AGRICULTURAL DRAINAGE: TOWARDS AN INTEGRATED APPROACH[1]

Safwat Abdel-Dayem[2], Jan Hoevenaars[3], Peter P. Mollinga[4], Waltina Scheumann[5], Roel Slootweg[6], Frank van Steenbergen[7]

ABSTRACT

Drainage needs to reclaim its rightful position as an indispensable element in the integrated management of land and water. An integrated approach to drainage can be developed by means of systematic mapping of the functions of natural resources systems (goods and services) and the values attributed to these functions by people. This mapping allows the exploration of the implications of particular drainage interventions. In that sense an analytical tool for understanding a drainage situation is proposed. It provides a framework for discussion and negotiation of trade-offs related to the different functions and values related to drainage. In that sense it is a communication, planning and decision-making tool. The tool is called DRAINFRAME, which stands for Drainage Integrated Analytical Framework.

1 INTRODUCTION

Drainage has almost disappeared from the international water discourse as a theme and a concern. It does not appear in important recent water policy documents and investments in drainage are going down, despite substantial potential for enhanced crop production through improved drainage. Drainage's importance as an inherent element of the hydrological cycle and of natural resources management and rural development strategies needs to be reclaimed. A study was conducted in 2002 and 2003 under the World Bank-Netherlands Partnership Programme – Environment Window (BNPPEW) called Agricultural Drainage: Towards an Interdisciplinary and Integrated Approach. The first phase was a set of six country case studies[8] covering different drainage situations: Bangladesh, Egypt, Indonesia, Mexico, the Netherlands and Pakistan. The final phase of the study uses the country case studies as its base material in an attempt to answer the question: what are the contours of an integrated approach to drainage?

The objectives of the study were the following.
Improve understanding of drainage systems as socio-technical and environmental systems by developing, at the macro-level, a typology of drainage situations including both technical/physical and social/managerial criteria, and, at a micro-level, a strategy to understand and deal with local diversity in the nature, function and organisation of drainage. Document and evaluate different institutional models in use in the drainage sector at both users and agency levels, including an evaluation of the appropriateness of users organisation approaches developed in the irrigation sector, by studying cases of the application of 'irrigation models' in drainage projects;
By generating this knowledge, contribute to improved design and implementation of interventions in the drainage sector, to meet users', managers' and funders' objectives to produce integrated and sustainable drainage development. This paper summarizes the outcome of the study. The full report will appear as a World Bank publication.

2 AGRICULTURAL DRAINAGE: TOWARDS AN INTEGRATED PERSPECTIVE

Drainage, with few exceptions, is generally considered from a narrow sector angle. A review of the global experience shows a wide range of drainage situations with different impacts and affecting many functions of the natural resource system. The sector approach gives drainage its low profile and isolation from the big picture of integrated management of land and water.

2.1 Impacts:

Drainage has many impacts, of which the main categories are agricultural impacts, public health impacts, protection of buildings and roads, and ecological impacts. In planning and designing drainage interventions these impacts are not equally addressed. The following are conclusions drawn from the country case studies:

- Drainage's impact on agricultural production and productivity can be substantial, agricultural drainage investments may have short payback periods, but drainage planning needs a relatively long planning horizon and flexibility because drainage needs may change over time.
- Drainage's contribution to public health, drinking water supply and sanitation can be substantial but is generally not acknowledged, and depends on the quality of operation and maintenance of the drainage system.

- Drainage's importance for the protection of buildings and roads is under-emphasised. The appreciation of land value and the introduction of 'sites-and-services' approaches might be considered in drainage evaluation and planning.

Agricultural drainage has often had negative effects on ecological functions and has also acted as a conduit for the spread of wastewater and other pollutants. However there are examples of drainage enhancing ecological functions, but substantially more emphasis needs to be put on mitigating drainage's negative effects and balancing its impact on production functions with that on other functions.

2.2 Diversity

Drainage situations exhibit diversity in term of the combinations of natural resources systems functions affected, scale, historical evolution, environmental factors (climate, elevation, soil, groundwater quality, biology and ecology, vegetation cover), and social factors (prosperity and values, distribution of power and cultural background, socio-political structure). Listing of diversity in drainage situations encountered across the world and the variety of factors causing it shows that 'drainage' is a container concept, covering an extremely varied set of instances. Talking about drainage in general is therefore hardly useful – neither at an analytical level nor at an intervention level. A context-specific approach is required for both analysis and intervention.

2.3 Institutional trajectories

The starting point for enhancing institutional performance and/or institutional reform is quite different in different contexts. Three trajectories of drainage development can be distinguished:

1) focussed government initiatives,

2) spontaneous development of drainage through local initiative, and

3) incomplete or stagnating drainage development. The importance of local user initiatives may be underestimated because underreported in developing countries, and would merit closer study. Reform of centralised drainage bureaucracies is an issue that occurs only in a very limited number of cases.

Much more common is the situation in which drainage received limited attention and priority, and leads a fledgling existence. Though governments are necessary partners in the transformation of the approach to drainage, it is unlikely that central governments will be the main initiators of such an approach. Different mechanisms and strategies will have to be found to put drainage on a firmer footing. There are considerable hurdles in the present governance framework to make local users organisations effective on a large scale and new forms of regulation are required. There is a need to pitch 'integrated' drainage organisation at a higher level than the local users groups.

2.4 Drivers for change

The drivers for a change towards an integrated approach to drainage are the following:

- The increasing complexity of water control systems,
- The conflicts of interest in many water management systems,
- Re-prioritisation of land and water management objectives because of changing societal values, and
- The declining lustre of drainage as a professional sector and the need for the professional drainage community to rethink its position.

Based on this analysis of the present situation with regard to drainage a new, broader definition of drainage, less exclusively focussed on agricultural productivity, can be formulated as a first step towards an integrated approach.

Drainage consists of the processes of removing excess surface water and managing shallow water tables – by retaining and removing water -- and of managing water quality to achieve an optimal mix of economic and social benefits while safeguarding key ecological functions.

More specifically, integrated management of drainage would mean the following:

- Acknowledgement of the multiple objectives served by the management of excess surface water and shallow water tables and the disposal of drainage water, and of the need to reproduce the resource system over time (resource sustainability).
- Adaptation of drainage interventions to the natural resources system, taking into account the diversity of drainage situations and aiming at optimisation of goods and services produced by the natural resources system (understanding and managing diversity and multi-functionality)

- Inclusive forms of (drainage) governance/decision-making, having representation of the different stakeholders (democratisation).
- Improvement of the scientific knowledge base, implying a major shift in the focus of the scientific community towards the fields of sustainability, multi-functionality, and stakeholder representation in governance and decision making.

3 MAPPING DIVERSITY AND MULTI-FUNCTIONALITY: A FRAMEWORK FOR DRAINAGE FUNCTIONS AND VALUES ANALYSIS AND ASSESSMENT

3.1 Typologies of drainage situations

Diversity does not imply randomness. It is possible to distinguish between types of drainage situations at different levels of aggregation or geographical scale. The description of a drainage situation (or drainage type) is based on a set of characteristics and relationships that define the main and common features in a particular area. A finite number of drainage types can be described at any given scale-level. A series of drainage types at a particular scale-level forms a typology. Three levels of analysis can be defined.

- The hydro-ecological region is a macro-scale characterisation focussed on the physical characteristics of a region, broadly defining the main drainage issues at hand and drainage interventions that may be appropriate. Typologies at this level serve policy development.
- The landscape level. A landscape provides a coherent set of functions that deliver goods and services for society (agricultural production, water supply and sanitation, tourism, navigation, fisheries, etc). Groups in society value these good and services and become stakeholders. Drainage interventions aim to enhance certain functions for the benefit of these stakeholders. Institutional arrangements are created to manage these interventions. Landscape level typologies serve the planning of such drainage interventions.
- A system-level typology provided detailed and locally specific descriptions of drainage systems. Typologies at this level serve field-level design and implementation of drainage interventions in particular land and water resources control systems.

Landscapes are the logical level for integrated planning of drainage interventions, and the focus of the study. The landscape concept as elaborated in the study closely resembles the ecosystem approach as adopted in the Convention of Biological Diversity.

3.2 The DRAINFRAME tool

To operationalise an integrated approach to drainage a tool called Drainage Integrated Analytical Framework (DRAINFRAME) is proposed for planning and decision-making purposes. The first element of this tool is a functions and values analysis and assessment at landscape level (though in principle applicable to other levels also). The second element of the tool consist of the specification of the outcomes of that analysis and assessment towards 1) governance, management and finance institutions for drainage, and 2) technology for multi-functionality (see Figure 1).

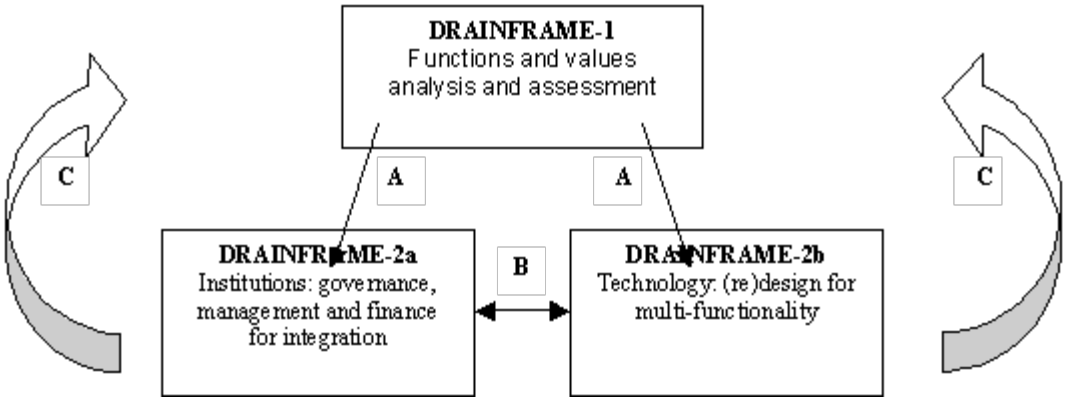

Figure 1 Schematic representation of DRAINFRAME

A = operationalisation of defined negotiated functions and values; B = institutional requirements of technologies and vice versa.; C = feedback loop for the iterative process of matching institutional and physical design with defined/negotiated functions and values.

The terms ‘Functions’ and ‘Values’ are defined in the context of this analysis as follows: ‘Functions’ is a concept that summarises

the products and processes that natural resource systems provide and perform. These functions include production functions, processing and regulation functions, carrying functions, and significance functions. 'Values' is the concept through which societal preferences, perceptions and interests with regard to resources are summarised. These values are social, economic and (temporal and spatial) ecological values. 'Functions' and 'values' are expressions of complex biophysical and societal processes, which are the object of study of a large number of scientific disciplines, and which are spoken for by an array of interest groups/stakeholders. A function/value matrix or framework can be considered as a 'boundary object': it is a device through which these differentials become communicable and negotiable across the boundaries of disciplines and interests. Though a lot of science goes into this process as an input, the tool suggests that this 'optimisation' is not a straightforward calculating procedure, but a social process in which meanings and interests are negotiated.

The analytical framework for doing a functions and values analysis and assessment is presented in Figure 2. The starting point in this analysis is that people realise the values and utilise the products (goods) and services that are provided by landscapes. In economic terms, society constitutes the demand side, and the resources constitute the supply side. Simply stated, sustainability deals with the equilibrium in supply and demand, now and in the future. Perceived imbalances in this equilibrium trigger institutions to act by managing either the supply from nature or the demand from society, or both. The figure depicts how the need for institutional arrangements, technology and infrastructure, and knowledge and human resources capacity is triggered by a perceived disequilibrium in the relation between supply and demand. The demand for goods and services from nature may surpass the available supply, which leads to a present or expected future problem (e.g. over-exploitation or insufficient supply), or the potential supply may be larger than what is actually being used, representing a development opportunity.

The analysis itself proceeds by a series of analytical steps that look at both the physical and social change processes induced by a particular drainage intervention. Details can be found in the final report (Abdel-Dayem et al. 2003). The tool may also be used for scenario development, exploring the impacts and implications of different (sets of) interventions.

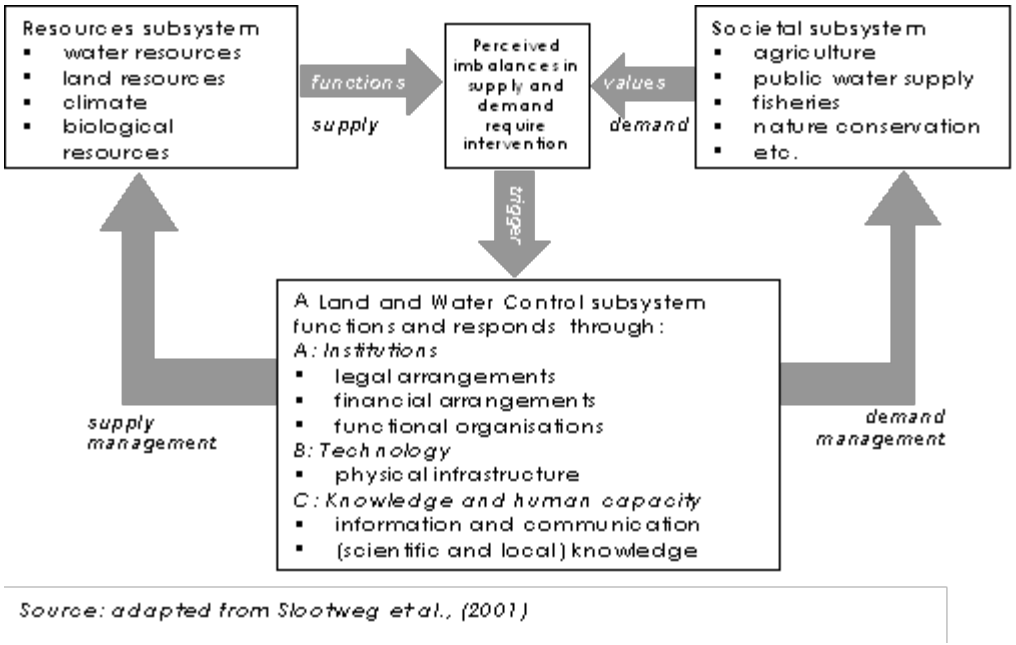

Figure 2 The three subsystems of the socio-ecological system: the natural resources subsystem, the societal subsystem and the land & water control subsystem.

4 THE INSTITUTIONAL DIMENSIONS OF DRAINAGE: GOVERNANCE, MANAGEMENT AND FINANCE

The general questions related to drainage institutions hardly differ from those of the rest of the land and water sector. How to design effective institutions to govern drainage in a way to support local demand as well as requirements at regional or basin level? What are the roles the different actors can play? Who manages which tasks to the benefit of whom? Which is the adequate level for management? Who finances drainage?

However, answering these questions is less straightforward than in other land and water resources sectors because the institutional dimensions of drainage have not received much attention – neither in theory nor in practice. Other caveats are that context-specific approaches are required, implying that general recommendations to adopt particular institutional forms cannot be given. Lastly, not all issues related to drainage governance, management and finance derive from the need for an integrated perspective; there are many issues to be resolved also for drainage 'as it is'.

The issues that are the focus of discussion in the drainage context are:

- The specific characteristics of drainage, notably its public good character, and the implications for drainage institutions.
- The appropriate scale-level or unit for effective drainage organization.
- Broadening the financial basis for drainage.

5 SPECIFIC CHARACTERISTICS OF DRAINAGE: THE SPECIFIC FEATURES OF DRAINAGE TRANSLATE INTO A NUMBER OF PRINCIPLES FOR DEVELOPMENT OF DRAINAGE GOVERNANCE STRUCTURES.

- Multifunctional aspects of drainage would require governance structures that either have representation systems where multiple beneficiaries have a voice, or have mechanisms and forums for coordination.
- The unevenly spread demand for drainage requires a diversity of governing units that are able to respond to diversified local demands.
- Technical externalities require arrangements to address negative effects and distribute costs among multiple beneficiaries and different jurisdictions.
- The public and private benefits provided by drainage are highly differentiated, and hence the costs have to be structured and shared accordingly. Due to the public good characteristics of drainage, governing bodies would develop, or rely on, effective collection strategies based on legally assigned authority to enforce legal and financial sanctions.

5.1 The unit of governance and management

Present institutional dynamics in the field of drainage includes trends of decentralisation of government institutions/departments at national level, and upscaling of user's organisations to higher, intermediate levels. Experience with basin level organisation of coordination, regulatory authorities and private sector involvement is very limited, if not absent. A logical medium-term perspective is to support a polycentric governance structure that allows institutional experimentation and evolution.

5.2 Broadening the financial base

To remedy the poor financial resource base for drainage investment and management, combinations of public funding and cost-sharing arrangements are required. Additional resources need to be raised through introduction or strengthening of the benefit-pay(-say) principle.

There are many institutional challenges to be addressed, depending on the development trajectory as illustrated in Table 1.

Table 1 Drainage development trajectories and institutional issues: some examples

Trajectories Issues	Focussed government initiative	Users initiated development	Limited or stagnating development
Governance	Transform highly centralized drainage / irrigation agencies to less centralized ones (implement principle of subsidiarity)	Create an appropriate regulatory structure within which local organizations can operate with sufficient autonomy	Define the institutional space(s) for drainage governance
	Redefine the 'ownership' of drainage across sectors and include more constituencies than the agricultural in the planning and decision-making process	Constitutional and collective choice rules for local organizations (representation different stakeholder groups and charter)	Alignment of different constituencies for enhancing attention to drainage
Management	Upwardly accountable public officials and poor maintenance to be transformed into managers responsive to local needs and incentives for better performance	Professionalise management if required, and consider appropriate scale-level of different activities	Support and mainstream local initiatives and practices for drainage management

	Create workable modes of collaboration between agriculture and other departments relevant for addressing multi-functionality	Define and create support services for local organisations	
Finance	Change centralised, highly subsidized into cost-sharing between government and drainage beneficiaries	Define co-financing arrangements between government and local organizations for different aspects of drainage investment and maintenance	Resource mobilization: lobby for allocations in government budgets and/or mobilize private sector capital for investment and/or mobilize resources from beneficiaries
	Include other constituencies than farmers in revenue generation	Balance financial contribution, benefits and say.	

6 DRAINAGE INFRASTRUCTURE AND OPERATION FOR MULTI-FUNCTIONALITY

An integrated perspective will have implications for the drainage technology that needs to be deployed and the operational procedures that need to be adopted to use it. The physical design and operation of many drainage systems has a long-standing bias towards agricultural productivity. Multipurpose design and operation is still the exception rather than the rule in drainage. Yet if drainage systems are to serve a variety of objectives, from land productivity, to water conservation, to protecting buildings, to public health, then technology design and operation needs to be done differently. This provides a major technical professional challenge. Some examples and issues are the following.

6.1 Water retention, water table management and controlled drainage

If the prime meaning of drainage is redefined as comprising the management of shallow water tables, the ability to control water table depth and drainage canal water levels is very important. It allows regulation of soil-moisture for both irrigated and rain-fed crops and enables maintaining of water levels for fisheries, to prevent land subsidence, and other purposes, and also affects soil chemistry. The concept of controlled drainage has been subject to experimentation and proved technically feasible, but the challenge is to develop appropriate low cost, easily manageable water conservation technology. A main problem is how to coordinate the different priorities of different farmers (growing different crops) in the absence of a strong local organization, that is, the ability to control water tables needs to be matched by the local institutional capacity to balance the different interests.

6.2 Flood management

Drainage and flood management need to be brought closer together at the level of (sub-)basin management, but the same is true at the level of drainage infrastructure design and operation. The capacity to store excess rainfall in the shallow aquifer is an important asset in flood management. In many cases investment in drainage infrastructure will complement flood mitigation strategies, In some cases drainage infrastructure has aggravated floods. This happens when the network of drainage pipes and canals quickly transports storm water to watercourses and rivers and there is no facility to store or slow-down the run-off.

6.3 Re-use and the management of effluent quality

The design of drainage infrastructure affects the quality of the drainage effluent. The quality of drainage water may be affected by high salinity, acidity or by chemical or bacteriological contamination. In the design or operation of drainage facilities the quality of the effluent and the possibility of mixing it or neutralizing it should be given a prominent place, but often this has been neglected. In addition to controlling pollution through using appropriate technology at the source a regulatory framework that controls the disposal of effluent from different sources in a drainage system is a prerequisite.

6.4 Vector control

Drainage infrastructure can have significant effects on vector organisms and improve local sanitary conditions. Yet drainage has in the past also added significantly to health problems, with stagnant water becoming a main source of transmission of diseases. Over the years a number of guidelines and good practices have been formulated that improve drainage's positive impact on public health, but it is testimony to the isolated position of drainage that these have not been mainstreamed.

6.5 Choice of unit size

Multi-purpose drainage management raises the question of the size of the unit at which drainage is managed. Compartmentalisation into smaller units allows more or less tailor-made solutions to local water issues. This is particularly useful where local variation in drainage conditions and drainage interests is large. The downside however is that as management becomes more tailor-made and fragmented, the organisational requirements get more complicated and the cost of management

increases.

6.6 Planning, design and evaluation technologies

Integrated water resources management aims at linking land and water resources in the regional and river basin context and dealing with the multi-functionality of drainage (crop production, water quality, landscape, environment), as well as conflicting interests of user groups (farmers, fisher(wo)men, industries and municipalities). These concepts are novel, and the implementation is not straightforward because data to support the operationalisation of these concepts is not always available and the number of variables and interactions would be far too great to be captured by the conventional methods and simple analysis. New tools that are able to capture enough information and simulate complex hydrological and environmental processes as well as social processes and responses are needed.

6.7 Knowledge management

There is scope for a far larger sophistication in the development of drainage infrastructure and the management of drainage systems than is common so far. The question is how? A fresh look at research agendas, with far larger attention for technologies and water management strategies that serve multifunctional resource use is necessary. Also, as the emphasis changes in water governance research and knowledge development, clients should also change. The natural recipient for knowledge and how to effectively disseminate should be more clearly defined. At the same time there is scope to learn more from ongoing practices and allow practitioners to innovate and upgrade their knowledge. In practice this means giving room for experimentation in water investment programmes and a much stronger link between research organizations and training institutes. In developing new drainage technology there seems to be little place for the classic field experiments as used in agricultural drainage and other types of single purpose water management.

7 NEW POLICY FOR DRAINAGE

There usually is no clear policy specifically on drainage. The development of policies that achieve integration raises several questions such as: Which policies can contribute to the mainstreaming of an integrated approach to drainage? And how? Which type of policy – top-down, bottom-up, comprehensive, step-by-step, linear, iterative, prescriptive, interactive – do we adopt to nurture an integrated approach to drainage?

7.1 Policy context

The World Bank's Water Resources Sector Strategy paper (World Bank, 2003) stresses that it is now time for a pragmatic but principled approach (efficient, equitable and sustainable). It is suggested that 'Progress takes place more through 'unbalanced' development than comprehensive planning approaches'. Such an approach would thus include a strong 'learning by (and before) doing' component. The major challenge is to develop context specific, prioritised, sequenced, realistic and patient approaches for implementation. The development of an integrated approach for drainage subscribes to this perspective. The framework proposed by this study tallies very closely with the World Bank's strategy for rural development and its environmental strategy (World Bank 2002 and 2001). Drainage is part of integrated natural (land and water) resources management. The framework can also be seen as an operationalisation of the IWRM concept.

7.2 A realistic policy concept

Policies and related strategies can never be fully consistent. Inconsistencies exist vertically between levels of governance and horizontally between sectors of water management because water conditions change continuously, generic policies don't have tailor made answers to the infinite variety of drainage problems; lack of resources prevent the realisation of ambitions; private interests often prevail over public interests.

Policies are nested, in a variety of ways. Policies can therefore not be conceived in isolation. It is neither wise nor possible to design a new drainage policy for all times. Policies, including drainage policy, should be continuously 'under reconstruction'.

7.3 Steps towards new policy:

The main steps in a process towards new policies and policy reform regarding drainage are the following:

- Understanding of the drainage situation from an integrated perspective;
- Identification of problems and opportunities;
- Formulation of the long-term vision and ambitions;
- Implementation of small, sometimes opportunistic, steps in:
- Setting the modalities for multifunctional ''optimisation'' of goods and services;
- Principles and guidelines for implementation;

- Making resources available and organisations responsible;
- Setting gentle targets and time horizons;
- Creating in-built learning and reform mechanisms.

7.4 Policy messages

Although the following messages have been formulated, with the donors and governments in mind, they carry general relevance.

- Dare to look at all costs and benefits. Expanding the assessment of drainage, and the management of water resources more generally, to include both benefits and negative effects, and thus make it more balanced, would provide incentives for mobilising resources and financing for investment in multifunctional drainage systems, because it would show that the drainage sector is inseparable from the other water management sectors.
- Move Towards an Integrated Approach with Pragmatism and Vision. Because of the two-sided effects of agricultural drainage on poverty, it is obvious that agricultural drainage policies and strategies for implementation have to address both positive and negative sides of drainage. This is difficult. There is hardly any experience with the implementation of agricultural drainage following the concept of multi-functionality. Nevertheless, a paradigm shift towards integrated drainage is required. Pragmatism should be pursued within a visionary framework that fosters the main direction where to go.
- Identify Drivers, Triggers and Carriers of Reform. Strategic analysis and identification of opportunities and carriers of innovation and reform processes is required.
- Learning before Doing. In complex contexts understanding each situation and its specific needs is indispensable and comes before action.
- Nature provides many functions: detect those functions;
- Agricultural drainage has impact on the resources: know the changes;
- Changing resources affect all functions: understand the effects;
- Functions have stakeholders: identify and involve them;
- Stakeholders attach values to functions: assess them;
- Stakeholders have different says in decision making: analyse it and reform it;
- Policies and institutions are lagging behind actual requirements for needed services: make an audit and put pressure on them.

8 CONCLUSION

The main substantive message of the study is that drainage needs to be looked at and acted upon from an integrated perspective. This implies the following.

- Acknowledgement of the diversity in drainage situations and the need for regionally and locally specific planning and intervention in drainage institutions and technology,
- Systematic mapping of the multi-functionality of landscapes influenced by drainage and the plurality of values attributed to these functions by different interest groups.
- Conception of institutions for governance, management and financing of agricultural drainage as well as the (re)design of physical interventions/technical infrastructure from the perspective of multi-functionality and plurality of values.
- Policies that create an environment conducive to change and that empower actors to make the necessary changes.

9 REFERENCES

Abdeldayem, S., J. Hoevenaars , P.P. Mollinga, W. Scheumann, R. Slootweg and F. van Steenbergen. 2003. Re-claiming drainage; towards and integrated approach. The World Bank, Agricultural and Rural development Department, Washington D.C. (draft report)

Slootweg, R., F. Vanclay & M.L.F. van Schooten. 2001. 'Function evaluation as a framework for integrating social and environmental impacts'. Impact Assessment and Project Appraisal 19:1

World Bank. 2001. Making Sustainable Commitments: An Environment Strategy for the World Bank. The World Bank, Washington, D.C.

World Bank. 2002a. Reaching the Rural Poor I; Strategy and Business Plan. World Bank Staff Edition. Agriculture and Rural Development, ARD of World Bank, Washington D.C.

World Bank. 2002b. Reaching the Rural Poor II; Annexes. World Bank Staff Edition. Agriculture and Rural Development, ARD of World Bank, Washington D.C.
World Bank. 2003. Water Resources Sector Strategy: Strategic Directions for World Bank Engagement. The World Bank, Washington, D.C.

---

[1] Paper No 137. Presented at the 9th International Drainage Workshop, September 10 – 13, 2003, Utrecht, The Netherlands.

[2] Drainage Adviser,Tthe World Bank, 1818 H Street NW, Washington D.C. 20433, USA, sabdeldayem@worldbank.org

[3] Independent Adviser, Hoevenaars Advice & Assistance, Driehoek 15, 5126 NX Gilze, The Netherlands, hoevenaars.ana@wxs.nl

[4] Associate Professor at the Irrigation and Water Engineering group at Wageningen Agricultural University, the Netherlands, pmollinga@hotmail.com

[5] Associate Professor, the Institute for Management in Environmental Planning, Berlin, Germany, Scheumann@imup.tu-berlin.de

[6] Independent Consultant, The Netherlands, SevS@SevS.nl

[7] Senior Advisor Water Management, Arcadis Euroconsult, Arhnem, the Netherlands, fvansteenbergen@compuserve.com

[8] The reports of the country case studies are published on the World Bank website (www.worldbank.org/irrigation-drainage)