapter 6, questions about property rights in land, water and infrastructure, and the effects of these phenomena on poverty, social security, and class and gender relations. Research on these issues has developed strongly for farmer managed irrigation, but much less so for canal

---

[44)] For critiques of the water supply augmentation and infrastructure creation orientation of the Irrigation Department, see for example Santhakumar and Rajagopalan (1993) and Santhakumar, Rajagopalan and Ambirajan (1995).

[45)] I implicitly advocate what could be called a 'social contract' approach to reform here. During the IDPAD conference referred to above a trinity of models for reform was distinguished in the discussions. The two other models identified were *(i)* integrated water resources planning dominated by water resources specialists, involving, at the most, consultation of resource users, and *(ii)* the market and litigation oriented model which relies on the allocative efficiency of market or market-like mechanisms, and the force of law and jurisprudence. When it is accepted that the institutional structure and the behaviour of the water bureaucracy is part of the problem, the first model can hardly be relied on. It creates no mechanisms to question that structure and behaviour. The second model is also not a very attractive avenue. The introduction of water markets in South Asian canal irrigation does not seem a feasible proposition (see Moore, 1989 for detailed discussion; also see Wade, 1982a:320), and the paralysis of the legal system with regard to irrigation management has been referred to in chapters 3 and 7. The 'social contract' model seems to have more to speak for it. In other domains, like forestry, watershed management under rainfed conditions and minor irrigation, it has been experimented with with some success (see Chambers, Saxena and Shah, 1989). It is not a defence of a populist view of participation (see Scoones and Thompson, 1994).

irrigation.[46] Also here a comparative approach, across the subcontinent, would be needed, in consideration of socio-economic, political, agro-ecological and technical diversity (see chapter 3 for a first step towards a regional typology). A specific topic that emerges from this book is the role of migrant farmers in agricultural innovation and resource management.

From a reform perspective research on these topics would enable elaboration of the generally rather vague equity objective, and more insight in these phenomena may also affect the local level methodologies for irrigation reform by 'grounding' them more profoundly in local level social realities.

Conclusion

In 1997 a senior and highly placed irrigation engineer made the remark to me that what was required in Karnataka was not more research, but studies. Research to him was an activity of academics which generally had little relevance to the practical problems he and his colleagues faced in the irrigation systems. Studies in his mind were activities oriented towards practical problems with the aim to suggest practical solutions for these problems. My guess is that, had we continued the discussion, we would have been unable to agree on which exactly were the most pressing practical problems, how these should be perceived, and how the studies should be undertaken. There are still many gaps to bridge, both in theory and in practice. But on one point we fully agreed. Research and studies must be located on the waterfront.

---

[46] See Saleth (1996) on a property rights perspective on irrigation. I thank Vishal Narain for bringing this work to my notice (also see Narain, forthcoming). I became aware of the existence of this literature too late to be able to integrate it into the discussion in this chapter.

REFERENCES

CAD	= Command Area Development
CADA	= Command Area Development Authority
DES	= Directorate of Economics and Statistics
DOA	= Department of Agriculture
DRLAD	= Development and Rural Local Administration Department
GOAP	= Government of Andhra Pradesh
GOHYD	= Government of Hyderabad
GOI	= Government of India
GOKAR	= Government of Karnataka
GOMAD	= Government of Madras
GOMYS	= Government of Mysore
GONOH	= Government of the Nizam of Hyderabad
IIC	= Indian Irrigation Commission (of 1901-03)
ID	= Irrigation Department
KWDT	= Krishna Water Disputes Tribunal
MOAI	= Ministry of Agriculture and Irrigation
MOI	= Ministry of Irrigation
MOIP	= Ministry of Irrigation and Power
MOWR	= Ministry of Water Resources
PC	= Planning Commission
PD	= Planning Department
PWD	= Public Works Department
TBP	= Tungabhadra Project

ADAMS, W.M. (1988)
"Rural protest, land policy and the planning process on the Bakolori project, Nigeria". *Africa*, Vol. 58, No. 3, pp. 315-335.

AGARWAL, BINA (1994)
A field of one's own. Gender and land rights in South Asia. Edition for South Asia. Cambridge University press, Cambridge etc., and Foundation Books, New Delhi.

AGARWAL, BINA (1998)
"Disinherited peasants, disadvantaged workers. A gender perspective on land and livelihood". *Economic and Political Weekly*, Vol.33, No.13, pp. A2-14.

AHMED, AMINULLAH (n.d.)
Draft recommendations and suggestions for the problems prevailing in Tungabhadra Left Bank Canal command area. TBP/CADA, Munirabad.

AMBLER, JOHN S. (1994)
"The language of farmer water users' associations: rethinking irrigation organisation development in India". In: M.V.K. Sivamohan and Christopher A. Scott (eds.) *India: irrigation management partnerships*. Booklinks Corporation, Hyderabad, pp. 15-33.

ANAGOL, JAYAKUMAR (1969)
"A strategy for ayacut development under major irrigation projects". *Economic and Political Weekly*, Vol. 4, No. 26, pp. A111-118.

ANDERSON, PERRY (1980)
"Agency". In: *Arguments within English Marxism.* New Left Books, London, pp. 16-58.

ANDERSON, ROBERT S., PAUL R. BRASS, EDWIN LEVY AND BARRIE M. MORRISON (1982)
Science, politics, and the agricultural revolution in Asia. AAAS Selected Symposium 70. Westview Press, Boulder Colorado.

ANJANEYA SWAMY, G. (1988)
Agricultural Entrepreneurship in India. Chugh Publications, Allahabad.

APPADURAI, ARJUN (1990)
"Technology and the reproduction of values in rural Western India". In: Frédérique Apffel Marglin and Stephen Apfell Marglin (eds.) *Dominating knowledge. Development, culture, and resistance.* Clarendon Press, Oxford, pp. 185-216.

ASSADI, MUZAFFAR (1995)
"'Khadi curtain', 'weak capitalism' and 'operation ryot': Some ambiguities in farmers' discourse, Karnataka and Maharashtra 1980-83". In: Tom Brass (ed.), *New Farmers' movements in India*. Frank Cass, Essex, pp. 212-227.

ATCHI REDDY, M. (1990)
"Travails of an irrigation canal company in South India, 1857-1882". *Economic and Political Weekly*, Vol. 25, No. 12, pp. 619-628.

ATTWOOD, DONALD W. (1985)
"Peasants versus capitalists in the Indian sugar industry: the impact of the irrigation frontier". *Journal of Asian Studies*, Vol. 45, No. 1, pp. 59-80.

ATTWOOD, DONALD W. (1987)
"Irrigation and imperialism: the causes and consequences of a shift from subsistence to cash cropping". *Journal of Development Studies*, Vol. 23, No. 3, pp. 341-366.

ATTWOOD, DONALD W. (1993)
Raising cane: The political economy of sugar in Western India. Oxford University Press, New Delhi.

AZEEMUDDIN, KHAJA (1944)
Paper on Dindi Project. (typescript)

AZEEMUDDIN, KHAJA (1947)
"Dindi Project". *Journal of the Institution of Engineers (India)*, Vol. 26, No. 3, pp. 22-54.

AZIZ, ABDUL, CHARLES NELSON AND DEVENDRA BABU (1996)
"Power to the people: the Karnataka experiment". In: Abdul Aziz and David D. Arnold (eds.) *Decentralised governance in Asian countries*. Sage, New Delhi, pp. 146-163.

BAIRD SMITH, R. (1852)
Italian irrigation. Being a report on the agricultural canals of Piedmont and Lombardy. Addressed to the honourable the court of directors of the East India Company. Vol.II Practical and legislative. William Blackwood, Edinburgh.

BANAJI, JAIRUS (1977)
"Capitalist domination and the small peasantry. Deccan districts in the late nineteenth century". *Economic and Political Weekly*, Vol. XII, No. 33 & 34, pp. 1375-1404.

BANDARAGODA, D.J. (1998)
Design and practice of water allocation rules: lessons form warabandi in Pakistan's Punjab. Research Report 17. International Irrigation Management Institute, Colombo.

BANERJI, ARUN (1995)
Finances in the Early Raj: Investments and the External Sector. Sage Publications, New Delhi.

BARBER, C.G. (1940)
History of the Cauvery-Mettur project (revised edition). CBIP Publication No.185 (reprint).

BARDHAN, PRANAB (1984a)
The political economy of development in India. Basil Blackwell, Oxford.

BARDHAN, PRANAB K. (1984b)
"Private property as a growth constraint in a hydraulic economy". In: *Land, labor and rural poverty. Essays in development economics*. Oxford University Press, New Delhi, pp. 212-219.

BARDHAN, PRANAB (ED.) (1989)
Conversations between economists and anthropologists: methodological issues in measuring economic change in rural India. Oxford University Press, New Delhi.

BARDHAN, PRANAB (1991)
"On the concept of power in economics", *Economics and Politics*, Vol. 3, No.3, pp. 265-277.

BARNETT, TONY (1981)
"Evaluating the Gezira scheme: Black box or Pandora's box?" In: J. Heyer, P. Roberts and G. Williams (eds.) *Rural development in tropical Africa*. St. Martin's Press, New York, pp. 306-324.

BASU, D.N. AND P.P. SHIRAHATTI (1991)
"Performance possibilities and limits in Indian surface irrigation". In: Ruth Meinzen-Dick and Mark Svendsen (eds.) *Future directions for Indian irrigation: research and policy issues*. IFPRI, Washington, pp. 75-98.

BEEKER, JOOST (1993)
Struggle at the outlet. The distribution of water at tertiary level of the Kabul river Canal System, NWFP, Pakistan. M.Sc. thesis. Wageningen Agricultural University.

BENDA-BECKMANN, F. VON AND M. VAN DER VELDE (EDS.) (1992)
Law as a resource in agrarian struggles. Wageningsche Sociologische Studies 33. Agricultural University, Wageningen.

BENNETT, JOHN W. (1990)
"Ecosystems, environmentalism, resource conservation, and anthropological research". In: Emilio F. Moran (ed.) *The ecosystem approach in anthropology. From concept to practice.* The University of Michigan Press, Ann Arbor, pp. 435-457.

BENTUM, MAARTEN VAN (1992)
"Irrigation technology as a social construction: a case study in south east Spain". In: Geert Diemer and Jacques Slabbers (eds.) *Irrigators and Engineers.* Thesis Publishers, Amsterdam, pp. 65-72.

BENTUM, MAARTEN VAN (1995)
Water, werk en waterwerken: de ontwikkeling van irrigatietechnologie in het stroomgebied van de Segura, Zuidoost - Spanje. Ph.D. thesis. Wageningen Agricultural University.

BENVENUTI, BRUNO (1975)
"De Technologische-Administrative Taakomgeving (TATE)". *Marquetalia,* tijdschrift voor landbouw en politiek: arbeid & technologie in de veenkoloniën, pp. 111-136.

BENVENUTI, BRUNO (1991)
Geschriften over landbouw, structuur en technologie. Ingeleid, bewerkt en vertaald door Jan Douwe van der Ploeg. Wageningen Studies in Sociology No. 29, Wageningen Agricultural University.

BERKOFF, D.J.W. (1988)
Irrigation management in South India: the approach of the national water management project. ODI/IIMI Irrigation Management Network Paper, No. 88/2d.

BERKOFF, D.J.W. (1990)
Irrigation management on the Indo-Gangetic plain. World Bank Technical Paper, No. 129. World Bank, Washington DC.

BERNSTEIN, HENRY (1979)
"African peasantries: a theoretical framework". *Journal of Peasant Studies,* 6, No. 4, pp. 421-443.

BHADURI, AMIT (1983)
The economic structure of backward agriculture. Academic Press, London.

BHAGWATI, JAGDISH (1993)
India in transition. Freeing the economy. Clarendon Press, Oxford.

BHARADWAJ, B.M. (1949)
"Suggested improvements on the Kirkpatrick open-type semi-module". *Journal of the Institution of Engineers* (India), Vol. 30, No. 4, pp. 33-40.

BHARADWAJ, KRISHNA (1974)
Production conditions in Indian agriculture: A study based on farm management surveys. University of Cambridge Department of Applied Economics Occasional Paper 33. Cambridge University Press, Cambridge.

BHARADWAJ, KRISHNA (1985)
"A note on commercialisation in agriculture". In: K.N. Raj, Neeladri Bhattacharya, Sumit Guha and Sakti Padhi (eds.) *Essays on the commercialisation of Indian agriculture.* Centre for Development Studies, Trivandrum and Oxford University Press, Delhi, pp. 331-347.

BHARADWAJ, KRISHNA (1990)
Irrigation in India. Alternative perspectives. Research in Economics: second survey. Monograph-3. Indian Council of Social Science Research, New Delhi.

BHASKAR, ROY (1979A)
"On the possibility of social scientific knowledge and the limits of naturalism". In: John Mepham and D.H. Ruben (eds.) *Issues in Marxist Philosophy. Vol III. Epistemology, Science, Ideology.* The Harvester Press, Brighton, pp. 107-139.

BHASKAR, ROY (1979B)
The possibility of naturalism. A philosophical criticque of the contemporary human sciences. The Harvester Press.

BHASKAR, ROY (1989)
The possibility of naturalism. A philosophical criticque of the contemporary human sciences. (second edition). Harvester Wheatsheaf, New York.

BHATIA, B.M. (1991)
Famines in India. Konark Publishers, Delhi.

BHATIA, RAMESH (1991)
"Irrigation financing and cost recovery policy in India: Case studies from Bihar and Haryana". In: Ruth Meinzen-Dick and Mark Svendsen (eds.) *Future directions for Indian irrigation: Research and policy issues.* IFPRI, Washington DC, pp. 168-213.

BISALIAH, S. AND DONALD C. TAYLOR (1973)
An economic analysis of major irrigated crops in the Tungabhadra project. UAS Research Series No.15. UAS, Bangalore.

BLOEMEN, IRENE AND JAN DE MOOR (1983)
Waterbeheer in neo-koloniale context. Een vooronderzoek naar de financiering en export van irrigatiekennis en technologie. M.Sc. thesis. Department of Irrigation, Wageningen Agricultural University.

BOLDING, ALEX (1992)
Irrigation means irritation. Three papers on the failure of the policy of protective irrigation on a tail end distributary of the Tungabhadra Left Bank Canal, Karnataka, India. M.Sc. thesis. Department of Irrigation and Soil and Water Conservation, Wageningen Agricultural University.

BOLDING, ALEX, PETER P. MOLLINGA AND KEES VAN STRAATEN (1995)
"Modules for modernisation: colonial irrigation in India and the technological dimension of agrarian change". *Journal of Development Studies* Vol.31, No.6, pp. 805-844.

BOLHUIS, EPPO AND JAN DOUWE VAN DER PLOEG (1985)
Boerenarbeid en stijlen van Landbouwbeoefening: een socio-economisch onderzoek naar de effecten van incorporatie en institutionalisering op agrarische ontwikkelingspatronen in Italië en Peru. Ph.D. thesis. Leiden University.

BONT, MICHAEL DE (1992)
"Linking design and construction to operation: participation in Guinea Bissau". In: Geert Diemer and Jacques Slabbers (eds.), *Irrigators and Engineers,* Thesis Publishers, Amsterdam, pp. 165-184.

BOS, M.G. (1978)
Discharge measurement structures. ILRI Publication No. 20, 2nd edition, Wageningen.

BOSS, MARTIJN (1998)
Water management in the Tungabhadra irrigation system. Comparing two sides of one river. M.Sc. thesis. Wageningen Agricultural University.

BOTTRALL, ANTHONY (1985)
Managing large scale irrigation schemes: a problem of political economy. Agricultural Administration Unit Occasional Paper 5. Overseas Development Institute, London.

BOTTRALL, ANTHONY (1992)
"Fits and misfits over time and space: technologies and institutions of water development for South Asian agriculture". *Contemporary South Asia,* Vol. 1, No. 2, pp. 227-247.

BOURDIEU, PIERRE (1977)
Outline of a theory of practice. Cambridge University Press, Cambridge, etc., (original 1972).

BOYCE, JAMES K. (1987)
Agrarian impasse in Bengal. Institutional constraints to technological change. Oxford University Press, New York.

BRASS, PAUL R. (1980)
The politics of India since Independence. The New Cambridge History of India, IV.1. Cambridge University Press, Cambridge.

BRASS, PAUL R. (1990)
"The politicization of the peasantry in a North Indian state: I". *The Journal of Peasant Studies,* Vol. 7, No. 4, 1990, pp. 395-426.

BRASS, TOM (1986)
"The elementary strictures of kinship: unfree relations and the production of commodities". *Social Analysis.* Special Issue 'Rethinking commodity production', No. 20. December. pp. 56-68.

BRASS, TOM (ED.) (1995)
New farmers' movements in India. Frank Cass, Essex and Portland.

BROWN, JOYCE M. (1983/84)
"Contribution of the British to irrigation engineering in Upper India in the nineteenth Century". In: *Transactions of the Newcomen society for the study of the history of engineering and technology*, Vol. 51, pp. 85-112.

BREMAN, JAN (1993)
Beyond patronage and exploitation. Changing agrarian relations in South Gujarat. Oxford University Press, Delhi.

BREWER, JEFFREY D., R. SAKTHIVADIVEL AND K.V. RAJU (1997)
Water distribution rules and water distribution performance: a case study in the Tambraparani irrigation system. Research Report 12. International Irrigation Management Institute, Colombo

BUCKLEY, ROBERT BURTON (1905)
The irrigation works of India. Spon, London and Spon and Chamberlain, New York (2nd edition).

BUGGI, CHANDRASHEKAR, HULAGUR BASAVARAJ AND M. SHIVAMURTHY (1997)
Success and failure of local organization for irrigation management - A sociological case study in Karnataka. Paper presented at XXIV All India Sociological Conference, Osmania University, Hyderabad, 22-24 December 1997.

BURAWOY, MICHAEL (1985)
The politics of production. Factory regimes under capitalism and socialism. Verso, London.

BURNS, ROBERT E. (1993)
"Irrigated rice culture in monsoon Asia: the search for an effective water control technology". *World Development*, Vol. 21, No. 5, pp. 771-789.

BYRES, TERENCE J. (1981)
"The new technology, class formation and class action in the Indian countryside". *Journal of Peasant Studies*, Vol. 8, No. 4, pp. 403-454.

BYRES, T.J. (1988)
"A Chicago view of the Indian state: an oriental grin without an oriental cat and political economy without classes". *The Journal of Commonwealth and Comparative Politics* Vol. 26, No. 3, pp. 240-269.

BYRES, T.J. (ED.) (1994)
The state and development planning in India. Oxford University Press, New Delhi.

CADA (1997)
A brief report on waterlogged saline and alkaline area affected in Tungabhadra Project. (typescript)

CADA/TBP (1979)
Report of the Tungabhadra Project Ryots Grievances Committee. Munirabad.

CALLINICOS, ALEX (1987)
Making history: agency, structure and change in social history. Polity Press, Oxford.

CALLON, MICHEL (1980)
"The state and technical innovation: a case study of the electrical vehicle in France". *Research Policy*, Vol. 9, No. 4, October 1980, pp. 358-376.

CALLON, MICHEL (1992)
"The dynamics of techno-economic networks". In: R. Coombs, P.Saviotti and V. Walsh (eds.) *Technological change and company strategies: economic and sociological perspectives*. Academic Press, London, pp. 72-102.

CARLSTEIN, TOMMY (1982)
Time resources, society and ecology. On the capacity for human interaction in space and time. Vol. 1. Preindustrial societies. George Allen and Unwin, London.

CARNEY, JUDITH AND MICHAEL WATTS (1991)
"Disciplining women? Rice, mechanization and the evolution of Madinka gender relations in Senegambia". *Signs*, Vol. 16, No. 4, pp. 651-681.

CARTER, ANTHONY T. (1974)
Elite politics in rural India: Political stratification and political alliances in Western Maharashtra. Cambridge University Press, London.

CENSUS OF INDIA (1961A)
Volume XI Mysore. Part VI Village survey monographs. No.26 *Village survey monograph of Sirwar.*

CENSUS OF INDIA (1961B)
Volume XI Mysore. Part VI Village survey monographs. No.10 *Yerdona village, Gangavati taluk, Raichur district.*

CENSUS OF INDIA (1981)
District Census Handbook. Series-9 Karnataka. Parts XIII- A & B village and town directory. Village & Townwise primary census abstract. *Raichur district.*

CHAKRAVARTHY, SUKHAMOY (1987)
Development planning. The Indian experience. Oxford University Press, Delhi.

CHAMBERS, ROBERT (1988)
Managing canal irrigation. Practical analysis from South Asia. Oxford & IBH Publishing Co., New Delhi and Calcutta.

CHAMBERS, ROBERT (1994)
"Irrigation against rural poverty". In: R.K. Gurjar (ed.) *Socio-economic dimensions & irrigation.* Printwell, Jaipur, pp. 50-83.

CHAMBERS, ROBERT, N.C. SAXENA AND TUSHAAR SHAH (1989)
To the hands of the poor. Water and trees. Oxford & IBH, New Delhi.

CHAYANOV, A.V. (1925)
The theory of peasant economy. 1987 edition with an introduction by Teodor Shanin. Oxford University Press, Delhi.

CHOPRA, VIR K. (1996)
Marginal players in marginal assemblies: the Indian MLA. Orient Longman, Hyderabad.

COWARD, E. WALTER (1986A)
"State and locality in Asian irrigation development: The property factor". In: K.C. Nobe and R.K. Sampath (eds.) *Irrigation management in developing countries: current issues and approaches.* Studies in Water Policy and Management No. 8, Westview Press, Boulder Colorado, pp. 491-508.

COWARD, E. WALTER (1986B)
"Direct or indirect alternatives for irrigation investment and the creation of property". In: K.W. Easter (ed.) *Irrigation investment, technology and management strategies for development.* Studies in Water Policy and Management No. 9, Westview Press, Boulder Colorado, pp. 225-244.

CROW, BEN, ALAN LINDQUIST AND DAVID WILSON (1995)
Sharing the Ganges. The politics and technology of river development. Sage Publications, New Delhi.

CROW, BEN AND K.A.S. MURSHID (1994)
"Economic returns to social power: merchants' finance and interlinkage in the grain markets of Bangladesh". *World Development,* Vol. 22, No. 7.

CRUMP, E.S. (1922)
A note. Dated 15th June 1922, by Mr. E.S. Crump, executive engineer, on the moduling of irrigation channels. (typescript)

DAHLBERG, KENNETH A. AND JOHN W. BENNETT (EDS.) (1986)
Natural resources and people. Conceptual issues in interdisciplinary research. Westview Special Studies in Natural Resources and Energy Management. Westview, Boulder and London.

DATYE, K.R. (1997) (assisted by Suhas Paranjape and K.J. Joy)
Banking on biomass. A new strategy for sustainable prosperity based on renewable energy and dispersed industrialisation. Environment and Development Series. Centre for Environment Education, Ahmedabad.

DATYE, K.R, SUHAS PARANJAPE, K.J. JOY AND SEEMA KULKARNI (1997)
Krishna valley development: emerging options for sustainable development and conflict management. Paper presented at the IDPAD Seminar "Managing water scarcity: experiences and prospects", 13-17 October, Amersfoort, the Netherlands.

DAVISON-JENKINS, DOMINIC J. (1997)
The irrigation and water supply systems of Vijayanagara. Manohar American Institute of Indian Studies, New Delhi.

DEAKIN, ALFRED (1893)
Irrigated India. An Australian view of India and Ceylon their irrigation and agriculture. Thacker, London.

DEVARAJULU NAIDU, C. (1987)
Economics of irrigation. A study of farm productivity, income and employment under Tungabhadra Project. Sri Venkateswara University, Tirupati.

DHAWAN, B.D. (1988)
Irrigation in India's agricultural development. Productivity, stability, equity. Sage, New Delhi.

DHAWAN, B.D. (1989)
"Enhancing production through crop pattern changes". *Artha Vijnana,* Vol. 31, No. 2, pp. 153-175.

DHAWAN, B.D. (ED.) (1990)
Big dams: claims, counter claims. Commonwealth Publishers, New Delhi.

DHAWAN, B.D. (1993)
"Faulty ICSSR survey of Indian irrigation". In: *India water resource development for irrigation: issues, critiques, reviews.* Commonwealth Publishers, New Delhi, pp. 167-175.

DIA, IBRAHIMA, GEERT DIEMER, WIM F. VAN DRIEL AND FRANS P. HUIBERS (1996)
"Designing for farmer management in the Senegal river valley". In: Geert Diemer and Frans P. Huibers (eds.) *Crops, people and irrigation. Water allocation practices of farmers and engineers.* Intermediate Technology Publications, London, pp. 128-149.

DIEMER, GEERT (1990)
Irrigatie in Afrika. Boeren en ingenieurs, techniek en kultuur. Ph.D thesis, Leiden University.

DIEMER, GEERT AND JACQUES SLABBERS (EDS.) (1992)
Irrigators and engineers. Thesis Publishers, Amsterdam.

DIEMER, GEERT AND FRANS P. HUIBERS (EDS.) (1996)
Crops, people and irrigation. Water allocation practices of farmers and engineers. Intermediate Technology Publications, London.

DOORENBOS, J. AND W.O. PRUITT (1977)
Guidelines for predicting crop water requirements. Irrigation and Drainage Paper No. 24. Food and Agriculture Organization, Rome.

DRÈZE, JEAN AND AMARTYA SEN (1995)
India. Economic development and social opportunity. Oxford University Press, Delhi.

DUTT, ROMESH C. (1900)
Famine and land assessments in India. Kegan Paul, Trench, Trubner & Co., Ltd., London.

ELLIS,, W.M. (1931 AND 1950)
College of engineering manual irrigation. Government Press, Madras.

ENGE, KJELL I. AND SCOTT WHITEFORD (1989)
The keepers of water and earth. Mexican rural social organization and irrigation. University of Texas Press, Austin.

FAMINE COMMISSION (1880)
Report of the Indian Famine commission 1880-1885. Part I-III. Agricole Publishing Academy. New Delhi. (1989 reprint)

FAMINE COMMISSION (1881)
East India (Report of Famine Commission). Appendix V. Irrigation as a protection against famine. George Edward Eyre and William Spottiswood, London (In all likelihood part of: *Further report of the Indian Famine Commission, with Proceedings, Evidence and Appendices.* Parliamentary Paper LXXI. 1881)

FAMINE COMMISSION (1898)
Report of the Indian Famine Commission 1898. Agricole Publishing Academy, New Delhi. (1989 reprint)

FRANKEL, FRANCINE (1978)
India's political economy. The gradual revolution. Princeton University Press, Princeton, NJ.

FRANKEL, FRANCINE R. AND M.S.A. RAO (1989, 1990)
Dominance and state power in modern India. Volume I. Volume II. Oxford University Press, Delhi.

FREEMAN, DAVID M. (1989) (with Vrinda Bhandarkar, Edwin Shinn, John Wilkins-Wells, and Patricia Wilkins-Wells)
Local organizations for social development. Concepts and cases of irrigation organization. Westview Special Studies in Social, Political, and Economic Development. Westview Press, Boulder and London.
FRIEDLAND, WILLIAM H., AMY E. BARTON AND ROBERT J. THOMAS (1981)
Manufacturing green gold. Capital, labour and technology in the lettuce industry. Cambridge University Press, Cambridge.
FROENTJES, TJEERD AND KEES DE RUITER (1991)
"Kunstwerk of boerenwerk: allocatieprincipes in een ontwerp en in de praktijk; een case-studie op Java". In: Geert Diemer and Jacques Slabbers (eds.) *Irrigatietechniek en cultuur. Opvattingen van boeren en ingenieurs over de verdeling van water.* Thesis Publishers, Amsterdam, pp. 87-100.
FROUWS, JAAP (1995)
The social regulation of agriculture. Reflections from a politico-sociological perspective. Paper presented at the "Agrarian Questions: The Politics of Farming anno 1995" conference, Wageningen, May 1995.
GALLOPIN, G. (1994)
Impoverishment and sustainable development: a systems approach. International Institute of Sustainable Development, Winnipeg.
GANDHI, P.R. (1979)
"Management of irrigation in Maharashtra - Shej-pali system in the south and waharibandi system in the north". *Irrigation and Power*, Vol. 36, No. 4, pp. 395-408.
GANDHI, P.R. AND H.V. DHAMDHERE (1982)
"Water distribution practices in Maharashtra (India)". In: IWRS, *Proceedings workshop on water distribution practices*, pp. 70-76.
GERBRANDY, GERBEN AND PAUL HOOGENDAM (1996)
"The materialization of water rights: hydraulic property in the extension and rehabilitation of two irrigation systems in Bolivia". In: Geert Diemer and Frans P. Huibers (eds.) *Crops, people and irrigation. Water allocation practices of farmers and engineers.* Intermediate Technology Publications, London, pp. 53-72.
GIDDENS, ANTHONY (1976)
New rules of sociological method. A positive critique of interpretative sociologies. Hutchinson, London.
GIDDENS, ANTHONY (1984)
The constitution of society. Outline of the theory of structuration. Polity Press, Cambridge.
GOAP (1959)
Report on the economic survey of the Tungabhadra project area. Hyderabad.
GOAP (1982)
Report of the commission for irrigation utilisation. Volume I. Volume II. Hyderabad.
GOAP/PWD (1960)
Draft memorandum on the benefits of Tungabhadra Project left side canal to Andhra Pradesh State. Government of Andhra Pradesh, Public Works Department.
GOHYD/LAW DEPARTMENT (1956)
The Irrigation Act. (No.XXIV of 1357 Fasli) In: *The Hyderabad Code.* Volume II, Unrepealed Hyderabad Acts 1338F-1357F. Hyderabad-Deccan, pp. 1097-1160.
GOHYD/PWD (n.d.)
Report on the Tungabhadra Project. Secunderabad.
GOI/KWDT (1973)
The report of the Krishna Water Disputes Tribunal with the decision. Volume I. Volume II. Volume III. New Delhi
GOI/KWDT (1976a)
Final order of the further report of the Krishna Water Disputes Tribunal. 27th May .
GOI/KWDT (1976b)
Further report of the Krishna Water Disputes Tribunal under Section 5(3) of the Inter-State Water Disputes Act, 1956. New Delhi.

GOI/KWDT/MYDK-15 (1970)
Data relating to withdrawals into Tungabhadra Left Bank Canal for power and irrigation from June 1961 to December 1969 (Tribunals order dated 7th August 1970 on Andhra Pradesh's petition - CMP No.16 (107)/70/KWDT. October

GOI/MOAI (1976)
Report of the national commission on agriculture 1976. New Delhi.

GOI/MOI/CAD AND WATER MANAGEMENT DIVISION (1984)
Compendium of important circulars on the Command Area Development programme. New Delhi.

GOI/MOIP (1972)
Report of the Irrigation Commission. Volume I. New Delhi.

GOI/MOWR (1987)
National water policy.

GOI/NATIONAL COMMISSION ON AGRICULTURE (1973)
Interim report on modernising irrigation systems and integrated development of commanded areas. New Delhi.

GOI/PC (1992)
The eighth five year plan 1992-1997. Volume I: Objectives, perspective, macro-dimensions, policy framework and resources. Volume II: Sectoral programmes of development. New Delhi.

GOI/PC/PROGRAMME EVALUATION ORGANISATION (1965)
Evaluation of major irrigation projects - some case studies.

GOKAR (n.d.)
Tungabhadra Project Left Bank Canal. Proposal for inner treatment works.

GOKAR/DES
Annual Season and Crop Reports.

GOKAR/DES (1995)
Brochure on irrigation statistics in Karnataka 1980-81 to 1993-94. Directorate of Economics & Statistics, Bangalore.

GOKAR/ID (1981)
Tungabhadra Left Bank Canal (revised-estimate). Volume I Report.

GOKAR/PD (1976)
Report on re-examination of cropping pattern under T.B.P. Left Bank Canal by the technical committee. Tungabhadra Project.

GOMAD (1954)
Tungabhadra Project. Correspondence from 1946-1950. Government Press, Madras.

GOMAD/PWD (1947)
Tungabhadra Project. Correspondence from 1937 to 1946. Government Press, Madras.

GOMYS (1956-57, 1957-58, 1958-59)
Tungabhadra Project development. Left Bank Canal (Raichur side). The annual administration reports for the years 1956-57, 1957-58 and 1958-59.

GOMYS (1959-60, 1960-61)
Tungabhadra Project development. Left Bank Canal (Raichur side). The annual administration reports for the years 1959-60 and 1960-61. Office of the Divisional Commissioner and Ex-officio administrator, Tungabhadra Project, Gulbarga.

GOMYS (1961-62)
Tungabhadra Project Left Bank (Raichur side). Annual administration report of the development schemes for the year 1961-62. Office of the Deputy Administrator, Tungabhadra Project, Munirabad.

GOMYS (1962-63)
Tungabhadra Project (Left Bank). Annual administration report of the development schemes for the year 1962-1963. Office of the Deputy Administrator, Tungabhadra Project, Munirabad.

GOMYS (1966-67, 1967-68, 1968-69, 1969-70)
Tungabhadra Project (Left Bank and Right Bank). Administration report for 1966-67. Also 1967-68, 1968-69, 1969-70. By: Narasing Rao Madarkal, Deputy Administrator, TBP, Sindhanur.

GOMYS (1971)
Tungabhadra Project (Left Bank and Right Bank). Administration report for 1970-71. Deputy Administrator, Tungabhadra Project, Sindhanur.

GOMYS/DOA (1968)
Report of the expert committee on the development of light irrigation on the Left Bank area of the Tungabhadra Project 1965. Bangalore.

GOMYS/DRLAD (1962)
Tungabhadra Project. Raichur side (development schemes). Budget estimates 1962-1963. Gulbarga.

GOMYS/DRLAD (1963)
Tungabhadra Project. Raichur side (development schemes). Budget estimates 1963-1964. Gulbarga.

GONOH/DOA (1944)
Final report of the Hyderabad dry farming research scheme Raichur for the period December 1933 to June 1943. Government Central Press, Hyderabad Deccan.

GONOH/PWD (1935)
The Tungabhadra Project Raichur District. Volume II Correspondence from 1933 AD/1342 Fasli to 1934 *AD/1343 Fasli*. Government Central Press, Hyderabad-Deccan, 5th June 1935/30th Thir 1344 Fasli.

GONOH/PWD (1936)
The Tungabhadra Project Raichur District. Volume III Correspondence from March 1934 AD/Ardibehisht 1343 F to December 1935 AD. Bahmon 1345 F. Government Central Press, Hyderabad-Deccan, 20th July 1936/14th Shehrewar 1345 F.

GONOH/PWD (1937)
The Tungabhadra Project. Volume I Correspondence from 1898 AD/1307 Fasli to 1937 AD/1346 Fasli. Government Central Press, Hyderabad-Deccan.

GONOH/PWD (1945)
The Tungabhadra Project. Volume II Correspondence from 1937 AD/1346 Fasli to 1944 AD/1353 Fasli. Government Central Press, Hyderabad-Deccan.

GOODMAN, DAVID, BERNARDO SORJ AND JOHN WILKINSON (1987)
From farming to biotechnology. A theory of agro-industrial development. Basil Blackwell, Oxford.

GOPALAN, M. (1934)
Report on the Tungabhadra project. H.E.H. the Nizam's Government Public Works Department. Government Central Press, Hyderabad Deccan.

GOPALAN, M. (1948)
"Scheme for the agricultural development under the irrigation projects in Hyderabad". *The Hyderabad Government Bulletin on Economic Affairs*. With Conference Supplement. December, pp. 1086-1092.

GORE, V.N. (1998)
Water technologies. Overview and status of development. (1) timber - bamboo gabions and embankments, (2) ponds and small tanks, (3) ponds and channels, (4) small water storage tanks, (5) distribution and delivery system - channels and pipes, (6) farmers innovations - alternative to drip and sprinkler. Collection of papers. CASAD/SOPPECOM, Mumbai, January.

GORTER, PIETER (n.d.)
The politics of canal irrigation. An analysis of the water distribution in a canal irrigation system in Gujarat, India. CASA Werkdocument No.5. Centre for Asian Studies Amsterdam.

GORTER, PIETER (1989)
"Canal irrigation and agrarian transformation. The case of Kesala". *Economic and Political Weekly*, Vol. 24, No. 39, pp. A94-105.

GOSSELINK, PAUL AND JOHN THOMPSON (1997)
Application of participatory rural appraisal methods for action research on water management. Short report series on locally managed irrigation. Report No. 18. International Irrigation Management Institute, Colombo.

GOVINDAIAH, T. (1989)
Irrigation development in India. Chugh Publications, Allahabad.

GREEN, C.H. (1996)
"Water and economics - What does experience teach us so far?" In: P. Howsam and R.C. Carter (eds.). *Water policy: Allocation and management in practice*. E & F.N. Spon, London, pp. 213-227.

GROENHUIJZEN, PETER AND EDWIN NOORDMAN (1992)
Shaping water distribution. An analysis of phenomena of water distribution in distributary D-36 of the Tungabhadra Project, India. M.Sc thesis. Wageningen Agricultural University.

GUIJT, IRENE AND J. THOMPSON (1994)
"Landscapes and livelihoods: environmental and socioeconomic dimensions of small-scale irrigation". *Land Use Policy*, Vol. 11, No. 4, pp. 294-308.

GUPTA, AKHIL (1987)
Technology, power and the state in a complex agricultural society: the green revolution in a North Indian village. Ph.D. thesis. Stanford University.

GUYER, JANE I. (1984)
"Naturalism in models of African production". *Man*, Vol. 19, No. 3, pp. 371-388.

HALSEMA, GERARDO E. VAN AND PHILIPPUS WESTER (1994)
The "art" of diverting water. Irrigation water management in the Kabul river canal system, NWFP, Pakistan. M.Sc. thesis. Department of Irrigation and Soil and Water conservation, Wageningen Agricultural University, and Report for the research program of the Water Management Project (WAMA), Agricultural University Peshawar, Pakistan.

HARAWAY, DONNA J. (1991)
Simians, cyborgs, and women. The reinvention of nature. Free Association Books, London.

HARRISS, JOHN (1985)
What happened to the green revolution in South India? Economic trends, household mobility and the politics of an "awkward class". Discussion Paper No. 175. School of Development Studies, University of East Anglia, Norwich.

HART, HENRY C. (1978)
"Anarchy, paternalism, or collective responsibility under the canals?" *Economic and Political Weekly*, Vol. 13, No. 51 & 52, pp. A125-134.

HEYBROEK, FRANK AND VICTOR WITTER (1981)
De Heidemij. Van ontginnen naar ontwikkelen. De Uitbuyt, Wageningen.

HILL, POLLY (1984)
"The poor quality of official socio-economic statistics relating to the rural tropical world: with special reference to South India". *Modern Asian Studies*, Vol. 18, No. 3, pp. 491-514.

HODGSON, GEOFFREY M. (1988)
Economics and institutions: A manifesto for a modern institutional economics. Polity Press, Oxford.

HOFSTEDE, KO TER AND JAN VAN SANTBRINK (1979)
Nederlands Indië. Koloniaal waterbeheer. Een onderzoek naar het ontstaan en de ontwikkeling van het technisch beheer van irrigatiesystemen met als ingang de schakelfunktie tussen projectorganisatie en bevolking. Landbouwhogeschool, Vakgroep Agrarische Geschiedenis and Vakgroep Weg- en Waterbouwkunde en Irrigatie, Wageningen (2 volumes).

HOOGEVEEN, JIPPE (1991)
Water management in Indian chaks. (a research to water distribution on tertiary level in the Tungabhadra Left Bank Main Canal Irrigation Scheme). M.Sc. thesis. Wageningen Agricultural University.

HOPE, ELIZABETH REID (1900)
General Sir Arthur Cotton R.E. K.C.S.I. His life and work. By his daughter Lady Hope. With some famine prevention studies by William Digby C.I.E. Hodder and Stoughton, London.

HORST, LUCAS (1987)
Choice of irrigation structures (the paradox of operational flexibility). (typescript)

HORST, LUCAS (1996)
Irrigation water division technology in Indonesia: a case of ambivalent development. Liquid Gold Paper 2. Wageningen Agricultural University and International Institute for Land Reclamation and Improvement, Wageningen.

HUGHES, THOMAS P. (1987)
"The evolution of large technological systems". In: W.E. Bijker, T.P. Hughes and T.J. Pinch (eds.) *The social construction of technological systems*. M.I.T. Press, Cambridge MA, pp. 51-82.

HUNT, ROBERT C. (1990)
"Organizational control over water: the positive identification of a social constraint of farmer participation". In: R.K. Sampath and Robert A. Young (eds.) *Social, economic, and institutional issues in Third World irrigation management*. Studies in Water Policy Management, No. 15. Westview Press, Colorado, pp. 141-154.

HUPPERT, WALTER (1989)
Situation conformity and service orientation in irrigation management. Basic concepts. Sonderpublikation der GTZ No.242. GTZ, Eschborn.
HYDBUL III/9
"Editorial notes. The Nizam Sagar project: retrospect and prospect". *The Hyderabad Bulletin on Economic Affairs*, Vol. III, No. 9, 1950, pp. 707-712.
INCID (1994)
Guide for preparation of plans of operation and maintenance of irrigation systems in India. Indian National Committee on Irrigation and Drainage, New Delhi, March.
IIC (1901-1903) (INDIAN IRRIGATION COMMISSION) (1903)
Report of the Indian Irrigation Commission 1901-1903. Her Majesty's Stationery Office, London.
INGLIS, C.C. (1928A)
Note on the design of distributaries and their outlets in the Bombay Deccan. Government of Bombay, Public Works Department, Technical Paper No.19. Government Central Press.
INGLIS, C.C. (1928B)
A note on standing wave pipe outlets. Technical Paper No.23. Government of Bombay, Public Works Department, Government Central Press, Bombay.
INGLIS, C.C AND RAO SAHIB D.V. JOGLEKAR (1940)
Note on the theory, design and construction of Gibb modules, which, without moving parts, give a constant discharge within working limits, irrespective of variations in upstream and downstream water levels. Central irigation and hydrodynamic research station, Poona, Research Publication No.3. Government of India Press, Calcutta.
INTERIM REPORT (1996)
The interim report of the expert committee constituted by the government to study the requirements of amandments to certain acts and rules in the context of constitution of a state CAD (Command Area Development) council and reconstitution of CAD Boards and constitution of farmers' associations. Bangalore, Karnataka.
IWRS (INDIAN WATER RESOURCES SOCIETY) (1982)
Proceedings workshop on water distribution practices. July 2-3, 1982. IWRS.
IYENGAR, S. KESAVA (1951)
Rural economic enquiries in the Hyderabad State (1949-1951). Government Press, Hyderabad.
JACOB, ALICE AND S.N. SINGH (1972)
Law relating to irrigation. N.M. Tripathi Private Ltd., Bombay.
JACOBS, CLAIRE, JEROEN DE JONG, PETER P. MOLLINGA AND WIM BASTIAANSSEN (1997)
"Constraints and opportunities for improving irrigation management in a water scarce but waterlogged area in Haryana, India". In: James M. de Jager, Laszlo P. Vermes, Ragab Ragab (eds.), *Sustainable irrigation in areas of water scarcity and drought.* Proceedings of the International Workshop. ICID Working Group on Sustainable Crops and Water Use, ICID Working Group on the Impact of Drought on Irrigated Agriculture, ICID European Regional Work Team on Drought, British National Committee on Irrigation Drainage, Oxford, 11-12 September 1997, pp. 82-91.
JAIRATH, JASVEEN (1984)
Role of irrigation in agricultural production. A case study of Punjab. Ph.D. thesis. School of Social Sciences, Centre for Economic Studies and Planning, Jawaharlal Nehru University, New Delhi.
JAIRATH, JASVEEN (1985)
"Technical and institutional factors in utilisation of irrigation. A case study of public canals in Punjab". *Economic and Political Weekly*, Vol. 20, No. 13, pp. A2-10.
JESSOP, BOB (1990)
Book review of J.S. Midgal (1988). *Journal of Peasant Studies*, Vol. 17. No. 3, 1990, pp. 484-486.
JOHNSTON, R.J. (1996)
Nature. state and economy. A political economy of the environment. John Wiley.
JURRIËNS, M. AND W. LANDSTRA (1990)
Tungabhadra Irrigation Pilot Project. Final report. Conclusions and recommendations. International Institute for Land Reclamation and Improvement, Wageningen.

JURRIËNS, M., P.P. MOLLINGA AND P. WESTER (1996)
Scarcity by design: protective irrigation in India and Pakistan. Liquid Gold Paper 1. Wageningen Agricultural University, International Institute for Land Reclamation and Improvement, Wageningen.

JURRIËNS, M., V. RAMAIAH AND J.G. VAN ALPHEN (1988)
Irrigation water management in the Tungabhadra Scheme, India. ILRI reprint No.50, Wageningen, pp. 22-32.

JURRIËNS, RIEN AND KORNELIS DE JONG (1989)
Irrigation water management. A literature survey. Working Party "Irrigation and Development". Publication No. 01189.

JURRIËNS, RIEN AND PETER P. MOLLINGA (1996)
"Scarcity by design: protective irrigation in India and Pakistan". *ICID Journal*, Vol. 45, No. 2, pp. 31-53.

KALLUR, M.S. (1988)
Irrigation and economic development. Chugh Publications, Allahabad.

KENCHANA GOWDA, S.K. (1978)
"Effect of continuous irrigation on physical, chemical and mineralogical properties of the soils of Tungabhadra project command area". In: Soil and water management seminar. *Proceedings.* Regional Research Station Raichur, 22nd August 1978, pp.9-11.

KENNEDY, R.G. (1906)
On the distribution of water for irrigation by measurement. Punjab Irrigation Paper No.12. Edinburgh.

KERKVLIET, BENEDICT J. TRIA (1990)
Everyday politics in the Philippines. Class and status relations in a Central Luzon village. University of California Press, Berkeley.

KLOEZEN, WIM AND PETER P. MOLLINGA (1992)
"Opening closed gates: recognizing the social nature of irrigation artefacts". In: Geert Diemer and Jacques Slabbers (eds.), *Irrigators and Engineers*, Thesis Publishers, Amsterdam, pp. 53-64.

KOHLI, ATUL (ED.) (1988)
India's democracy. An analysis of changing state-society relations. Princeton University Press, Princeton.

KONING, NIEK (1994)
The failure of agrarian capitalism: Agrarian politics in the United kingdom, Germany, the Netherlands and the United States, 1846-1919. Ph.D. thesis. Wageningen Agricultural University.

KONINGS, PIET (1981)
"The domestic community as producer of cash crops for the national and international market". In: *Peasantry and state in Ghana: the example of the Vea irrigation project in the Upper Region in Ghana.* Working Papers No. 5. African Studies Centre, Leiden.

KOSNAM, S.S. (1952-3)
"The Tungabhadra canal-survey and design". *Journal of the Institution of Engineers (India)*, Vol. 33, pp. 313-331.

KOTHARI, RAJNI (1988)
State against democracy. In search of humane governance. Ajanta Publications, Delhi.

KRISHNA, D.G., A.D. DESAI AND CH. KRISHNAMURTHY (1959)
Deep black cotton soils of Raichur. National Council of Agricultural Research, New Delhi.

KRISHNA-GODAVARI COMMISSION (n.d.)
Report of the Krishna Godavari Commission. Annexure XVI Irrigation practices, policy and administration in Krishna and Godavari basins.

KRISHNAPPA, A.M., BADRINATH, B.N. PATIL AND K. BALAKRISHNA (1985)
Soils of Karnataka - a taxonomic approach. Station Technical Bulletin No.4. National Agricultural Research Project, University of Agricultural Sciences, Brahmavar.

KRISHNAPPA, A.M., S.N. UPPERI, NISAR AHMED, A.B. KHOT AND A.S. HADIMANI (1986)
Soils of region-I in Karnataka. Station Technical Bulletin No.1. Regional Research Station, Raichur.

KRISHNARAJULU, B. (1989)
"The Karnataka peasant movement". In: Sunil Sahasrabudhey (ed.) *Peasant movement in modern India.* Chugh Publications, Allahabad, pp. 76-109.

KULKARNI, R.P. (1990)
"Irrigation engineering in India". In: G. Kuppuram and K. Kumudamani (eds.) *History of science and technology in India Vol. X Irrigation*. Sundeep Prakashan, Delhi, pp. 3-29.

LACROIX, ANNE (1981)
Transformations du procès de travail agricole. Incidences de l'industrialisation sur les conditions de travail paysannes. Institut National de la Recherche Agronomique, Institut de Recherche Economique et de Planification, Grenoble.

LAKSHMINARAYANA (1990)
Tungabhadra Board (a study in development administration). The Director, Prasangara, University of Mysore, Mysore.

LATOUR, BRUNO (1992)
"Where are the missing masses? The sociology of a few mundane artifacts". In: Wiebe E. Bijker and John Law (eds.) *Shaping technology/building society. Studies in sociotechnical change*. MIT Press, Cambridge MA and London, pp. 225-258.

LEONARD, KAREN (1971)
"The Hyderabad political system and its participants". *Journal of Asian Studies*, Vol. 30, No. 3, pp. 569-582.

LEONARD, KAREN (1978)
"Hyderabad. The Mulki-non-Mulki conflict". In: Robin Jeffrey (ed.) *People, princes and paramount power. Society and politics in the Indian princely states*. Oxford Univewrsity Press, New Delhi, pp. 65-106.

LEVINE, GILBERT (1980)
"Hardware and software: an engineering perspectice on the mix for irrigation management". In: *Report of a planning workshop on irrigation water management*. IRRI, Philippines.

LEVINS, RICHARD AND RICHARD LEWONTIN (1985)
The dialectical biologist. Harvard University Press, Cambridge MA and London.

LIPTON, MICHAEL (1991)
"Agriculture, rural people, the state and the surplus in some Asian countries: Thoughts on some implications of three recent approaches in social science". In: Jan Breman and Sudipto Mundle (eds.) *Rural transformation in Asia*. Oxford University Press, Delhi, etc., pp. 93-124.

LONG, NORMAN (ED.) (1989)
Encounters at the interface: a perspective on structural discontinuity in rural development. Wageningen Studies in Sociology 27. Wageningen Agricultural University.

LONG, NORMAN, JAN DOUWE VAN DER PLOEG, CHRIS CURTIN AND LOUK BOX (1986)
The commoditization debate: labour process, strategy and social network. Papers of the Department of Sociology 17. Wageningen Agricultural University.

LONG, NORMAN AND JAN DOUWE VAN DER PLOEG (1989)
"Demythologizing planned intervention: an actor perspective". *Sociologia Ruralis*, Vol. 29, No. 3/4, pp. 226-249.

LONG, NORMAN AND JAN DOUWE VAN DER PLOEG (1994)
"Heterogeneity, actor and structure: towards a reconstruction of the concept of structure." In: David Booth (ed.) *Rethinking social development. Theory, research and practice*. Longman, pp. 62-89.

LOWDERMILK, MAX K. (1990)
"Irrigation, water control and anarchy". In: R.K. Sampath and Robert A. Young (eds.) *Social, economic, and institutional issues in Third World irrigation management*. Studies in Water Policy and Management, No. 15, Westview Press, Colorado, pp. 155-174.

MAASS, ARTHUR AND RAYMOND L. ANDERSON (1978)
... and the desert shall rejoice. Conflict, growth and justice in arid environments. MIT Press, Cambridge MA and London.

MAAT, HARRO AND PETER P. MOLLINGA (1994)
"Water bij de uien. Technologische en andere ontwikkelingen op het Ile à Morphil, Senegal". In: *Kennis en Methode*, Vol. 18, No. 1, pp. 40-63.

MACKENZIE, DONALD AND JUDY WAJCMAN (EDS.) (1985)
The social shaping of technology. How the refrigerator got its hum. Open University Press, Milton Keynes and Philadelphia.

MACKINTOSH, MAUREEN (1992)
"Introduction". In: Marc Wuyts, Maureen Mackintosh and Tom Hewitt (eds.) *Development Policy and Public Action*. Oxford University Press, in association with the Open University, Oxford, pp. 1-9.

MADARKAL, NARASING RAO (1970)
Tungabhadra Project. Achievements and aspirations. Government Press, Bangalore.

MADARKAL, NARASING RAO (ED.) (1968)
Tungabhadra. A citadel of hope (Survey of progress, problems and future plans of Tungabhadra Project). Government of Mysore, Department of Information and Tourism, Bangalore

MADRAS BOARD OF REVENUE, Proceedings 24.8.1931

MAHBUB, S.I. AND N.D. GULHATI (1951)
Irrigation outlets. (Revised and enlarged by N.D. Gulhati) Atma Rau & Son, Delhi.

MALHOTRA, S.P. (1982)
The warabandi system and its infrastructure. Publication No. 157. Central Board of Irrigation and Power, New Delhi.

MALHOTRA, S.P., S.K. RAHEJA AND DAVID SECKLER (1984)
"Performance monitoring in the warabandi system of irrigation management". In: Niranjan Pant (ed.) *Productivity and equity in irrigation systems*. Ashish Publishing House, New Delhi, pp. 69-83.

MALONEY, CLARENCE AND K.V. RAJU (1994)
Managing irrigation together: practice and policy in India. Sage Publications, New Delhi.

MANN, HAROLD H. (1931)
Note on land and soils irrigable under the Tungabhadra Project. Bulletin No.4 of the Agriculture Department, Hyderabad. Secunderabad-Deccan.

MANN, SUSAN A. AND JAMES M. DICKINSON (1978)
"Obstacles to the development of a capitalist agriculture". *Journal of Peasant Studies*, Vol. 5, No. 4, pp. 466-481.

MANOR, JAMES (1988)
"Parties and the party system". In: Atul Kohli (ed.) *India's democracy. An analysis of changing state-society relations*. Princeton University Press, Princeton, pp. 62-98.

MANOR, JAMES (1989)
"Karnataka: caste, class, dominance and politics in a cohesive society". In: Francine R. Frankel and M.S.A. Rao (eds.) *Dominance and state power in modern India. Decline of a social order. Volume 1*. Oxford University Press, Delhi etc., pp. 322-361.

MANOR, JAMES (1993)
Power, poverty and poison. Disaster and response in an Indian city. Sage Publications, New Delhi.

MANZUNGU, EMMANUEL AND PIETER VAN DER ZAAG (1996)
The practice of smallholder irrigation: case studies from Zimbabwe. University of Zimbabwe Publication, Harare.

MARX, KARL (1973)
Grundrisse. Foundations of the critique of political economy. The Pelican Marx Library. Penguin Books (in assocation with New Left Review), Harmondsworth. (first published in 1939 in German)

MARX, KARL (1977)
Capital. A critique of political economy. Volume I. Progress Publishers, Moscow. (original German edition 1867)

MCALPIN, MICHELLE BURGE (1983)
Subject to famine. Food crises and economic change in Western India, 1860-1920. Princeton University Press, Princeton.

MEHTA, JEHANGIR B. (1933)
Report on the agricultural survey Tungabhadra Project Raichur District 1341F-1932. Government Central Press, Hyderabad-Deccan.

MEIJERS, TON (1992)
"A process approach to design: experiences in Sub-Saharan Africa". In: Geert Diemer and Jacques Slabbers (eds.) *Irrigators and Engineers*, Thesis Publishers, Amsterdam, pp. 141-154.

MEIJERS, A.L.M. AND P.P. MOLLINGA (1991)
"Ieder is gelijk en heeft recht op water: waterverdeling bij de Haalpulaar in de Senegalvallei". In: Geert Diemer and Jacques Slabbers (eds.) *Irrigatietechniek en cultuur. Opvattingen van boeren en ingenieurs over de verdeling van water*. Thesis Publishers, Amsterdam, pp. 61-86.

MEILLASSOUX, CLAUDE (1981)
Maidens, meal and money: capitalism and the domestic community. Cambridge University Press, Cambridge.

MEINZEN-DICK, RUTH SUSEELA (1989)
Water in a thirsty land: irrigation development and agrarian structure in South India. Ph.D. thesis. Cornell University, Ithaca.

MEINZEN-DICK, RUTH (1996)
Policy trends in farmer participation. Paper presented at Workshop on Institutional Reform in Indian Irrigation, National Council of Applied Economic Research, New Delhi, November 6, 1996.

MERREY, DOUGLAS J. (1983)
Irrigation, poverty and social change in a village of Pakistani Punjab: an historical and cultural ecological analysis. Ph.D. thesis. University of Pennsylvania, Philadelphia.

MERREY, DOUGLAS J. (1995)
Institutional design principles for accountability on large irrigation systems. Paper prepared for presentation at a seminar at Wageningen Agricultural University, Wageningen, 27 October 1995.

MERREY, DOUGLAS J. (1998)
"Governance and institutional arrangements for managing water resources in Egypt". In: Peter P. Mollinga (ed.), Douglas J. Merrey, Martin Hvidt and Lutfi S. Radwan *Water control in Egypt's canal irrigation. A discussion of institutional issues at different levels*. Liquid Gold Paper 3. Wageningen Agricultural University and International Institute for Land Reclamation and Improvement.

MERREY, DOUGLAS J. AND JAMES M. WOLF (1986)
Irrigation management in Pakistan: four papers. IIMI Research Paper No.4. IIMI, Sri Lanka.

MERS (MYSORE ENGINEERING RESEARCH STATION) (1966)
Note on irrigation outlets. (typescript)

METI, T.K. (1972)
Tungabhadra irrigation strategy and accelerator of development. Volume 1. Department of Economics, Karnataka University, Dharwad. (mimeograph)

MICC (MADRAS IRRIGATION AND CANAL COMPANY) (1859)
Report of the directors.

MICC (MADRAS IRRIGATION AND CANAL COMPANY) (1867)
Report of proceedings at the sixteenth ordinary general meeting.

MIGDAL, JOEL S. (1988)
Strong societies and weak states: state-society relations and state capabilities in the Third World. Princeton University Press, Princeton and New Jersey.

MITCHELL, WILLIAM P. AND DAVID GUILLET (EDS.) (1993)
Irrigation at high altitudes: the social organization of water control systems in the Andes. Volume 12, Society for Latin American Anthropology Publication Series. A publication of The Society for Latin American Anthropology and The American Anthropological Association.

MITRA, ASHOK K. (1986)
"Underutilisation revisited. Surface irrigation in drought prone areas of western Maharashtra". *Economic and Political Weekly*, Vol. 26, No. 17, pp. 752-756.

MITRA, SUBRATA K. (1992)
Power, protest and participation. Local elites and the politics of development in India. Routledge, London and New York.

MOENCH, MARCUS (ED.) (1994)
Selling water: conceptual and policy debates over groundwater markets in India. VIKSAT, Pacific Institute and Natural Heritage Institute, Ahmedabad.

MOLLINGA, PETER P. (1989)
Modes of water distribution and patterns of commoditisation in canal irrigation: the case of the Tungabhadra Left Bank Canal irrigation system, Karnataka, India. Research proposal. (typescript)

MOLLINGA, PETER P. (1992)
Protective irrigation in South India. Deadlock or development. DPP working paper No. 24. Development Policy and Practice Research Group, Faculty of Technology, the Open University in conjunction with the Department of Irrigation and Soil and Water Conservation, Wageningen Agricultural University.

MOLLINGA, PETER P. (1994)
Performance assessment approaches to main system management analysis. A critical evaluation with some examples. (typescript)

MOLLINGA, PETER P. AND ALEX BOLDING (1996)
"Signposts of struggle: pipe outlets as the material interface between water users and the state in a large-scale irrigation system in South India". In: Geert Diemer and Frans P. Huibers (eds.) *Crops, people and irrigation. Water allocation practices of farmers and engineers.* Intermediate Technology Publications, London.

MOLLINGA, PETER P. AND JOS E. MOOIJ (1989)
Cracking the code. Towards a conceptualization of the social content of technical artefacts. Occasional Paper No. 18. Technology Policy Group. Open University, Milton Keynes.

MOOIJ, JOS E. (1996)
Food policy and politics. The public distribution system in Karnataka and Kerala, South India. Ph.D. thesis. University of Amsterdam.

MOORE, MICK (1989)
"The fruits and fallacies of neoliberalism: the case of irrigation policy". *World Development*, Vol. 17, No. 11, pp. 1733-1750.

MORAN, E.F. (1990)
The ecosystem approach in anthropology: from concept to practice. University of Michigan Press, Ann Arbor.

MORRIS, J. (1996)
"Water policy: Economic theory and political reality." In: P. Howsam and R. Carter (eds.), *Water policy: Allocation and management in practice.* E & FN Spon, London, pp. 228-239.

MUNDLE, SUDIPTO (1994)
Deprivation and public policy. Redefining the developmental state. The Wertheim lecture 5. Centre for Asian Studies Amsterdam, Amsterdam.

MURRAY-RUST, D. HAMMOND AND W. BART SNELLEN (1993)
Irrigation system performance assessment and diagnosis. IIMI, ILRI and IHE.

MYSORE ENGINEERS ASSOCIATION BANGALORE, THE (1931)
Silver Jubilee. Souvenir Volume.

MYSORE STATE GAZETTEER. Raichur District (1970)
Gazetteer of India. The Government Press, Bangalore.

NADKARNI, M.V. (1987)
Farmers' movements in India. Allied Publishers, Ahmedabad, etc.

NAGARAJU, GOTLA (1989)
Peasant immigration and agrarian change. A case study from Raichur district of Karnataka. M.Phil. thesis. Centre for Development Studies, Trivandrum.

NAIR, KUSUM (1961)
Blossoms in the dust. The human element in Indian development. Gerald Duckworth, London.

NANDA, MEERA (1991)
"Is modern science a Western, patriarchal myth? A critique of the populist orthodoxy". *South Asia Bulletin*, Vol. XI, Nos. 1 & 2, pp. 32-61.

NARAIN, VISHAL (FORTHCOMING)
"Towards a new ground water institution for India". To be published in *Water Policy.*

NEDA (1997)
Rights of women to the natural resources land and water. Working Paper 2 Women and Development. Ministry of Foreign Affairs, The Hague.

NEOCOSMOS, MICHAEL (1982)
Agrarian reform and the development of capitalism in agriculture. A critical analysis of theories of agricultural development and agrarian reform, with reference to agrarian reform policies in Chile (1962-1972). Ph.D. thesis. University of Bradford, Postgraduate School of Studies in Social Analysis.

NIJMAN, CHARLES (1993)
A management perspective on the performance of the irrigation subsector. Ph.D. thesis. Wageningen Agricultural University.

NOBLE, DAVID F. (1985)
"Social choice in machine design: the case of automatically controlled machine tools". In: Donald MacKenzie and Judy Wajcman (eds.) *The social shaping of technology. How the refrigerator got its hum*. Open University Press, Milton Keynes and Philadelphia, pp. 109-124.

NOIJ, F.T.M. (1992)
Farming households in the Tungabhadra irrigation scheme, South India. Irrigated agriculture and household economics of farming households in six chaks of distributary 36 of the Left Bank Main Canal. Research Report. Tungabhadra Chak Water Management Research Project, Department of Irrigation and Soil & Water Conservation, Wageningen Agricultural University.

NWMP/PMU (1992)
Irrigation laws, policies and procedures (Andhra Pradesh). Main text. April.

OMMEN, NIELS VAN (1997)
Participation in progress. Local organisation for irrigation management in a South Indian village. M.Sc. thesis. Wageningen Agricultural University.

OORTHUIZEN, JOOST AND WIM H. KLOEZEN (1995)
"The other side of the coin: A case study on the impact of financial autonomy on irrigation management performance in the Philippines". *Irrigation and Drainage Systems*, No. 9, pp. 15-37.

OSTROM, ELINOR (1990)
Governing the commons. The evolution of institutions for collective action. Cambridge University Press, New York.

OSTROM, ELINOR (1992)
Crafting institutions for self-governing irrigation systems. Institute for Contemporary Studies Press, San Francisco.

OSTROM, ELINOR AND ROY GARDNER (1993)
"Coping with asymmetries in the commons: self-governing irrigation systems can work". *Journal of Economic Perspectives*, Vol. 7, Number 4, pp. 93-112.

PALANISAMI, K. (1984)
Irrigation water management. The determinants of canal water distribution in India - A micro analysis. Agricole, New Delhi.

PANDIAN, M.S.S. (1987)
"Rainfall as an instrument of production in late nineteenth-century, Nanchilnadu, India". *Journal of Peasant Studies*, Vol. 15, No. 1, pp. 61-82.

PANDIAN, M.S.S. (1990)
The political economy of agrarian change. Nanchilnadu 1880-1939. Sage, New Delhi.

PANT, NIRANJAN (ED.) (1984)
Productivity and equity in irrigation systems. Ashish Publishing House, New Delhi.

PANT, NIRANJAN AND R.K. VERMA (1983)
Farmers' organisation and irrigation management. Ashish, New Delhi.

PARANJAPE, SUHAS AND K.J. JOY (1995)
Sustainable technology. Making the Sardar Sarovar project viable. A comprehensive proposal to modify the project for greater equity and ecological sustainability. Environment and Development Series. Centre for Environment Education, Ahmedabad.

PATEL, K.N. AND O.T. GULATI (1994)
"Farmers' participation from micro to macro: the Anklav sub minor in the Mahi Project: Gujarat." In: M.V.K. Sivamohan and Christopher A. Scott (eds.) *India: irrigation management partnerships*. Booklinks Corporatoion, Hyderabad, pp. 123-139.

PATIL, S.T., S.N. LELE AND R.K. PATIL (1992)
Report on organizational and procedural changes for increasing farmer participation in irrigation system management in The Upper Krishna Project. Water and Land Management Institute, Dharwad.

PATIL, S.V. AND B.V. VENKATA RAO (1965)
Effects of irrigation on black soils in the Tungabhadra Project area in Mysore State. UAS Miscellaneous Series No.1. UAS, Bangalore.

PATNAIK, UTSA (1987)
Peasant class differentiation. A study in method with reference to Haryana. Oxford University Press, Delhi.

PATNAIK, UTSA (ED.) (1990)
Agrarian relations and accumulation. The "mode of production' debate in India. Oxford University Press, Bombay.

PEPPER, DAVID (1993)
Eco-socialism: from deep ecology to social justice. Routledge, London and New York.

PERRY, CHRIS (n.d.)
Irrigation in conditions of water shortage - the case of India. Draft. (typescript)

PETER, J. RAYMOND (1998)
Management of irrigation systems by farmers in Andhra Pradesh, India: the process. Paper presented at the Fourth International Seminar on Participatory Irrigation Management, 14-19 July, Bali, Indonesia.

PFAFFENBERGER, BRYAN (1988)
"Fetishised objects and humanised nature: towards an anthropology of technology". *Man*, Vol. 23, pp. 236-252.

PINCH, TREVOR J. AND WIEBE E. BIJKER (1984)
"The social construction of facts and artefacts: or how the sociology of science and the sociology of technology might benefit each other". *Social Studies of Science*, Vol. 14, No. 3, pp. 399-441.

PLOEG, JAN DOUWE VAN DER (1991)
Landbouw als mensenwerk: arbeid en technologie in de agrarische ontwikkeling. Coutinho, Muiderberg.

PLOEG, JAN DOUWE VAN DER (1993)
Over de betekenis van verscheidenheid. Inaugurele rede (Inaugural lecture). Wageningen Agricultural University.

PLUSQUELLEC, HERVÉ, CHARLES BURT AND HANS W. WOLTER (1994)
Modern water control in irrigation. Concepts, issues, and application. World Bank Technical Paper 246. World Bank, Washington DC.

POTTER, DAVID C. (1986)
India's political administrators 1919-1983. Clarendon Press, Oxford.

PRADHAN, T.M.S. (1996)
Gated or ungated. Water control in government-built irrigation systems. Ph.D. thesis. Wageningen Agricultural University.

PROCEEDINGS OF THE MADRAS GOVERNMENT, PUBLIC WORKS DEPARTMENT (1866)
Nos. 398-400, 20th August 1866; Nos. 523-525, July 1866.

PUBLIC WORKS COMMITTEE (1879)
Report from the Select Committee on East India (Public Works); together with the proceedings of the committee minutes of evidence, and appendix.

RAGHAVAN, T.N.S. (1947A)
Tungabhadra project. Low Level Canal Scheme. Report on cropping scheme. Government Press, Madras.

RAGHAVAN, T.N.S. (1947B)
Tungabhadra Project. Low Level Canal Scheme. Report on the levy of compulsory water rates-rates for different crops-concessions in the earlier years. Government Press, Madras.

RAGHAVAN, T.N.S. (1947C)
Tungabhadra Project. Low Level Canal Scheme. Report on labour and betterment contribution problems. Government Press, Madras.

RAJU, K.V. (1997)
Irrigation rules and laws for water distribution and management transfer. Paper for the IDPAD Seminar on "Managing water scarcity: experiences and prospects", Amersfoort, 13-17 October 1997.
RAMAKRISHNA REDDY, V. (1987)
Economic history of Hyderabad State (Warangal Suba: 1911-1950). Gian Publishing House, Delhi.
RAMAMURTHY, PRITI (1984)
Water management at the level of the chak: empirical observations and analyses of nine groups along distributary 36 of the Tungabhadra left bank canal. Report submitted to the Netherlands Ministry of Foreign Affairs as part of the Second Appraisal Mission to the Tungabhadra Project, Karnataka, India.
RAMAMURTHY, PRITI (1988)
Colonial policy and bureaucratic practice in the post colonial state: canal irrigation in India. Paper to be presented at the 17th Annual Conference on South Asia, Madison, Wisconsin, on November 4, 5 and 6, 1988. Syracuse University.
RAMAMURTHY, PRITI (1989)
On sangams and sirs: farmer associations and the irrigation bureaucracy in South India. Prepared for delivery at the 1989 Annual Meeting of the Association for Asian Studies, Washington Hilton and Towers, Washington DC. Syracuse Unversity.
RAMAMURTHY, PRITI (1995)
The political economy of canal irrigation in South India. Ph.D. thesis. The Graduate School of Syracuse University.
RAO, G.N. (1985)
"Transition from subsistence to commercialised agriculture. A study of Krishna district of Andhra, c.1850-1900". *Economic and Political Weekly*, Vol. 20, No. 25 & 26, pp. A60-69.
RAO, P.S. AND A. SUNDAR (1984)
"Tungabhadra project". *Wamana*, Vol. 4, No. 1, pp. 1-19.
RATH, N. AND A.K. MITRA (1989)
"Economics of irrigation in water-scarce regions: study of Maharashtra". *Artha Vijnana*, Vol. 31, No. 1, pp. 1-129.
RAY, BHARATI (1988)
Hyderabad and British Paramountcy 1858-1883. Oxford University Press, Delhi.
REIDINGER, RICHARD B. (1974)
"Institutional rationing of canal water in Northern India: conflict between traditional patterns and modern needs". *Economic Development and Cultural Change*, Vol. 23, No. 1, pp. 79-104.
REPETTO, ROBERT (1986)
Skimming the water: rent-seeking and the performance of public irrigation systems. Research Report No.4. World Resources Institute.
REPORT OF THE COMMITTEE ON PRICING OF IRRIGATION WATER (1992/94)
Government of India, Planning Commission, New Delhi, September 1992. Also in: *Indian Journal of Agricultural Economics*, Vol. 49, No. 1, 1994, pp. 107-133.
REPORT OF THE EXTERNAL REVIEW (1998)
Tungabhadra Irrigation Pilot Project, Phase II. Government of India, Ministry of Water Resources and Government of the Netherlands, Royal Netherlands Embassy. Delft
RICHARDS, PAUL (1985)
Indigenous agricultural revolution: ecology and food production in West Africa. Hutchinson, London.
ROSE, STEVEN (1987)
Molecules and minds. Essays on biology and the social order. Open University Press, Milton Keynes and Philadelphia, pp. 17-32.
ROSEGRANT, MARK W. AND HANS P. BINSWANGER (1994)
"Markets in tradable water rights: potential efficiency gains in developing country water resource allocation". *World Development*, Vol. 22, No. 11, pp. 1613-1625.
RUDOLPH, LLOYD I. AND SUSANNE HOEBER RUDOLPH (1987)
In pursuit of Lakshmi. The political economy of the Indian state. University of Chicago Press, Chicago and London.

RUDOLPH, LLOYD I. AND SUSAN HOEBER RUDOLPH (1988)
"Lakhsmi defended". *Journal of Commonwealth and Comparative Politics*, Vol. 26, No. 3, pp. 270-295.

RUSSELL, STEWART (1986)
"The social construction of artefacts: A response to Pinch and Bijker". *Social Studies of Science*, Vol. 16, No. 2, May 1986, p. 331-346.

SAFILIOS-ROTHSCHILD, CONSTANTINA (1988)
Farming systems and gender issues: implication for agricultural training and projects. (mimeograph)

SAIN, KANWAR (1959)
Report on visit to U.S.A., Italy, and Yugoslavia 1957. Government of India, Ministry of Irrigation & Power, Central Water & Power Commission, Zodiac Press, Delhi.

SALETH, R. MARIA (1996)
Water institutions in India. Economics, law and policy. Studies in Economic Development and Planning No. 63. Institute of Economic Growth, Delhi and Commonwealth Publishers, New Delhi.

SANDES, E.W.C. (1935)
The military engineer in India. Vol. II. The Institution of Royal Engineers, Chatham.

SANTHAKUMAR, V. AND R. RAJAGOPALAN (1993)
"Technological prejudice: Case of Indian irrigation". *Economic and Political Weekly*, Vol. 28, No. 14, pp. 586-594.

SANTHAKUMAR, V., R. RAJAGOPALAN AND S. AMBIRAJAN (1995)
"Planning Kerala's irrigation projects: Technological prejudice and politics of hope". *Economic and Political Weekly*, Vol. 30, No. 12, March 25, pp. 30-38.

SARAP, KAILAS (1991)
Interlinked agrarian markets in rural India. Institute of Economic Growth. Studies in Economic Development and Planning No. 57. Sage, New Delhi.

SATHYAMURTHY, T.V. (1998)
"Labour of Sisyphus, feast of Barmecide. The sentence and the promise in development studies". *Economic and Political Weekly*, Vol. 32, No. 24, pp. 1447-1451.

SATYANARAYANA, A. (1990)
Andhra peasants under British rule. Agrarian relations and the rural economy 1900-1940. Manohar Publications, New Delhi.

SAYER, ANDREW (1981)
"Abstraction: a realist interpretation". *Radical Philosophy*, No. 28, pp. 6-15.

SAYER, ANDREW (1984)
Method in social science. A realist approach. Hutchinson, London.

SCHEER, STEVEN H. (1996)
Communication between irrigation engineers and farmers: The case of project design in North Senegal. Ph.D. thesis. Wageningen Agricultural University.

SCHENDEL, WILLEM VAN (1991)
Three deltas. Accumulation and poverty in rural Burma, Bengal and South India. Indo-Dutch Studies on Development Alternatives 8, Sage, New Delhi.

SCHRIJVERS, JOKE (1985)
Mothers for life. Motherhood and marginalization in the North Central Province of Sri Lanka. Eburon, Delft.

SCOONES, IAN AND JOHN THOMPSON (1994)
Beyond farmer first. Rural people's knowledge, agricultural research and extension practice. Intermediate Technology Publications, London.

SCOTT-MONCRIEFF, C.C. (1868)
Irrigation in Southern Europe. Being the report of a tour of inspection of the irrigation works of France, Spain, and Italy, undertaken in 1867-68 for the Government of India. E. & F.N. Spon, London.

SEN, AMARTYA (1977)
"Rational fools: a critique of the behavioural foundations of economic theory". *Philosophy and Public Affairs*, 6.

SEN, D. AND P.K. DAS (1986)
Water utilisation at farm level. A study in Tungabhadra command area. National Institute of Rural Development, Hyderabad.

SENGUPTA, NIRMAL (1985)
"Irrigation: traditional vs. modern". *Economic and Political Weekly*, Vol. 20, No. 45, 46 & 47, pp. 1919-38.

SENGUPTA, NIRMAL (1991)
Managing common property. Irrigation in India and the Philippines. Indo-Dutch Studies on Development Alternatives 6. Sage, New Delhi.

SENGUPTA, NIRMAL (1993)
User-friendly Irrigation Designs. Sage Publications. New Delhi and London.

SHAH, ANIL C. (n.d.)
Learning from farmers (PRA approach for PIM). (mimeograph)

SHAH, TUSHAAR (1993)
Groundwater markets and irrigation development: political economy and practical policy. Oxford University Press, Bombay.

SHAH, TUSHAAR (1997)
The deepening divide: Diverse responses to the challenge of groundwater depletion in Gujarat. Paper presented at the IDPAD "Managing water scarcity: experiences and prospects" conference, Amersfoort, the Netherlands, 13-17 October 1997.

SHANAN, L., B. ALBINSON, R.L. CHOPRA AND B.K. UPPAL (1986)
Design and operating guidelines for structured irrigation networks. Fourth draft paper. Irrigation II Division, South Asia Projects Department, April.

SHANMUGHAM, C.R. (1991)
Organising farmers for irrigation management: the Lower Bhavani Project experience. Administrative Staff College of India, Hyderabad and The Ford Foundation.

SHIVA, VANDANA (1988)
Staying alive: women, ecology and survival in India. Kali for Women, New Delhi and Zed Books, London.

SINGH, K.K. (ED.) (1981)
Warabandi for irrigated agriculture in India. Publication No. 146. Central Board of Irrigation and Power, New Delhi.

SINGH, K.K. (ED.) (1991)
Farmers in the management of irrigation systems. Sterling, New Delhi.

SINGH, NARESH AND VANGILE TITI (1995)
Empowerment for sustainable development: toward operational strategies. Fernwood Publishing, Nova Scotia and Zed Books, Atlantic Highlands.

SINGH, SATYAJIT (1997)
Taming the waters: the political economy of large dams in India. Oxford University Press, New Delhi.

SIRIWARDENA, S.S.A.L. (1989)
From planned intervention to negotiated development. The struggle of bureaucrats, farmers and traders in the Mahaweli irrigation scheme in Sri Lanka. Ph.D. thesis. Agricultural University of Wageningen.

SIVAMOHAN, M.V.K. (ED.) (1986)
Issues in irrigated agriculture and command area development. Ashish. New Delhi.

SIVAMOHAN, M.V.K. AND CHRISTOPHER A. SCOTT (EDS.) (1994)
India: irrigation management partnerships. Booklinks Corporation, Hyderabad.

SIVASWAMY, K.G. (1947)
Land speculators and absentee buyers in the Tungabhadra Project area. South Indian Federation of Agricultural Workers Unions, Madras.

SMALL, LESLIE E. AND MARK SVENDSEN (1992)
A framework for assessing irrigation performance. Working Papers on Irrigation Performance 1. International Food Policy Research Institute, Washington.

SMITH, SHELDON AND ED REEVES (EDS.) (1989)
Human systems ecology. Studies in the integration of political economy, adaptation and socionatural regions. Westview Special Studies in Applied Anthropology. Westview Press, Boulder.

SMITS, ANNET (1993)
Vrouwenwerk. Een onderzoek in Raichur District, India. M.Sc. thesis. Vakgroep Vrouwenstudies in de Landbouw. Wageningen Agricultural University.

SREERAMAKRISHNAIAH, K. (1979)
Tungabhadra complex. A draft note on the study of cropping pattern proposals, 1900 AD to 1979 AD. (mimeograph)

SRIVASTAVA, L.P. AND JEFFREY D. BREWER (1994)
Irrigation management transfer at Paliganj canal, Bihar, India. Short report series on locally managed irrigation. Report No. 7. International Irrigation Management Institute.

STONE, IAN (1984)
Canal irrigation in British India. Perspectives on technological change in a peasant economy. Cambridge South Asian Studies No.29. Cambridge University Press, Cambridge.

STRAATEN, KEES VAN (1992)
Power, corruption and lies. Water distribution on a distributary of the Tungabhadra Left Bank Canal Karnataka, India. M.Sc. thesis. Department of Irrigation and Soil and Water Conservation, Wageningen Agricultural University.

SVENDSEN, MARK (1991)
"Sources of future growth in Indian irrigated agriculture". In: Ruth Meinzen-Dick and Mark Svendsen (eds.) *Future directions for Indian irrigation: research and policy issues.* IFPRI, Washington DC, pp. 42-68.

SVENDSEN, MARK AND ASHOK GULATI (EDS.) (1994)
Strategic change in Indian irrigation. Indian Council of Agricultural research, New Delhi, India and International Food Policy Research Institute, Washington DC.

SUFI, AHMED B.N. AND F.A. ZUBERI (1993)
"Improving irrigation and drainage of irrigated lands of the Punjab in view of Water Apportionment Accord of 1991". Water management in the next century. *Transactions of the 15th International Congress on Irrigation and Drainage. Volume 1-A.* International Commission on Irrigation and Drainage, New Delhi. pp. 387-402.

THE IRRIGATION CONFERENCE SIMLA 1904 (1905)
Vol. I Papers, Vol. II Discussion, Vol. III Plates. Superintendent of Government Printing Press, Calcutta.

THE OSMANIA ENGINEERING GRADUATES ASSOCIATION (1948)
Development of Hyderabad (the part played by Engineers). Popular Pamphlet No.1.

THIRUMALAI IYENGAR, M.S. (1945)
Report on the Tungabhadra project, 1942. Low level canal scheme. Public Works Department Madras. Government Press, Madras, 61pp.

THORNER, DANIEL AND ALICE THORNER (1962)
"The weak and the strong on the Sarda canal". In: *Land and labour in India.* Asia Publishing House, London, pp. 14-20.

TIPP-II (1996)
Water quality assessment. Water quality monitoring plan and preliminary sampling results. Ministry of Foreign Affairs, Directorate General for International Cooperation, the Netherlands and Command Area Development Authority Tungabhadra Scheme, Munirabad, India.

TOYE, JOHN (1988)
"Political economy and the analysis of Indian development". *Modern Asian Studies,* Vol. 22, No. 1, pp. 97-122.

TUNGABHADRA BOARD (1959)
Tungabhadra project. Resume of work 1945-58. Government Press, Bangalore.

TUNGABHADRA PROJECT (1970)
Proceedings. Agricultural information seminar-cum-workshop, Munirabad, Raichur District (Mysore State) April 14 to 17, 1970. Bangalore.

UAS (1973)
Seminar on problems and prospects of soil and water management in Tungabhadra Project area. Seminar proceedings. Held at Agricultural Research Station Siruguppa, January 29, 1973.

UBELS, JAN (1989)
"Irrigation systems as social interfaces: Towards an understanding of irrigation development as an interactional process". Norman Long (ed.), *Encounters at the interface: A perspective on social discontinuities in rural development*. Wageningse Sociologische Studies 27, Wageningen Agricultural University, pp. 183-204.

UIJANKOP, S.R. (1995)
Mexican model of participatory irrigation management and its applicability in our context. Paper presented in the workshop on Land and Water, organised by Indo-Dutch Development Programme Royal Netherlands Embassy, New Delhi, held at Bangalore, December 7-8, 1995.

UPADHYA, CAROL BOYACK (1988)
"The farmer-capitalists of coastal Andhra Pradesh". *Economic and Political Weekly*, Vol. 23, No. 27, pp. 1376-1382 and Vol. 23, No. 28, pp. 1433-1442.

UPHOFF, NORMAN (1986)
Getting the process right: improving water management with farmer organisation and participation. Working Paper. Cornell University, Ithaca.

UPHOFF, NORMAN (WITH PRITI RAMAMURTHY AND ROY STEINER) (1991)
Managing irrigation. Analyzing and improving the performance of bureaucracies. Sage, New Delhi.

UPHOFF, NORMAN, W.L. WICKRAMASINGHE AND C.M. WIJAYARATNA (1990)
""Optimum" participation in irrigation management: issues and evidence from Sri Lanka". *Human Organization*, Vol. 49, No. 1, pp. 26-40.

VAIDYANATHAN, A. (1983)
Water control institutions and agriculture: a comparative perspective. Working Paper No.178. Centre for Development Studies, Trivandrum. (Also in *Indian Economic Review*, Vol XX, No. 1, 1984, pp. 25-83).

VAIDYANATHAN, A. (1991)
"Critical issues facing Indian irrigation". In: Ruth Meinzen-Dick and Mark Svendsen (eds.) *Future directions for Indian irrigation: research and policy issues*. IFPRI, Washington DC.

VANAIK, ACHIN (1990)
The painful transition. Bourgeois democracy in India. Verso, London and New York.

VANDERVELDE, EDWARD J. (1980)
"Local consequences of a large scale irrigation system in India". In: E. Walter Coward (ed.) *Irrigation and agricultural development in Asia*. Perspectives from the social sciences. Cornell University Press, Ithaca and London, pp. 299-328.

VARMA, C.V.J. AND K.R. SAXENA (EDS.) (1989)
Modern temples of India. Selected speeches of Jawaharlal Nehru at Irrigation and Power projects and various technical meetings of engineers and scientists.

VARSHNEY, ASHUTOSH (1993)
"Self-limited empowerment: democracy, economic development and rural India". *Journal of Development Studies*, Vol. 29, No. 4, Special Issue: Beyond Urban Bias, edited by A. Varshney, pp. 177-215.

VENKATA REDDY, M. (1979)
"Hybrid cotton: adoption and yield" In: J.P. Singh, K.V. Govindaraju, M. Prahladachar, S. Giriappa, A.R. Rajapurohit, M. Venkata Reddy and D.V. Raghava Rao. *New seeds. Adoption and yield*. Sterling Publishers, New Delhi, pp. 185-275.

VENKATA REDDY, M. (1990)
Dynamics of irrigation water management. Ashish Publishing House, New Delhi.

VENKATA RAMIAH, P. (1937)
Report on the soil survey of the Tungabhadra project Department of Agriculture Madras. Government Press, Madras.

VERHOEVEN, RICK (1992)
Irrigatie in het Raichur District: een onderzoek naar de reactie van de Kannada boeren op de introduktie van irrigatie in het Raichur District, in India in 1956. Master's thesis. Erasmus University, Rotterdam.

VERMILLION, D.L. (1996)
The privatization and self-management of irrigation: final report. IIMI, Colombo.

VIJAYATILAKAM, K.J. (1998)
Legislators in Indian politics. Rawat Publications, Jaipur, New Delhi.

VILLARREAL, MAGDALENA (1994)
Wielding and yielding: power, subordination and gender identity in the context of a Mexican development project. Ph.D. thesis. Wageningen Agricultural University.

VINCENT, LINDEN F. (1997)
Irrigation as a technology, irrigation as a resource: a sociotechnical approach to irrigation. Inaugural *lyecture*. Wageningen Agricultural University.

VISVESVARAYA, M. (1934)
Planned economy for India. Bangalore Press, Bangalore.

VISVESVARAYA, M. (1951)
Memoirs of my working life. Bangalore.

VOHRA, B.B. (1975)
Land and water management problems in India. Training Volume-8. Training Division. Department of Personnel and Administrative Reforms, Cabinet Secretariat, New Delhi.

VYASULU, VINOD (1997)
"Nehru and the Visvesvaraya legacy". In: *Facets of development. Studies in Karnataka*. Rawat Publications, Jaipur and New Delhi, pp. 33-48.

VYASULU, VINOD AND B.P. VANI (1997)
"Development and deprivation in Karnataka: a district level study". *Economic and Political Weekly*, Vol. 32, No. 46, pp. 2970-2975.

WADE, ROBERT (1975)
Water to the fields: institutional innovations in India's Command Area Development programme. IDS Discussion Paper No. 79. Institute of Development Studies, Sussex.

WADE, ROBERT (1976)
Rationing water: principle and practice in South India. ODI workshop on choices in irrigation management. ODI Workshop on Choices in Irrigation Management 27 September-1 October 1976. Paper C.4. Institute of Development Studies, Sussex. (mimeograph)

WADE, ROBERT (1979)
"The social response to irrigation: an Indian case study". *Journal of Development Studies*, Vol. 16, No. 1, pp. 3-26.

WADE, ROBERT (1980A)
"Access to the irrigation department: the tail-end problem under South Indian irrigation canals". *Indian Journal of Public Administration*, Vol. 26, pp. 359-378.

WADE, ROBERT (1980B)
"On substituting management for water in canal irrigation". *Economic and Political Weekly*, Vol. 15, No. 52, pp. A147-160.

WADE, ROBERT (1982A)
"The system of administrative and political corruption: canal irrigation in South India". *Journal of Development Studies*, Vol. 18, No. 3, pp. 287-328.

WADE, ROBERT (1982B)
"The World Bank and India's Irrigation Reform". *Journal of Development Studies*, Vol. 18, No. 2, pp. 171-184.

WADE, ROBERT (1985)
"The market for public office: why the Indian state is not better at development". *World Development* Vol. 13, No. 4, pp. 467-497

WADE, ROBERT (1988A)
Village republics: economic conditions for collective action in South India. Cambridge South Asian Studies No.40. Cambridge University Press, Cambridge.

WADE, ROBERT (1988B)
"The management of irrigation systems: How to evoke trust and avoid prisoner's dilemma". *World Development*, Vol. 16, No. 4, pp. 489-500.

WADE, ROBERT (1990)
"On the 'technical' causes of irrigation hoarding behavior, or why irrigators keep interfering in the main system". In: R.K. Sampath and Robert A. Young (eds.) *Social, economic and institutional issues in Third World irrigation management*. Studies in Water Policy and Management No.15. Westview Press, Boulder, pp. 175-193.

WADE, ROBERT (1995)
"The ecological basis of irrigation institutions: East and South Asia". *World Development*, Vol. 23, No. 12, pp. 2041-2049.

WADE, ROBERT AND ROBERT CHAMBERS (1980)
"Managing the main system: canal irrigation's blind spot". *Economic and Political Weekly*, Vol. 15, No. 39, pp. A107-112.

WALLACE, TINA (1981)
"The Kano river project, Nigeria. The impact of an irrigation scheme on productivity and welfare". In: J. Heyer, P. Roberts and Gavin Williams (eds.) *Rural development in tropical Africa*. St. Martin's Press, New York, pp. 281-305.

WALLACH, BRET (1985)
"British irrigation works in India's Krishna basin". *Journal of Historical Geography*, Vol. 11, No. 2, pp. 155-173.

WEBSTER'S new dictionary of synonyms. (1984)

WHATMORE, SARAH, RICHARD MUNTON, TERRY MARSDEN AND JO LITTLE (1987)
"Towards a typology of farm businesses in contemporary British agriculture". *Sociologia Ruralis*, Vol. 17, No. 4, pp. 21-37.

WHITCOMBE, ELIZABETH (1972)
Agrarian conditions in northern India. Vol. I. The United Provinces under British rule, 1860-1900. University of California Press, Berkeley.

WHITCOMBE, ELIZABETH (1983)
"Irrigation". In: Dharma Kumar (ed.) *The Cambridge economic history of India. Vol 2: c.1757 - c.1970*. Cambridge University Press, Cambridge.

WILSON, HERBERT M. (1903)
Irrigation in India. Daya Publishing House, Delhi. (1989 reprint)

WINNER, LANGDON (1985)
"Do artefacts have politics? In: Donald MacKenzie and Judy Wajcman (eds.) *The social shaping of technology. How the refrigerator got its hum*. Open University Press, Milton Keynes and Philadelphia, pp. 26-38.

WINNER, LANGDON (1993)
"Upon opening the black box and finding it empty: social constructivism and the philosophy of technology". *Science, Technology and Human Values*, Vol. 18, No. 3, pp. 362-378.

WITHERS, BRUCE AND STANLEY VIPOND (1974)
Irrigation: design and practice. B.T. Batsford, London.

WITTFOGEL, KARL A. (1957)
Oriental despotism. A comparative study of total power. Vintage Books, New York (1981 edition).

WOOD, GEOF D. (1995)
From farms to services: agricultural reformation in Bangladesh. Draft paper, prepared for Workshop on Agricultural Growth and Agrarian Structure in Contemporary West Bengal and Bangladesh. Centre for Studies in Social Sciences, Calcutta 9-12 January 1995.

WORLD BANK (1991)
India. Irrigation sector review. Volume I: Main Report. Volume II: Supplementary Analysis. Report No. 9518-IN. Agriculture Operations Division, India Country Department, Asia Region.

WORSTER, DONALD (1985)
Rivers of empire: water, aridity, and the growth of the American West. Pantheon Books, New York.

YIN, ROBERT K. (1984)
Case study research. Design and methods. Applied Social Research Methods Series Volume 5. Sage Publication, Newbury Park (revised edition).

ZAAG, PIETER VAN DER (1992)
Chicanery at the canal. Changing practice in irrigation management in western Mexico. CEDLA, Amsterdam.

ZEY, MARY (1992)
"Criticisms of rational choice models". In: (ed.) *Decision making: alternatives to rational choice models*. Sage, Newbury, pp. 9-31.

ZWART, FRANK DE (1992)
Mobiele bureaucratie. Manipulaties met overplaatsingen van ambtenaren in India. Ph.D. thesis. University of Amsterdam.

NEDERLANDSE SAMENVATTING

Dutch Summary

DE WATERLINIE
Waterverdeling, technologie en agrarische verandering in een kanaal-irrigatiesysteem in Zuid India

Dit boek bespreekt waterverdeling in het Tungabhadra Left Bank Canal irrigatiesysteem in Raichur district, Karnataka, India. Het is gelegen in het binnenland van Zuid India, waar de regenval laag is (ongeveer 600 mm per jaar) en zeer variabel. In het verleden werd het gebied geteisterd door mislukte oogsten en hongersnoden. Een grootschalig irrigatiesysteem werd geconstrueerd ter oplossing van deze problemen. Het systeem is operationeel sinds 1953 en was volledig gereed in 1968. Het te irrigeren areaal is 240.000 ha.

Het Tungabhadra Left Bank Canal is een zogenaamd 'protective' ('beschermend') irrigatiestelsel. Het is ontworpen om het beschikbare water dun te spreiden over een grote oppervlakte. Er is sprake van supplementaire en partiële irrigatie. De gewas-waterbehoefte wordt niet geheel gedekt en in een bepaald seizoen wordt slechts een gedeelte van het areaal geïrrigeerd. Niet de produktie per eenheid land wordt gemaximaliseerd, maar die per eenheid water.

In het laatste punt ligt een fundamentele tegenstrijdigheid besloten. Voor een boer met een gegeven hoeveelheid land ligt het meer voor de hand om per eenheid land te maximaliseren, in plaats van bij te dragen aan het maximale totale produkt gegeven de hoeveelheid water. De meest rendabele gewassen, rijst en suikerriet, vragen veel water. Daarom eigenen boeren die daartoe de mogelijkheid hebben zich meer water toe dan hun 'beschermende' deel, waardoor anderen te weinig krijgen. Het irrigatiewater in het Tungabhadra Left Bank Canal wordt in de praktijk net als in veel andere irrigatiesystemen zeer ongelijk verdeeld.

Hoe deze ongelijke verdeling van dag tot dag tot stand komt is het centrale thema van het proefschrift. Het beoogt een interdisciplinaire analyse van 'water control' (waterbeheersing) op verschillende nivo's: het tertiaire vak, het secundaire kanaal, en het hoofdkanaal. De technisch/fysische, organisatorische en sociaal-economisch/politieke dimensies van de problematiek worden met elkaar in verband gebracht. De centrale onderzoeksvraag is de volgende.

> *Hoe worden de organisatievormen voor waterverdeling in het Tungabhadra Left Bank Canal beïnvloed door 1) het patroon van de commercialisering van de landbouw, 2) de vorm van overheidsregulatie en 3) de technische infrastructuur, en hoe beïnvloeden die organisatievormen op hun beurt deze faktoren ?*

De gevolgde methode is die van een intensieve gevalstudie. Het onderzoek is gestart op lokaal nivo met de bestudering van de waterverdeling in een aantal tertiaire vakken (lokale irrigatie-eenheden waar boeren onderling het water verdelen), gelegen in het bovenstroomse en het benedenstroomse deel van het irrigatiestelsel, waar een zekere mate van waterschaarste heerstte. De veronderstelling was dat waterschaarste organisatie zou induceren.

Na het onderzoek op dit nivo bewogen de onderzoekingen zich geleidelijk tegen de stroom in het kanaalstelsel op naar de daar gelegen verdeelpunten, naar de kantoren van de ambtenaren van het Irrigatie Departement die dit gedeelte van het stelsel beheren, naar de huizen van politici, naar de winkels van de handelaren in zaaigoed en kunstmest, en zelfs naar het Hooggerechtshof en Parlement van Karnataka. Er zijn vooral sociaal-antropologische onderzoekstechnieken gebruikt.

Het boek bestaat uit tien hoofdstukken. Na een inleiding bespreekt hoofdstuk 2 het theoretische raamwerk van de analyse. Hoofdstuk 3 t/m 5 geven achtergrondsinformatie over het verschijnsel 'beschermende' irrigatie, het ontwerp van het systeem, en de sociaal-economische ontwikkeling in de regio als gevolg van de irrigatie. De kern van het proefschrift wordt gevormd door hoofdstuk 6 t/m

9 waarin de waterverdelingspraktijken op de verschillende nivo's besproken worden. Hoofdstuk 10 geeft de konklusies en bespreekt de mogelijkheid van hervorming van de huidige situatie m.b.t. het waterbeheer.

Hoofdstuk 2 introduceert de twee analytische kernbegrippen. Het eerste is de notie dat irrigatiesystemen sociaaltechnische systemen zijn. Ze zijn heterogeen en complex omdat ze bestaan uit een groot aantal verschillende typen elementen, die op complexe wijze met elkaar verbonden zijn. Het tweede begrip is 'water control' of waterbeheersing. Er worden drie dimensies van 'water control' onderscheiden: de technisch/fysische dimensie, de organisatorische dimensie en de sociaal-economisch/politieke dimensie. De centrale aanname is dat deze drie dimensies onlosmakelijk met elkaar verbonden zijn. 'Water control' in irrigatie wordt beschreven als een voorbeeld van politiek betwist gebruik van een natuurlijke hulpbron ('politically contested resource use'). Hiermee wordt het belang van sociale machtsverhoudingen in het gebruik van irrigatiewater benadrukt.

In hoofdstuk 3 worden de begrippen 'bescherming en lokalisatie' ('protection and localisation') besproken. 'Bescherming' is een begrip dat stamt uit het Britse koloniale irrigatiebeleid. Drie betekenissen worden geïdentificeerd: 1) de algemene betekenis van de funktie van irrigatie als bescherming tegen droogte/oogstmislukking en hongersnood, 2) beschermende irrigatie als een financieel-administratieve categorie van irrigatiewerken in de koloniale tijd, en 3) beschermende irrigatie als een specifiek type irrigatie in de technische, organisatorische en sociaal-economisch/politieke zin. Onderdeel van 'bescherming' is in Zuid India de zogenaamde lokalisatie. Dit is een vorm van landgebruiksplanning waarin de overheid wettelijk aan boeren voorschrijft welke gewassen zij wel en niet met het irrigatiewater mogen verbouwen.

Het is opvallend dat de beschermingsdoelstelling een centraal element in het Indiase irrigatiebeleid is gebleven, ook na de onafhankelijkheid van India, ondanks de (erkende) praktijk van ongelijke waterverdeling. De verklaring hiervoor wordt gevonden in het populistische karakter van het Indiase politieke systeem. Politici handelen als 'resource brokers' ('hulpbron-makelaars') die hun politieke steun zeker kunnen stellen o.a. door te zorgen dat er irrigatiekanalen naar hun kiesdistrict aangelegd worden. Tegelijkertijd zijn ze binnen hun kiesdistrict vooral afhankelijk van de categorie van grote boeren, die nu juist zichzelf teveel water toeëigenen. Daarom ondernemen dezelfde politici geen aktie tegen ongelijke verdeling. Vanwege de invloed van politici op de uitvoering van hun werk zitten de ambtenaren van het Irrigatie Departement ook in een moeilijk parket.

Het tot stand komen van het Tungabhadra Left Bank Canal wordt besproken in hoofdstuk 4. De geschiedenis van het stelsel begint in de periode 1850-1860. De uitvoering van de plannen die toen en daarna zijn gemaakt voor een kanaal in Raichur district, werd bemoeilijkt door de verhouding tussen Madras Presidency, direkt bestuurd door een Britse koloniale regering, en de Nizam's Dominions, een formeel onafhankelijke 'Princely State'. De Tungabhadra rivier was de grensrivier tussen deze gebieden en de konstruktie van een dam voor het reservoir vereiste toestemming van beide overheden. Langdurige politieke onderhandelingen waren nodig om een verdeling van het beschikbare water overeen te komen. Uiteindelijk werd besloten, ondanks de dominantie van Madras Presidency, tot een 50/50 verdeling van het water. In 1944 was er een principe-overeenkomst, maar de onderhandelingen duurden nog voort tot 1976, onder andere als gevolg van de herindeling van de Indiase Staten na de onafhankelijkheid.

In 1945 werd begonnen met de constructie van het project. Toen de beschikbare hoeveelheid water eenmaal was vastgesteld was het verdere ontwerp vooral een aangelegenheid van ingenieurs, met weinig externe invloed. Het gewaspatroon was vanaf het begin 'protective', en vooral kosten faktoren hebben een rol gespeeld bij het bepalen van de tracé's van de kanalen. Er is geen rekening gehouden met sociale grenzen zoals die van dorpen en boerenbedrijven; topografie en bodemsoort zijn bepalend geweest voor het ontwerp. De verklaring hiervoor ligt in de zeer hoge sociale status van ingenieurs in die periode die het betwijfelen van hun technische keuzes onmogelijk maakte, en het ontbreken van instituties voor overleg en onderhandeling over ontwerp elementen.

De komst van irrigatie in Raichur district heeft gezorgd voor een zeer sterke economische ontwikkeling, die beschreven wordt in hoofdstuk 5. Irrigatie heeft geleid tot het ontstaan van een intensieve gecommercialiseerde landbouw met een hoge produktiviteit. De migratie van boeren uit de naburige deelstaat Andhra Pradesh naar het nieuwe irrigatiestelsel heeft een sleutelrol gespeeld in deze ontwikkeling. Zij brachten voldoende investeringskapitaal en kennis van de geïrrigeerde landbouw mee, en begonnen een landbouwbedrijfssysteem gebaseerd op de verbouw van rijst, en in mindere mate suikerriet. De lokale bevolking ontbrak het in eerste instantie in het algemeen aan investeringsmiddelen. De migranten kochten land van de lokale boeren; de groteren onder de laatsten gebruikten de opbrengst van de verkoop om ook te investeren in de ontwikkeling van hun land voor irrigatie (egalisatie, aanleggen van dijkjes rond de velden). Er heeft een massale overdracht van land aan migranten plaatsgevonden. Na verloop van tijd is ook geïnvesteerd, zowel door migranten als lokale boeren, in irrigatie met pompen, vanuit de rivier en de natuurlijke afvoerkanalen.

Er is een geografisch patroon ontstaan waarin grote en middelgrote boeren vooral land hebben in de bovenstroomse delen van de kanalen, en kleine en marginale boeren vooral in de benedenstroomse delen (in het hoofdstuk wordt eerst een typologie van deze vier categorieën ontwikkeld). Niettegenstaande deze algemene correlatie tussen lokatie en sociaal-economische klasse, verschilt de preciese relatie van geval tot geval. Migranten konden niet altijd land verwerven in de geografisch meest gunstige lokaties, en ook ontstond soms waterschaarste in gebieden waar eerder voldoende water beschikbaar was. Het proces van relokatie van landbezit met het oog op toegang tot water gaat nog steeds door via de mechanismen van aan- en verkoop van land, via de overdracht van land in bruidschatten, en via het verkrijgen van land door het uitzetten van leningen met land als onderpand.

Het proces van agrarische verandering kan niet goed begrepen worden zonder deze inherente ruimtelijke dimensie.

Hoofdstuk 6 is het eerste hoofdstuk over de dagelijkse waterverdelingspraktijk. Het analyseert de gebeurtenissen op het nivo van het tertiaire vak, waar boeren onderling de waterverdeling bepalen. Er blijken in veel gevallen gedetailleerde stelsels van regels te bestaan voor roterende waterverstrekking. Deze zijn gebaseerd op de principes van het verdelen van de irrigatie-eenheid in zones, het vaststellen van een volgorde in de irrigatie, en een vaste irrigatietijd per eenheid oppervlakte. De regels worden gebruikt in tijden van schaarste; daarbuiten vindt irrigatie plaats op basis van onderlinge afspraken.

Ondanks het bestaan van regels gebaseerd op een gelijkheidsprincipe kan sterk ongelijke waterverdeling geobserveerd worden. Dit komt doordat de regels slechts het aanbod van water betreffen, en niet continu worden toegepast. De vraag naar water is gedifferentieerd. Kleine, benedenstroomse boeren anticiperen op het verliezen van konflikten over water met grotere, bovenstroomse boeren door gewassen te verbouwen die minder water vergen, maar die ook minder rendabel zijn. De anticipatie komt voort uit hun afhankelijkheid van de grotere boeren voor het verkrijgen van krediet en werkgelegenheid voor henzelf en hun familieleden. Ook treden de grotere boeren op als vertegenwoordigers van de lokale irrigatie-eenheid in diskussies met het Irrigatie Departement en andere aktiviteiten om de watervoorziening veilig te stellen.

De waterverdeling op het nivo van het secundaire kanaal, in India 'distributary' genoemd, wordt behandeld in hoofdstuk 7 (de organisatorische aspekten) en hoofdstuk 8 (de technische aspekten). Hoofdstuk 7 bespreekt welke regels voor roterende waterverstrekking er ontstaan zijn in de interactie tussen de ambtenaren van het Irrigatie Departement die deze kanalen beheren, en de watergebruikers. In veel secundaire kanalen bestaan regels voor rotatie, die ook weer gemobiliseerd worden in tijden van schaarste. Ook hier bewerkstelligen de regels geen gelijkheid in waterverdeling. Ze drukken de machtsverhouding uit tussen groepen gebruikers in verschillende delen van het geïrrigeerde gebied, en die tussen watergebruikers en overheid.

In tegenstelling tot wat vaak gedacht wordt is corruptie niet het dominante mechanisme in de waterverdeling op secundair nivo in het Tungabhadra Left Bank Canal. De moeizame relatie tussen overheidsbeheerders en watergebruikers wordt niet ingevuld door middel van financiële transacties, maar door politieke bemiddeling. Lokale politici (parlementsleden) kunnen onder bepaalde omstandigheden een belangrijke rol spelen in de waterverdeling. De politici zijn afhankelijk van de politieke steun van boeren, die hen in ruil voor stemmen kunnen vragen het gedrag van de Irrigatie Departement staf te beïnvloeden. De lokale parlementsleden hebben macht over de Irrigatie Departement staf omdat zij veel invloed hebben op de driejaarlijkse (of eerdere) overplaatsing van ambtenaren. Zo ontstaat een 'driehoek van aanpassing' ('triangle of accommodation'), waarin geen van de partijen (boeren, ambtenaren en politici) de absolute overhand heeft, en waar voortdurend onderhandeld moet worden over de verdeling van het water.

Hoofdstuk 8 concentreert zich op het kunstwerk dat het secundaire kanaal verbindt met de lokale irrigatie-eenheid: de 'pipe outlet structure'. Omdat het debiet dat door de pijp van het secundaire kanaal naar de veldleiding stroomt afhangt van zowel de bovenstroomse als de benedenstroomse waterstand, en van de doorsnede van de opening van de pijp (die aangepast kan worden met een schuif), is het praktisch onmogelijk het debiet met enige nauwkeurigheid te regelen. Ook is het daardoor onbekend hoeveel water er precies afgetapt wordt. Waarom tot de dag van vandaag dit kunstwerk gebruikt wordt, en niet andere elders in India gebruikte kunstwerken die meer toegesneden zijn op de taak van gelijke waterverdeling, is niet geheel duidelijk.

Er bestaat in de praktijk een grote variatie in de preciese karakteristieken van de 'pipe outlet structure': stevigheid van konstruktie (beton/metselwerk), de plaats van de schuif (wel of niet zichtbaar en toegankelijk), het type slot of sloten dat bevestigd is en andere kenmerken. Deze variatie is een afspiegeling van de waterverdelingspraktijken en -problemen langs het betreffende kanaal. De kenmerken en de staat van de kunstwerken zijn een uitdrukking van de verhoudingen tussen verschillende groepen boeren en tussen boeren en de Irrigatie Departement.

Het laatste hoofdstuk over waterverdelingspraktijken, hoofdstuk 9, gaat over veranderingsprocessen binnen het Irrigatie Departement m.b.t. het beheer van het hoofdkanaal. In een tweejarige periode van extreem watertekort (1988-1990) hebben een aantal institutionele veranderingen plaatsgevonden die de watervoorziening naar het benedenstroomse deel van het kanaal verbeterd hebben. De oorspronkelijke regels voor verdeling van het water op basis van het voorgeschreven gewaspatroon zijn losgelaten. Daarvoor in de plaats zijn regels gekomen die aan de ene kant ongelijkheid bestendigen, maar aan de andere kant een realistischer basis vormen voor het onderhandelen over de waterverstrekking aan het benedenstroomse gedeelte van het kanaal. Als gevolg van het invoeren van deze nieuwe regels is de watervoorziening aan het benedenstroomse gedeelte van het hoofdkanaal verbeterd, en vooral stabieler geworden.

Het slothoofdstuk, hoofdstuk 10, geeft een samenvattend antwoord op de onderzoeksvraag, en bespreekt de implicaties van de analyse voor hervorming van het waterbeheer. Er wordt betoogd dat de analyse zowel een aantal structurele beperkingen of struikelblokken heeft geïdentificeerd voor hervorming, maar dat de dagelijkse praktijk van de waterverdeling ook openingen biedt voor verandering. De laatste liggen in de kapaciteit voor zelfbeheer door watergebruikers, de gezamenlijke formulering van regels voor waterverdeling door watergebruikers en Irrigatie Departement staf, en de technische creativiteit en de mogelijkheid van institutionele verandering binnen het Irrigatie Departement.

Vervolgens wordt besproken welke perspectieven er bestaan op de door bijna iedereen gevoelde noodzaak van hervorming. Deze variëren van technische en management argumenten voor 'goed beheer', economische argumenten voor 'efficiënt beheer', ecologische argumenten voor 'duurzaam beheer', tot politieke argumenten voor 'egalitair en democratisch beheer'. Gepoogd wordt een beschrijving te geven van een omvattende benadering waarin technische, organisatorische, economische en politieke elementen verweven zijn.

Wat betreft de situatie in Karnataka m.b.t. de hervorming van irrigatiebeleid wordt gesteld dat meer aandacht voor de participatie van gebruikers en andere belangengroepen in de formulering van beleid nodig is. Nu vinden pogingen tot verandering tamelijk geïsoleerd plaats op hoge nivo's binnen de overheid, of in individuele, lokale situaties in de irrigatiestelsels. Het werken aan een breed maatschappelijk draagvlak wordt als prioriteit genoemd.

Tenslotte worden een aantal onderzoeksonderwerpen genoemd en kort besproken die zouden kunnen bijdragen aan de hervormingsagenda. Dit zijn het ontwerpproces van de kanaalirrigatie technologie, de politieke dimensie van irrigatie, en de kwestie van gebruiksrechten. Dit onderzoek moet gesitueerd zijn in de dagelijkse problematiek van waterbeheer, d.w.z. aan de waterlinie.

Curriculum Vitae

Peter Paul Mollinga was born on 14 May 1959 in Leeuwarden, the Netherlands. He completed his secondary education in 1976, and started the study programme Tropical Land Use/Irrigation Engineering (*Tropische Cultuurtechniek, N31*) in that same year at Wageningen Agricultural University. He spent his practical period (1981-82) and conducted his M.Sc. thesis research (1983) in the Senegal river valley in West Africa, working on the design, construction and management of small-scale village lift irrigation schemes. Graduation took place in 1984, with irrigation as the main topic, and the additional topics sociological aspects of development planning and hydrogeology. He was active as a member of the *Imperialisme Kollektief* and *Temagroep Onderontwikkeling*. For 2½ years (1985 to 1987) he was a staff member at *Studium Generale*, Wageningen Agricultural University for Third World/development issues. He was a visiting researcher at the Development Policy and Practice Research Group, Open University, Milton Keynes, U.K. for 1½ years in 1988 and 1989. Since autumn 1989 he has been teaching and doing research as a staff member of the Irrigation and Water Engineering group, Wageningen Agricultural University. A WOTRO grant was awarded for Ph.D. research on the Tungabhadra Left Bank Canal, Karnataka, India in the period from 1990 to 1995. He is presently involved in an action research project on local organisation for irrigation management in the same State together with two local NGO's.