Rik Eweg

COMPUTER SUPPORTED RECONNAISSANCE PLANNING

Implementing a planning methodology with a Geographical Information System in Noord-Brabant, the Netherlands

Proefschrift
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in de landbouw- en milieuwetenschappen
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STELLINGEN

1 In een door GIS ondersteund planningsproces kunnen de keuzes van de planningsstrategie, reflectieve momenten en momenten van integratie van vorm-, haalbaarheids- en maatschappelijke en fysieke aspecten, niet worden beschreven in een formeel model.
(dit proefschrift)

2 Door kennis van disciplinaire experts en planners vast te leggen in GIS procedures, kunnen informatiesystemen het leerproces van anderen dan de direct bij het planningsproces betrokkenen, ondersteunen.
(dit proefschrift)

3 Het geografische aspect als integrerend element in Geografische Informatie Systemen, stimuleert de samenwerking tussen verschillende disciplines in het planningsproces.

4 Omdat modellen van processen en systemen in de ruimtelijke planning vaak betrekking hebben op één enkel aspect van de werkelijkheid, dient een planner de uitkomst van modelbewerkingen steeds te evalueren vanuit het gezichtspunt van verschillende sectoren.

5 Omdat een volledige reconstructie achteraf van een planningsproces ondoenlijk is, verdient het aanbeveling informatiesystemen zoals het *RISOR* tijdens het planningsproces real-time te gebruiken.
(dit proefschrift)

6 Toepassing van Geografische Informatie Systemen kan als een voorwaarde worden beschouwd bij het verkennen van consequenties van beleid dat ingrijpt in ruimtelijke systemen, mits die met omvangrijke en complexe datasets kunnen worden beschreven.
(dit proefschrift)

7 Te vaak wordt vergeten dat organisatorische en infrastructurele aspecten als beschikbare hardware, software, budgetten en systeembeheer van doorslaggevende invloed zijn op het al of niet succesvol functioneren van een Geografisch Informatie Systeem.
(dit proefschrift)

8 Het Richtingzoeken kan een bijdrage leveren aan de verantwoordelijkheid van overheden om de consequenties van keuzen aan te geven en het maatschappelijk debat over de meest wenselijke toekomst te bevorderen.
(dit proefschrift)

9 Het niveau van wetenschappelijke publicaties zou aanzienlijk stijgen indien de Landbouwuniversiteit aan haar medewerkers periodiek inspiratie en rust zou bieden, bijvoorbeeld in de vorm van een LU-cottage in de Schotse Hooglanden voor het bewerken van onderzoeksgegevens.

10 Resultaten van ruimtelijk onderzoek worden steeds meer vastgelegd in informatiesystemen, die de openbare toegankelijkheid van deze informatie voor individuen en belangengroepen belemmeren.

11 Gemeenteraadsleden zullen democratischer en politieker functioneren als individuele raadsvergoedingen worden vervangen door een systeem waarbij de werkgever van een raadslid in staat wordt gesteld om een tijdelijke vervanger voor het raadslid aan te stellen en daarnaast aan het raadslid het normale salaris door te betalen.

12 Doordat een grote groep mensen in de toekomst op elke gewenste locatie in de wereld met anderen zal kunnen werken en communiceren, dreigt een tweedeling te ontstaan tussen enerzijds hen die door hun werkomgeving deel uit maken van de 'global village' en anderzijds hen wier werkomgeving en leefwereld zich uitstrekt tot de eigen straat, dorp of stad.
(Naar aanleiding van Stefano Marzano, Michele De Lucchi, Workshop*, 1994)

For Annemarie and Henk

CONTENTS

PREFACE

This research is about computers and planning. For many people, computers and software are still black boxes. This also goes for the application of Geographical Information Systems (GIS) in Planning. In this thesis I give an illustration of how GIS can be used in planning. The research was a follow-up to the research done by Ron van Lammeren, who developed an information system to support a planning process.

GIS was and still is, often 'oversold': GIS technologists arouse high expectations in their audience and their clients yet, often these expectations have not been fulfilled within the expected time. But it is not only the GIS technologists who contribute to the image of GIS as a universal panacea. Once I attended a municipal hearing in which a harbour extension was being presented to the public. The need for this extension was underlined by stressing that 'computer calculations supported the necessity of the extension'. That demonstrates how policy makers also sometimes contribute to the mystique of GIS and computers. Overselling GIS or creating a mystique about computers not only misleads people but can also impede the development of a tool which could help us to better understand and manage our environment.

In planning, the application of GIS is often limited to storing, presentation and analysis. Data are fed into a system and presented in an attractive way. The added value of the computer is the ability to present complex and large amounts of data in an understandable way. Other applications of GIS concern the analysis of data. Application in the stages of plan construction are rare.

The purpose of this thesis is to demonstrate that GIS can be a valuable tool, not only for the data analysis but also for the planning process as a whole. In this way, GIS will contribute to the debate about the direction we all want to go, for this is the fundamental question facing planning in a democracy. To answer the question we have to explore the implications of our decision. In our stage of technological development, the consequences of decisions can have a large impact on our environment. In the Netherlands, this impact is illustrated by the deteriorating woods, the daily traffic jams, the polluted rivers. A thorough reconnaissance of our options might support the discussion of our decisions and might save us from making wrong decisions. This reconnaissance into the effects of complex processes on an even more complex environment requires not only creativity and common sense, but also the support of systems which can process large amounts of data and simulate complex processes.

The idea that Information Systems can contribute to planning was also in the mind of the researchers who initiated this research: Prof. dr. ir. Fer Kleefmann, who developed the reconnaissance planning methodology and was an inspiring and stimulating supervisor, and Dr. ir. Ron van Lammeren who was an enthusi-

astic guide, not only during this research but also earlier when as a graduate student, I took my first steps in the field of GIS.
Furthermore, I thank Prof. dr. Henk Ottens who was willing to act as my second supervisor and who gave valuable comments on drafts of my manuscript.
I am grateful to all personnel and colleagues of the Department of Physical Planning and Rural Development and the Centre for Geographical Information Processing in Wageningen, who created the indispensable 'atmosphere' for fruitful research. I specially thank Hans Hetsen and Jan van Nieuwenhuize who gave valuable advice and support. I'm specially indebted to my colleague Lilian van den Aarsen, with whom I not only shared a study area, but all the 'ups and downs' connected with a Phd research.
I'm grateful to the 'Landbouw Export Bureau' Foundation which partly financed the printing of this book. I thank Joy Burrough-Boenisch for advice on the English text and Toon Jansen for his editorial comments. Heleen Wessel and Roland van Zoest gave valuable help and advice in the lay-out of the text and maps. Annelien van der Meer gave advice in using the RISOR system. Gerard van der Moolen and Wieske Meijer provided me with books and articles. Gerrit Klein Rensink, Adri van 't Veer and Henk de Rooy prepared the illustrations, while Harry Harsema designed the cover of this book.
I'm grateful to the staff of the planning department of the Province of Noord-Brabant for their frank opinion and the valuable information they provided.
I'm indebted to the students who contributed to my research: José Buysman, Rudo Cleveringa, Arthur de Craen, Judith van der Laken, Piet-Hein de Leeuw and Léon van der Meij.
I'm specially indebted to my friends Frans, Karin, Marij, Marleen and Marianne, who gave valuable moral and social support and whom I thank for all the patience they had with me!

Part I

This thesis describes research on ways to operationalize a planning methodology, characterized as 'reconnaissance planning', with the help of a Geographical Information System. In this part the reader will be introduced to the basis of the research: its objectives, its background and its premises. In the first chapter I will describe the objective of the research and the theoretical and institutional context within which it was done. I will also outline the structure of the thesis. As modelling forms an important aspect of the application of information technology in planning, this will be discussed briefly in Chapter Two. For some readers of this book, the concept of 'GIS' (Geographical Information System) and terms such as 'expert system' and 'decision support system' will be new. Therefore these are introduced in Chapter Three, together with some definitions of GIS.

1 INTRODUCTION

1.1 Background, research objective and challenges

One of the themes of the research at the Department of Physical Planning*[1)] and Rural Development at Wageningen Agricultural University is the physical planning within the area of tension between sustainability and flexibility. In 1984, as part of this general research theme, Kleefmann described the planning methodology of 'searching for possible directions of development', also called 'reconnaissance planning'*. Information systems were considered to be important for implementing this methodology. Some years later, van Lammeren (1994) developed a prototype of a planning support system and called it *RISOR*[2)*]. He based the structure of the *RISOR* system on an analysis of the planning methodology as described by Kleefmann.
In 1988, I started research to test the functioning of the system. The aim of the research was to operationalize the planning methodology of 'searching for possible directions of development', at a regional level, using GIS. The results of the case study were to be used to evaluate the concept of the planning support system *RISOR* and to asses that system's structure in terms of its capacity to store the knowledge* used and generated during the case study in an accessible way.
This objective can be expressed in three questions which will be discussed in this thesis:

- how can the reconnaissance planning approach be operationalized at a regional level?
- how can Geographical Information Systems support such an operationalization?
- is the structure of the prototype of *RISOR* adequate to store the knowledge acquired during the planning process?

If the answer to the third question is affirmative, one of the results of this research would be a *RISOR* filled with different knowledge types.
The research involved more than a simple test of an existing system. At the beginning of this research, both the reconnaissance planning approach and the *RISOR* system existed conceptually. What was needed was an investigation of the operationalization of the planning methodology at regional level. To store information in the *RISOR* system, the planning process and the knowledge used within that process have to be systematized according to the systematics of the *RISOR* concept. However, the knowledge subsystem of the *RISOR* system itself did not become available until the end of the research. Furthermore, during the research it soon became apparent that the methodological and practical challenge of applying Geographical Information Systems in a planning process would have

to be met. The methodological challenge was to do with the impact of the software on the planning methodology, whereas the practical challenge was to surmount the technical constraints of the software and hardware.

1.2 The development of a new approach to planning in the Netherlands

The reconnaissance planning approach originated in the context of a reorientation in Dutch planning in the early eighties. The planning approach prevalent in the seventies was a mixture of strategic and negotiative elements. This practice was criticised by, among others, the Dutch planner van der Cammen (1982, 1984). To understand the rationale behind the reconnaissance planning approach, we must go back still further in Dutch planning history, starting in the sixties, when optimistic believe in economic growth flourished and society still seemed manageable.

The Second Policy Document on Physical Planning (1966)
In 1966, the Dutch government published the *'Tweede Nota over de Ruimtelijke Ordening'* (the 'Second Report on Physical Planning'), a design for 'clustered suburbanization' which is an example of 'blueprint' planning. The Policy Document described the desired situation for the year 2000. This description was not intended as a rough indication, but as a design for a reality that could be realized by deliberate policy. The plan intended to channel population growth into regional growth poles in an effort to prevent urbanization of rural areas. This policy was combined with an effort to stimulate economic development in the north-eastern and south-eastern fringes of the country (van der Cammen, 1984, van der Cammen and de Klerk, 1986).
However, the Policy Document was found to be unrealistic: e.g. the population growth had been greatly overestimated and also the government's ability to influence and steer investment and spatial processes turned out to be much weaker than expected. There was a lack of legislative instruments, organization, finances and of cooperation of regional and local authorities. The plan was soon nullified by economic development and by the differing decisions of local and regional authorities[3)].

Negotiative planning
Criticism of the 'Second Policy Document' and its failure led to a new planning approach, called negotiative planning, in which strategic and negotiative elements were important. The negotiative planning approach was the basis of the *'Derde Nota voor de Ruimtelijke Ordening'* (1973-1977)[4)] (the 'Third Policy Document on Physical Planning'), which appeared in three parts. In the introduction to the first part, the *'Oriënterings nota'*(1973), there was a modest perception of the ability to steer spatial developments and of the role of physical planning in the process of spatial development. In this introduction the minister wrote: 'Spatial planning in a dynamic society can hardly be contained in one overall conception,

presented at one certain moment, but should be the subject of a continuous process of re-evaluating and reformulating'. Economic and social influences were considered to be the main influences on spatial development.
The results of the negotiative planning approach, however, were also criticised. The Dutch planner Mastop (1989) describes the plans as 'a spin-off of some kind of negotiated order, rather than instruments purposefully prepared to change existing order'. According to van der Cammen, the planning process focused on the negotiating and decision-making process. The official and semi-public circuit was involved in these moments of decision making. Public and political discussion was limited to the end of the process. Moreover, focusing on the negotiating implied focusing on compromises. The aim to gain maximum support often resulted in vague and less decisive plans. Van der Cammen (1982) described the results of the negotiative planning process as products with 'a content that is described only in outline, statements of uncertain status, vague or ambiguous interpretation of figures, quickly out-dated and laborious combinations of different plans'. As a result of this, he discerned a tendency towards 'spatial plans that do not attract the attention of society; plans which do not stimulate imagination and lack the ability to start and support a public discussion'. As an answer to this problem, he advocated planning methods of a more exploratory nature.
Critical comments were also made by the Science Policy Council of the Netherlands which described the planning approach as 'an instrument for the sake of the instrument itself. Planning is regarded as an instrument to coordinate administrative actions which in their turn are regarded as instruments for planning'. The council favoured a more goal-oriented planning approach (WRR, 1983).

Towards a new planning approach
Kleefmann (1991) based his argument in favour of a new planning approach on two considerations. In his first consideration he linked the objections of the WRR to the government's central position. He contended that the government's position in society should be that of a co-acting governing body. Connected with this point of view he regarded 'society' as an emancipated participant in the planning process. Kleefmann's second consideration referred to the steering capacity of the governing body. The governing body faced severe problems regarding the relation between social organization and the environment. The gravity and complexity of these problems were daunting. At the same time the steering capacity of the governing body decreased due to deregulation. According to Kleefmann, in these circumstances the task of the governing body was to state the problems clearly and comprehensively and to initiate a process to find suitable directions of development for the spatial organization* of the Netherlands.
In accordance with van der Cammen, Kleefmann (1984) advocated a planning methodology of a more exploratory nature which he characterized as 'searching for possible directions of development'. Both van der Cammen and Kleefmann emphasized that a plan functions as a guiding document or compass. Similarly to

the 'blueprint plans', the compass plans describe a desired future situation, although this should be seen as a rough target, rather than as a mandatory one.
To turn their criticism into alternatives, Dutch planners started experimenting with techniques of forecasting planning*. One of the first experiments was a project initiated by the Science Policy Council of the Netherlands, published as *'Beleidsgerichte Toekomstverkenningen'* ('policy directed explorations', WRR, 1980, 1983). In the first publication of the project, in 1980, the council took the INTERFUTURES study of the OECD[5] as a starting point for working out prospects for various fields of policy in the Netherlands. In its second publication, in 1983, the council worked out characteristic notions*, which were developed in consultation with the scientific bureaus of the Dutch political parties. The notions represented the Dutch political mainstreams: liberal, socialist and Christian and went into detail about the government's sociocratic or technocratic position in society. The report described the future organization related to these notions. The scenarios* were worked out for the fields of social policy, production, socio-economic policy, environment, culture, foreign policy and the public nature of government.
The first report was subtitled: 'an attempt to provoke', which alluded to the project's aim to contribute to and stimulate public discussion about desired developments. This aim was rooted in the council's conviction that society also develops under the influence of actions arising from political ideas and public discussion. However, this aim was not entirely met.
Four years later, in 1987, the results of the *NNAO*[6] project were made public (van der Cammen ed., 1987). This project was carried out by the foundation of the same name and initiated by the Dutch Federation of Urban Planning (BNS) and the Dutch Museum of Architecture foundation. The aim of the project was to organize an exhibition about future possible spatial organization of the Netherlands. From the outset, the project put great emphasis on the presentation and visualization of its underlying premises.
The attention to visualization in the NNAO project contrasts with the exercise of the Scientific Council which presented its conclusions in a one-and-a-half centimetre thick memorandum. The results of the *NNAO* project were presented during a spectacular exhibition in the heart of Amsterdam. The exhibition had a long list of sponsors, and included numerous scale models, video and computer animation, sound effects, drawings, maps and photo compilations. A presentation and discussion on Dutch television were part of the publicity. The attention paid to the presentation and publicity contributed to the considerable interest the project attracted.
The normative premises in the *NNAO* project were related to the premises formulated by the scientific council, but were converted into four lifestyles discerned in Dutch society: conscientious, dynamic, critical and leisure-seeking. It was in this context that the government published its *'Vierde Nota voor de Ruimtelijke ordening'*(1988) and *'Vierde Nota voor de Ruimtelijke Ordening Extra'*(1990) ('Fourth Policy Document on Physical Planning / Extra'). In contrast

to the 'Third Policy Document', the 'Fourth Report' and its following elaborations, specified spatial development over the long term[7)].

1.3 Relation of the research with other research at the Department of Physical Planning at Wageningen University

The research under consideration in this thesis was not done in isolation. Since the publication of Kleefmann's methodology in 1984, the reconnaissance planning approach has formed an important field of study in the research programme of Wageningen Agricultural University's Department of Physical Planning.
The first illustration of the applicability of the methodology was given by Kerkstra and Kleefmann (1986). They intended their exercise to stimulate more research. The reconnaissance planning approach, as characterized in their study, should comprise alternative illustrations of possible developments, which should be evaluated on their probability, validity and desirability. The illustration given by Kerkstra and Kleefmann is only one possible direction of development for the Netherlands, in a European context.
In 1985 van Lammeren began his research, one of the results of which was a prototype information system called *RISOR* for the support of the planning methodology described by Kleefmann (van Lammeren, 1993). The basis of the design of the support system was the analysis of the reconnaissance planning approach and the knowledge types used during such a process. The philosophy of the *RISOR* support system will be discussed in chapter three.
An example of searching for possible directions of development is elaborated in the research by Hetsen and Hidding (1991). Their study was partly an analytical and partly a reconnaissance of possible agricultural developments. They analyzed the position of agriculture in the Netherlands from both a social and a physical perspective, using a model[*] of the relation between social and physical spatial aspects. This model will be discussed in chapter two of the present thesis, as it also forms the basis for the analysis in the research considered in this thesis. The reconnaissance of agricultural developments carried out by Hetsen and Hidding comprises a description of the expected future trend and three possible directions of development for the agricultural sectors in the Netherlands.
When exploring possible spatial directions of development, it is essential to examine the relation between society's claims and the physical environment. The environment is transformed in order to satisfy the requirements of societal functions. To predict and evaluate the consequences of interference with the physical environment, something must be known about the functioning of environmental systems. This was the field van den Aarsen (1994) investigated. She studied the relation between agriculture and the natural environment in areas with sandy soils in the Netherlands (the intensification of agriculture is causing severe environmental problems in the Netherlands and poses threats not only to nature, landscape, supply of drinking water, but also to agriculture itself). Part of

van den Aarsen's research was a case study in the south of the Netherlands, examining ecosystems and the impact of agricultural land use on them.

1.4 The research strategy followed

The conceptual nature of the planning theory and the *RISOR*, the limited experience regarding GIS applications in planning and the, existing facilities at the Centre for Geographical Information processing (CGI) at the time of this research, caused it to be explorative. The first step towards achieving the objective of the research was to operationalize the planning methodology. In order to describe the planning methodology clearly, comparable prospective and scenario planning exercises were studied. Furthermore, as most of the research was to do with the use of information systems, applications of GIS and decision support systems were evaluated.

The planning methodology was implemented in a case study. The original aim was to carry out two case studies, using the GIS techniques* developed in the first case on a second area, so that the applicability of the *RISOR* system could be evaluated. However, it took longer than expected to collect and digitize the data from the first case area. The development and application of GIS techniques also proved very time-consuming, largely because of technical constraints at the Centre for Geographical Information processing (which provides the GIS facilities at Wageningen University) while the research was being done. As a result, only one case study was done. However, this did not detract from the outcome of the research, as the main focus of the research was on methodology, not on comparison.

An area in the province of Noord-Brabant was chosen for the case study, and its social and physical aspects were studied.

The planning department of the provincial government was approached; this resulted in an agreement to exchange information and data. The provincial government was in the process of revising the regional plan*. Initially, I intended to analyze the provincial planning process and to describe the process and the knowledge used in the process in terms of the planning methodology and the *RISOR* concept. To explore the possibilities of formalizing a provincial planning process, a student analyzed and described the part of the provincial planning process which concerned the nature development plan (van der Laken, 1990). The planning process carried out by the province turned out to have little relation to the reconnaissance planning methodology. The provincial regional plan and the goals* it described were the outcome of a highly strategic planning process. Therefore, I decided to perform the reconnaissance planning exercise separately from the provincial context, in more 'laboratory' conditions. Only the physical aspects of the real situation in Noord-Brabant were taken into account. Nevertheless, the study of the provincial planning process gave more insight into the

relation between the reconnaissance planning approach described by Kleefmann and the 'practical' planning approach of the province.
After the study area had been chosen, the collecting and digitizing of the object data was begun. The acquisition and processing of external data and the generation of data by digitizing maps proved to be very time-consuming.
Once the basic data were ready for further processing the planning exercise in the study area could begin. In accordance with the planning methodology and its specification according to the *RISOR* concept, the planning process began with an orientation on normative premises. Based on this, normative premises for the plan construction were formulated and the accompanying plans were prepared. The final stages of the process were the visualization and evaluation of the resulting plans. The planning process involved using GIS.
To assess the capacity and ability of the *RISOR* system to store information, knowledge used in the case study and generated by it was saved in the *RISOR* system. To do this, the planning process had to be described in terms of the *RISOR* concept. However, other aspects of the ability of the *RISOR* system to support a planning process could not be tested thoroughly, as the prototype of the system did not become available until the final phase of the research.

Notes

1. Terms marked with an asterik are defined in the glossary.
2. RISOR is a Dutch acronym, standing for: '*Ruimtelijk Informatiesysteem ter Operationalisering van het Richtingzoeken*', which can be translated as 'Spatial Information System for Operationalizing the Reconnaissance Planning Methodology'.
3. Faludi mentions the following reasons for the failure of the plan: 'Local perspectives were different; procedures did not account for the reality of the day-to-day decision making; there was a reluctance to endanger the rapport between levels of government by the use of directives; and the pressure on the housing market was great.' (Faludi, 1991)
4. Part one was entitled '*Orienteringsnota*', giving the analysis and general policy. Part two dealt with urbanization. Part three, which dealt with the rural areas, was entitled '*Nota landelijke gebieden*'.
5. Interfutures report: *Facing the Future: Mastering the Probable and Managing the Unpredictable, OECD*, (Paris, 1979).
6. *NNAO* is a Dutch acronym, standing for '*Nederland Nu Als Ontwerp*' ('the design of the Netherlands').
7. An example of this is the description of a National Ecological Network of the Netherlands ('*Ecologische Hoofdstructuur*') in the Nature Policy Plan, which describes ecologically valuable areas and the way in which they should be developed (Natuurbeleidsplan, 1990).

2 THE USE OF MODELS WHEN EXPLORING POSSIBLE DEVELOPMENT OF SPATIAL ORGANIZATION

The use of models[*] is a condition to employ GIS[*] in a planning process and to develop systems that can support the planning process. The model makes the real world 'manageable' for exercises in forecasting planning as well as for computerized manipulation. In this chapter I will discuss three types of models that can be used. The description of the object of planning is based on the *MFO* model[1)*] developed by Kleefmann, which models the spatial organization of an area. Not only the object of planning can be modelled. For a successful discussion about the application of information systems, also parts of the planning process itself have to be described by formal models[*]. In his *RISOR* study, van Lammeren gives a theoretical model[*] of the reconnaissance planning approach. This model forms the base of the *RISOR* system.

2.1 Three types of models that typify spatial organization and planning processes

Modelling techniques are employed in various fields, and supported by an extensive collection of literature. Quade (1982) points to an important aspect of modelling. He states that the model should strike a balance between on one side over-simplification of reality by paying attention only to what can be quantified instead of what is relevant, and on the other side excessive attention to details. In order to decide what can relevantly be added to the model, the model should be determined by the questions being asked, as well as the process being described. Friedmann (1987) qualifies the meaning of models by emphasizing that 'rational actions should be based on holistic analyses of specific historical situations....The hypotheses, theories and models through which all scientific and technical knowledge is expressed are radical simplifications of the world: they are stated in universal terms, and their validity depends on the assumption that the world external to the model will remain unchanged. But in planning for the real world, "all other" conditions cannot be held constant.'
When discussing models, I follow the terminology used by Bertels and Nauta[2)] (1969). When typifying spatial organization and when describing planning processes, three types of models, including the real world, are relevant.

1. The real world
When discussing models of reality, the way we perceive the real world can be regarded as a 1:1 representation of a concrete system. The system's complexity and dimensions however, make it impossible to design desired futures in prospective planning exercises and to evaluate the consequences on this real world system

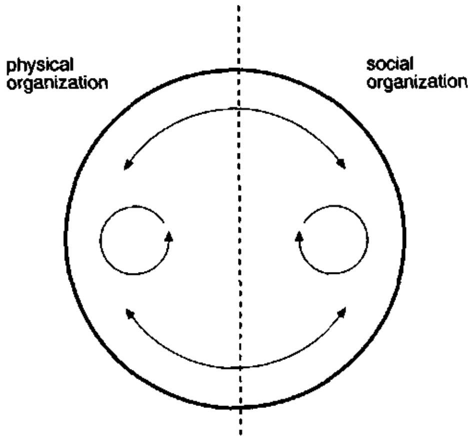
itself. Planning experiments in the real world may have unacceptable consequences. Par example, it is impossible to construct a road through a forest, just to get an impression 'how it looks'. Therefore, the use of theoretical models is inevitable. The representation of this real world contains the aspects relevant to the planning exercise.

2. Theoretical models

The representation of the real world can be regarded as a conceptual model, as described by Bertels and Nauta as a 'theoretical model of a concrete system'.

If we consider the spatial organization as the concrete system to be modelled in a theoretical model, we discern a model of the organization itself, models that describe the aspects that comprise the organization, and models that describe the processes and relations within the spatial organization (see Figure 2.1).

Figure 2.1 Processes to be modelled in the spatial organization



An example of a model of a concrete system is the *MFO* model, a model of the social and natural organization. Kleefmann (1992) modelled the spatial organization as an aspectual representation of this organization (see section 2.2). Soil maps are an example of models which describe aspects of the organization. An illustration of a model which describes processes within the spatial organization is a description of the hydrological cycle of a specified area.

A representation of a notion about what the real world should look like can also be regarded as a theoretical model, thus considering a designing process to be an act of modelling. Theoretical models which visualize aspects of the spatial organization will be called 'spatial models'[3)*].

The study of the social organization and the natural organization should be carried out in social and natural sciences that focus on these aspects. In this respect the modelling of the spatial organization can be regarded as an interdisciplinary task. An example of research which focuses on the effects of the social organization on the natural organization is van den Aarsen's research into the relation between nature and agriculture (van den Aarsen, 1994).

3. Formalized theoretical models

The formalization of theoretical models in this research can be regarded as an exercise of systematizing the theoretical models so they can be implemented on computers. In other words: 'modelling the theoretical models'. As previously explained, the spatial organization and processes within this organization can be described by theoretical models. The essential question to be addressed when studying the potential for developing and employing GIS and planning support systems, is the possibility of formalizing[4)] processes that take place in the spatial organization.

When developing a planning support system, not only the object of planning, but also the planning process itself has to be modelled. For this purpose, there must be an analysis of the spatial planning process followed by a formalization. Van Lammeren's *RISOR* research (1994) involved analysis and systematic description of the reconnaissance planning process as described by Kleefmann (1984). Before planning processes can become part of a planning supporting knowledge system, it must be known to what degree they can be formalized.

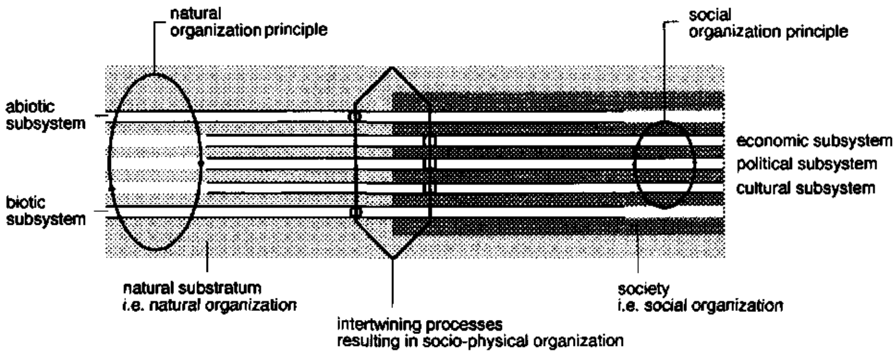
2.2 A model of spatial organization

The spatial organization of an area is the object of planning and is made up of several components and the processes within or between them. To construct scenarios and desired future situations, the components that constitute the spatial organization have to be described, i.e. the object of the planning process has to be modelled.

In this thesis, the planning object was based on the *MFO* model (Figure 2.2). This model was developed at the Physical Planning section of the Department of Physical Planning and Rural Development, in Wageningen Agricultural University. The brief explanation of the model in this section is based on publications in which the basis and the details of the model can be found: Kleefmann (1985), Hidding and Kleefmann (1989), Hetsen and Hidding (1991), Kleefmann (1992).

The *MFO* model regards spatial organization as the spatial aspect of a broader environment conceptualized by the mutual relations between society and its natural environment. Through these relations, the natural substratum[*] is transformed into physical conditions suitable for society. This new organization is

Figure 2.2 The *MFO* model: the base of the spatial organization (from Kleefmann, 1993)



called the socio-physical organization, and it is regulated by social and natural processes.

The natural environment is defined as the human habitat. Therefore, it comprises both the abiotic subsystem (water, earth and air), and the biotic subsystem (flora and fauna). Processes within these subsystems include groundwater flow, pedological processes and all types of biological or ecological processes.

The social processes result in the social organization which is divided into three subsystems: economic, political and cultural. The economic subsystem in the Dutch situation is formed by processes in a market economy system. The cultural subsystem concerns the development of notions and ideas in society. The political subsystem operates within the boundaries set by the cultural and economic subsystem, to steer and coordinate processes in the social organization. From the viewpoint of the reconnaissance planning approach, the task of the policy makers is to formulate their intentions*, goals and assumptions explicitly and consistently.

The ability of the government to influence spatial developments is determined by the social organization principle, which is the result of the interaction of the actors within the economic, political and cultural subsystems. Various principles of social organization are possible. Extremes are societies in which the political subsystem solely determines the developments, (e.g. former socialist systems in Eastern Europe) in which the cultural subsystem determines developments (e.g. societies with an economic or political subsystem which are hardly developed), or societies in which economics fully determines spatial developments (e.g. thoroughly capitalistic societies). Most societies will be mixtures of these extremes. A study of the way the interactions between the subsystems influence the steering capacity of the governing body results in a planning approach that is tailored to the conditions of the social organization being chosen.

2.3 Developing tentative directions of development or: 'reconnaissance planning'

Spatial planning comprises a variety of planning methodologies to do with the preparation of policy decisions, the preparation and realization of spatial plans, design and layout of areas, and methodologies of forecasting planning. The reconnaissance planning approach, which is the topic of this research, is an example of forecasting planning methodology[5)]. Forecasting forms the basis of a strategic planning process. Policy-makers, whether in a public governing body or heading a private enterprise, make choices that affect the future. In any strategic planning process it is desirable to ascertain the implications of the choices that are made, and to explore the boundaries within which the choices are possible. These explorations can be carried out with the help of scenarios as defined by van Vught[6)]. In this way, the scenario aims to support the decision-making process.

The goal of the reconnaissance planning approach is the formulation of tentative policy programmes[7)]. These are useful when choosing the most desirable direction of development can be chosen. According to Kleefmann such a programme should contain a cartographic representation of prospects which are described, a description of the future spatial organization and its management aspects. A financial analysis should also be part of the programme. Tentative policy programmes can only be constructed by an interdisciplinary team of specialists and planners working together. In order to satisfy the definition of a scenario according to van Vught, a sketch of the processes that should lead from the present situation to the described future has to be added.

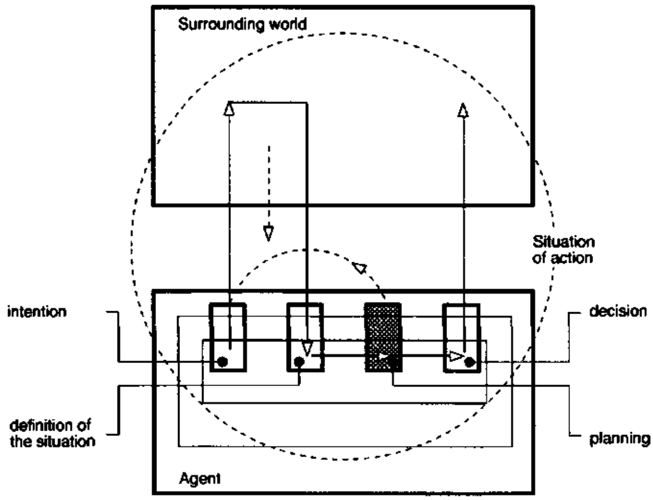
The reconnaissance planning approach, as described in Figure 2.3, regards the planning process as an action[*]. Kleefmann refers to the sociologists Alfred Schutz and Jürgen Habermas, borrowing his analysis of action and learning processes from the former and using Habermas's for the theoretical framework of the social context in which the 'actions' occur. In his book *'Handelen, Handelingscontext en Planning'* (1985), Kleefmann outlines a planning process based on a reconstruction of 'action' as described by Schutz. Within the 'action', Kleefmann discerns four phases: developing of what he calls an 'intentionality', definition of the situation, planning and decision making.

The 'action' has its roots in a certain '*intentionality*', which forms the normative basis of the course of the process. In accordance with Schutz, Kleefmann describes the 'intentionality' as the driving force underlying the 'action'. The 'intentionality' arises from the 'system of relevance' of the agent.

Departing from the 'intentionality', the agent describes and interprets the surrounding world and constructs a *definition of the situation*. This definition defines the problems of an area, based on a description (i.e. theoretical models) and an interpretation. Defining and re-defining a situation results in new insights and knowledge for the agent.

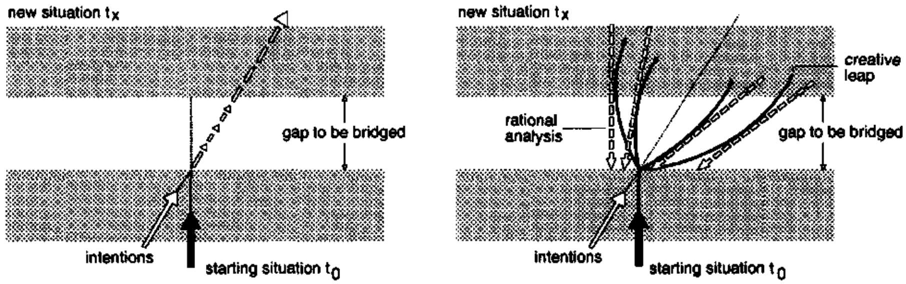
The third phase is the actual *planning*, within which possible actions are devised and within which the consequences of these actions are visualized. The planning process is a process of construction and analysis. Possible actions are devised by remodelling theoretical models of the real world. In this research I will characterize this phase, in which projections of 'intentionalities' are described in spatial models and action programmes involved, as 'plan-generating phase'.
In the final phase, the results of the various previous phases (i.e. the theoretical models as well as the action programmes involved) are assessed, evaluated, compared and considered in accordance with the starting 'intentionalities'. Generally, after this a *decision* on implementing one of the models (modified in minor points if necessary) will be taken.
The 'action' is not a linear process. The results of earlier phases can be accommodated as a result of succeeding phases, as there is a constant feedback in the process. Thus, the process can be regarded as a learning process, which combines experiences in distinct phases to arrive at the most appropriate policy.
The way reconnaissance planning is operationalized in the case study, which is only one of several possible operationalizations of the methodology, is described in Part Two of this thesis.

Figure 2.3 The planning process as an action process as described by Kleefmann, unfolding the process into four phases. (Kleefmann, 1985)



Planning approaches that concern possible future developments can have their starting point in the future or in the present. Kleefmann (1992) describes two approaches for planning, shown in Figure 2.4: a process of projective planning, 'bridging' the gap between present and future, which takes a situation in the present as its starting point and a process of prospective planning, 'leaping' over the gap between present and future, starting from a desired future situation after which the way back to the present is analyzed. Both approaches contain normative and explorative aspects. The explorative aspects concern the knowledge of the present situation and expectations about how it could develop. Normative premises form the base of a description of 'what the future organization should look like'.

Figure 2.4 Bridging and leaping the gap between present and future (Kleefmann, 1984)



Plans which sketch possible future developments are restricted by boundaries of a different nature. These boundaries have been characterized by De Jong (1988) as desirability, probability and possibility[8]. These boundaries should be explored when evaluating the tentative policy programmes. Their definition can also be helpful when developing processes that could link the present situation to the desired future.

Once a desired future development has been described, it can be regarded as a compass point, a dynamic point of orientation which supports the discussion and guides decisions that have to be made. This is in contrast to the 'blueprint plan' which was described in section 1.2, which regards the plan itself as a fixed goal for the future.

The plans resulting from the revival of explorative planning induced by the Science Policy Council in the Netherlands, were drawn up in full knowledge of the limited capacity to influence spatial developments. According to van der Cammen their main purpose was to attract public interest and to stimulate public discussion about desired future development.

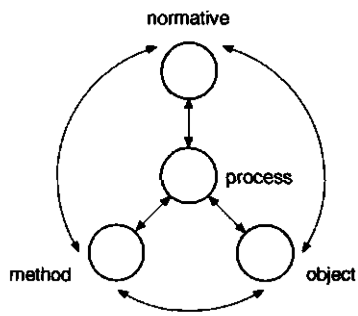
The Science Policy Council projects and the *NNAO* projects (see section 1.2) belong to the category of forecasting planning. However, these projects do not

describe the present situation or the processes that should lead from the present situation to the desired future. Neither type of project can therefore be regarded as a scenario according to van Vught's definition or as a tentative programme as defined by the *PCRO* (see notes six and seven).
In section 1.3 two reconnaissance planning exercises carried out by the Department of Physical Planning and Rural Development were mentioned (Kerkstra and Kleefmann, 1986, and Hetsen and Hidding, 1992). Kerkstra and Kleefmann based their description of normative premises on the present situation in the Netherlands. Hetsen and Hidding based their description of possible directions of development on an extensive description of the present spatial organization, concentrating on agricultural aspects in the Netherlands. A differing strategy was followed in a number of student projects, carried out in 1986 and 1987 at Wageningen University[9], which formulated the normative notions following the approach of the Scientific Council and the *NNAO* project: designing normative notions initially, prior to the description and analysis of the spatial organization in the studied area. These projects revealed that the development and evaluation of alternative directions of development is time-consuming. Information systems seemed to offer help to support the planning process, and therefore the prototype of the information system *RISOR* was designed, to support the methodology of reconnaissance planning (van Lammeren, 1988, 1991, 1994).

2.4 *RISOR* as a conceptual model of reconnaissance planning

In his *RISOR* study, van Lammeren (1994) describes and analyses reconnaissance planning. He discerns two aspects in the methodology: the 'action' and the 'knowledge used during the process'. In the *RISOR* concept the planning process is unfolded into 'action phases' and 'action moments', during which the knowledge categories are combined and new knowledge is developed (Figure 2.5).

Figure 2.5 Within the action moment the normative, object and method knowledge are combined and process knowledge is generated (van Lammeren, 1993)



The planning process according to the RISOR concept

Action phases and action moments in the reconnaissance planning process according to van Lammeren:

- developing of intentions:
  - description: listing of relevant goals, ideas, notions etc.
  - construction: constructing sets of coherent notions
  - evaluation: an examination as to whether the intentions are relevant to the area studied, resulting in choice being made of the notions that are to be elaborated
- the making of the plan:
  - description: gathering and analyzing data on the area; identifying potencies and conflicts
  - construction: designing possible ways that the area might develop
  - evaluation: examining the plans for their suitability to be submitted to the decision-making procedures; analysis of the consequences of the plans, and selection of the suitable plans
- choice of the plan:
  - description: determining the criteria important for making the choice
  - assessment: carrying out the validation based on the criteria
  - evaluation: discussing the designs and methods and choice

The structure of the planning supporting system *RISOR*, which will be described in section 3.5, is based on this model of the planning approach. As mentioned in section 1.4, a reconnaissance planning exercise supported by *RISOR* should be organized according to the structure sketched above.

Knowledge categories discerned by the RISOR concept

Within the planning process, four types of knowledge categories are distinguished: process knowledge*, normative knowledge*, object knowledge*, and method knowledge* (van Lammeren, 1994). The process knowledge concerns the process itself, regarding the process as a cyclic procedure of action phases and action moments. The normative knowledge concerns the normative notions. In the *RISOR* system the classification of the normative knowledge is based on the level of integration of the contents of the notions. The normative models are described on three levels:

1. normative models which integrate the spatial facet*;
2. normative models which integrate an aspect of the spatial facet;
3. normative models which integrate certain characteristics of an aspect: the sub-aspect level.

Van Lammeren describes the object knowledge as: 'the knowledge that states the nature, location and functioning of the object of planning'. The theory about data handling and GIS is well developed. Method knowledge[10)] in the sense of planning methods is described in literature and it is often classified according to the functionalities (Dessing, 1979). Methods can be formalized theoretical models which translate notions into spatial models, i.e. to solve planning problems if this is the case, they can be composed of GIS techniques. The research into formalized method knowledge is in its infancy.

Notes

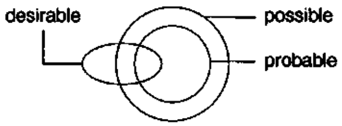
1. In Dutch: *Maatschappelijk- en Fysiekruimtelijke Organisatie*, (Social-Physical Organization).
2. Bertels and Nauta (1969) give the following definition of a model:
   'If a known system B, which is independent of a system O, is used to obtain knowledge about O, we can call B a model of O'.
   In their book Bertels and Nauta describe different ways of characterizing models. As the main classification of models they present a division into:
   - empirical models, consisting of objects;
   - conceptual models, consisting of concepts and notions;
   - formal models, consisting of abstract names.

   The conceptual models are further differentiated into:
   - theoretical models, which represent a concrete system, of relevance to the empirical sciences, e.g. real numbers as a scale division on a thermometer or the network structure representing social interaction in a group;
   - realization models, which represent a formalized system, of relevance to the formal sciences, e.g. real numbers as the model of the formalized theory of real numbers.
3. According to van Lammeren (1993) the methodology of reconnaissance planning consists mainly of two actions:
   1. the development of one or more coherent normative premises, called 'normative models',
   2. constructing one or more 'concrete models' of the future spatial organization, based on the normative models.

   In this thesis I will use the term 'spatial model' instead of the term 'concrete model' used by van Lammeren. Bertels and Nauta define empirical models as models consisting of concrete entities. However, they describe a conceptual system as a 'paper and pencil' construction of man, not a concrete entity. In this respect we can regard maps visualizing spatial patterns and structures as conceptual models. The term 'spatial model' in this thesis can thus be regarded as a conceptual model.
4. Formalization can be defined as 'describing the conceptual model which has to be studied, in an abstract language' (Nauta and Bertels, 1969). Nauta and Bertels use the definition of a formal model in an article by A. Rosenblueth and N. Wiener, 'The Role of Models in Science', *Phil. of Science*, 12(1945) pp. 316-321. The definition is: 'A formal model is a symbolic assertion in logical terms of an idealized relatively simple situation sharing the structural properties of the original factual system'.
5. Within the group of forecasting techniques van Vught discerns four approaches: explorative, speculative, explicatory and integrating forecasting techniques (van Vught, 1978).
   The explorative forecasting extrapolates trends and researches into logically expected alternatives.
   The speculative forecasting estimates subjective probabilities of phenomena.
   The explicatory forecasting explicates desired futures and the ways to reach these futures.
   The integrative forecasting researches the implications of the choices made and the relation between separate forecasts.

6. The term 'scenario' has various connotations.
Böttcher (1988) describes the way the term 'scenario' is used in forecasting research as a possible, desirable or undesirable development in the world or in that part of the world, relevant to the research. Regarding the uncertainties, more than one scenario is often taken into account.
In this thesis I adopt van Vughts's definition (1978), who describes a scenario as follows: 'A scenario describes the present situation of a specified part of reality, of one or more possible or desired future situations at a point of time in the future and of the processes that (should) lead from the present situation to the future situation'. According to van Vught, a scenario contains three components:
   - a description of the present situation
   - one or more alternative images of possible futures
   - one or more processes that could lead from the present situation to the described futures.

   Van Vught emphasizes that not all the components of each scenario necessarily have to be described broadly.
7. A memorandum of the *Permanente Contactgroep Ruimtelijke Ordening* (Working group on Spatial Planning of Wageningen Agricultural University, PCRO) mentions the following premises underlying tentative policy programmes (PCRO, 1992):
   - a clear distinction between the programmes, without solely presenting extremes;
   - a definition of the situation should be recognizable in the programmes;
   - the programmes should be comparable with respect to the items that are discussed;
   - within the limits of their tentative character, the programmes should be of high internal consistency;
   - the number of programmes should be limited.
8. De Jong describes the relation between these boundaries with the help of a figure.



   The possibilities open to us are delimited by technological developments, ecological exhaustion and social acceptability. The desirable future partly transcends these limits. Some of the desirable future is probable, some not. Part of the probable future is not desirable. Most of the possible future is neither desirable nor probable.
9. Terpstra, 1986, Domna and Groenendijk, 1987, Van Biesbergen and Eweg, 1987, Joop and Wessels, 1988.
10. The method knowledge comprises methods and techniques. In this study I will use the notions 'method' and 'technique' in accordance with van Lammeren, who refers to definitions of Sol (1986) who defines 'method' as: 'a collection of prescriptions and rules which are employed in reality (descriptive) or which should be used (prescriptive)'. He defines 'techniques' as:
   - means, possibly instruments, to perfom methods;
   - aids which are used, or skills which should be learned to perform methods.

3 INFORMATION SYSTEMS

The concept of 'GIS' is widespread and is used in a wide range of applications, hence the wide-ranging definitions of GIS. In this chapter, I will give a brief overview of the definitions, in the light of the topic of this thesis, an application of GIS in physical planning. Reconnaissance planning is a specific planning methodology, derived from a theoretical approach to physical planning, called 'planology'* in the Netherlands. Kleefmann produced the definition of planology used in the Department of Physical Planning and Rural Development at Wageningen University. Applications of GIS appropriate to aspects of planology will be given below. Furthermore, the terminology relating to 'expert and decision systems' will be clarified. The *RISOR* planning system will then be described and characterized, on the basis of this discussion.

3.1 The confusing concept of GIS

In the last ten years the number of articles dealing with GIS, software design and applications has grown exponentially. GIS conferences have resulted in a plethora of papers, lectures and posters[1].
The applications of GIS are many. They vary from the processing of population counts, surveying, civil engineering, environmental planning, and earth sciences to the planning of military operations and missile guidance[2]. Applications thus concern socio-economic, physical-environmental and management issues. The use of GIS is not limited to addressing solutions regarding specific topics. GIS software can also be used to improve flows of information within an organization in order to enhance that organization's efficiency.
The diversity of the applications and the diverse group of GIS users have caused misunderstandings about the meaning of GIS. The emergence of many systems operating under slightly different names such as Land Use Information Systems (LIS), Spatial Information Systems (SIS), Management Information Systems (MIS) and Rural Information Systems (RIS) completes the Babel-like confusion.
Also the difference between the interpretation of GIS as software and as a system could lead to confusion. In a paper presented at the EGIS '91 conference, de Meyere (1991) points out that calling software an 'information system' is confusing and creates false expectations[3].

3.2 A definition of GIS

In their introductory chapter of the EGIS '90 proceedings, Harts, Ottens and Scholten (1990, p.4) characterize GIS as a specimen of the group of Spatial

Information Systems. They describe GIS as 'a tool for research and policy-oriented monitoring, analysis, simulation and planning'. While focusing on the applications, they propose a classification of GIS based on the type of users and the sectors of GIS use.

In an article in the *International Journal for Geographical Information Systems*, Bracken and Webster (1989, p. 139) refer to a classification drawn up by the American Farmland Trust, which identified 61 types of GIS, based on functional characteristics[4)]. Bracken and Webster themselves propose a classification based on system architecture[5)]. They define a GIS as 'a specialized form of database system, distinguished by its ability to handle spatially referenced data'. The characterizations mentioned above are based on applications, functionalities or system architecture. They leave unanswered the question as to whether GIS should be regarded as a system, comprising data and the associated organization, or as software.

Leaving the discussion about the most desirable classification of GIS to the experts, it nevertheless seems useful to view GIS as a 'system' and as 'software'. If in this thesis GIS *software* is mentioned, Burrough's definition of GIS[6)] is adopted: *'a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world'*. The term Geographical Information *System* (GIS) will be used according to Carter's definition[7)]: *'an institutional entity, reflecting an organizational structure that integrates technology with a database, expertise and continuing financial support overtime'*.

3.3 GIS in physical planning

As mentioned above, GIS enjoys a wide range of applications in various fields. This thesis deals with an application in planning, in particular the use of GIS for a specific methodology of physical planning. Before discussing the applications of GIS in the distinctive phases of a physical planning process, it is necessary to explain the term physical planning, focusing on its operationalization at the Department of Physical Planning and Rural Development at Wageningen University.

In 1991, the working group on spatial organization at Wageningen University (PCRO), invited senior staff at Wageningen University working in the field of spatial planning to a series of lectures. They were asked to give their view on a description of physical planning (PCRO, 1991). Two main planning approaches could be discerned. The land use planner van Lier (1991) described planning as the realization of goals formulated by society. Planning is thus regarded as an instrument for converting the proposed goals into changes in the physical environment and the spatial lay-out of areas. Kleefmann (1991) described the physical planning process as an instrument for reconnaissance, as was described in section 2.3. In this approach the planning focuses on the process of change itself. It is this approach that has been incorporated in the following definition of planology in use at the physical planning section of the Department of Physical Planning and Rural Development at Wageningen Agricultural University:

'Planology is a scientific approach that views spatial organization as an aspectual representation of the socio-physical organization and deals with this spatial organization in planning and policy, by focusing on problems of allocation of land use in rural areas and the transition between town and countryside.
This implies describing and explaining the characteristics and problems of the spatial organization of an area, searching for solutions and evaluating these solutions. The starting point is the allocation of claims to space and the conditions these claims require; these are derived from intended functions of space and the activities intended to take place in that space. Taking into account aspects of the landscape that refer to cultural premises and the possibilities or restrictions of a technical and economic nature. All based on the aspects of a sustainable existence of the natural environment.'

This definition can be applied to the aspects of the working field of planology. The aspects describe the stages in which planology processes its object, the spatial organization: *describing* the characteristics and problems of the spatial organization, *explaining* these characteristics and problems, *searching* for possible solutions and *evaluating* the solutions found. In the succeeding sections, the potential use of GIS will be discussed briefly per aspect, and illustrated by examples of actual applications.

Description of characteristics and problems
Usually, a description of the spatial organization is based on an analysis of the aspects that comprise this organization. This description can be based on the *MFO* model (section 2.2), which not only provides a framework for analyzing the spatial organization itself, but provides also a basis on which to organize the information about the spatial organization.
GIS can be used to analyze physical as well as socio-economic aspects of the spatial organization. Furthermore, GIS can be used to study spatial patterns[8)] or to link thematic data to geographical features (examples of thematic data are flora and fauna inventories, socio-economic statistics, and hydrological measurements). The combination of these data with geographical features, e.g. soil units could provide insight into the spatial structure of an area.

example: A biotope inventory of Europe
The inventory of biotopes in Europe was part of a study carried out by Bischoff and Jongman (1993) into the development of an Ecological Main Structure for the European Community. This study was a recursor to the report *'Grond voor Keuzen'* (Grounds for Choice) which investigated possible changes in land use the EC (WRR, 1992). Information about existing biotopes in Europe was derived from the CORINE database[9)]. The data on biotopes in the CORINE database,

however, give information about biotopes related to points described by their coordinates. To obtain geographical entities, the data had to be combined with a map of the natural vegetation of Europe, the EC soil map and regional information (Jongman, 1992)[10]. This exercise resulted in maps of the 'Tentative Ecological Main Structure for the European Community'.

Explanation of the characteristics and problems of spatial organization
To explain the characteristics and problems of spatial organization, it is necessary to identify which elements compose a particular spatial organization, which processes can be identified within the spatial organization, and which are the causal relations between these elements and processes. A study of these elements and relations does not necessarily lead to a comprehensive system in which all variables are subsumed. As mentioned (section 2.1) when discussing the construction of models, only those elements and relations that are known should be described, omitting uncertainties and processes that cannot be described with the help of formal models. The natural, social and economic processes that constitute the spatial organization will include many that are unknown or that cannot be described by formal models[11].
Although it may only be possible to describe some of the characteristics and processes, a systematic description contributes to a better understanding of the functioning of the spatial organization and helps to predict the influence of choices on spatial changes.
Formal models can be converted into computer models using any programming language, existing statistical packages and GIS software[12]. Spatial planners and system designers have to be involved in the modelling. If possible, the spatial planner has to construct theoretical and formal models of aspects of the spatial organization, in consultation with experts. The systems designer has to design the software and hardware environment in which these models can function.

example: Erosion models
Studies on erosion control have a long history of modelling. Theoretical models describe the processes that lead to the loss of soil by water flow and predict the expected soil loss at different scenarios of land use and rainfall. De Jong and Riezebos (1992) mention two types of models: empirical black box models and quasi-mechanistic models[13]. In a case study they describe in a case study an empirical model constructed by Morgan, Morgan and Finney. This 'MMF model'[14] is based on topographical maps, satellite images, soil maps and long-term climatic data. Based on this input, the model calculates the soil erosion rate resulting from different scenarios.
Another approach in modelling erosion processes is the model described by Suryana (1992): the 'Inductive Erosion Model' (IEM). The IEM model can be used if knowledge about the processes contributing to erosion is unavailable or incomplete. The model is based on the knowledge of experts and on field observations to assess the change of erosion, rainfall, soil type, slope gradient,

slope length, percentage of ground cover, soil conservation practices and terrain mapping units. The erodibility of terrain units is assessed by a combination of these influences.

Searching for possible solutions with GIS
Models that provide insight into the processes within a certain spatial organization contribute substantially to the exploration of future development, by answering '*what if...*' questions. McHarg (1969) advocated a way of reconnaissance planning, based on overlaying and manipulating maps that involved including natural processes and values in the planning process. He assigned values to natural aspects as well as to socio-economic aspects and delineated these values on maps. By overlaying these maps, more insight could be gained into the effects of interventions in the spatial organization.
McHarg's planning approach formed the basis of the development of the raster-based GIS package 'MAP'[15] and the methodology of cartographic modelling, developed by Tomlin[16]. The methodology of cartographic modelling is based on combining existing geographical features. Thus, it can be regarded as an example of forecasting planning which departs from the actual situation, which was characterized in section 2.1 as 'projective' planning.
Forms of 'prospective' planning which 'leap' over the gap between present and future, also may be supported by a GIS. Adding the ability to draw and design new objects to the GIS could increase the potential of the software to support prospective planning.

example: New housing in Randstad Holland
Geertman and Toppen (1991) describe a case study of searching for possible solutions to urbanization with a GIS. They elaborated the Fourth Policy Document on Physical Planning (Vierde Nota, 1989). One of the goals described in that document is the realization of new building sites to meet the expected demand for one million new dwellings to be built on new sites during the period 1990-2015. The case study began by formulating criteria for the new sites. These criteria were derived from goals formulated in governmental reports: reducing mobility and safeguarding nature areas. They included conditions such as 'new building sites must be adjacent to built-up areas, within a certain distance from secondary schools' or 'no building sites should be located in large-scale landscapes or important nature areas'. Suitable new sites were identified in a reiterative process of weighing the selected criteria, selecting and evaluating suitable sites, computer on-screen simulations of new sites and repeated evaluation.

Evaluation
The evaluation of a plan can be regarded as comparable to the analysis. During the analysis, various aspects of the existing spatial organization of an area for which a plan is drawn up, are studied. The processes, spatial relations and patterns are studied and described. The result of the analysis may be the identification of

phenomena that are considered 'problems' or 'malfunctions'. These problems are not 'objective' problems, but are the results of a comparison of a view of 'how things should be' with the real world. When it comes to this comparison the analysis is comparable to the evaluation stage, in which the 'real world' as the object of analysis is replaced by the 'plan alternatives'. One can review a spatial plan with its goals, or evaluate its environmental acceptability (for example, to evaluate their environmental acceptability, important spatial plans are submitted to Environmental Impact Assessment (EIA) procedures[17)).
Multi-decision methods or multi-criteria analysis[18) are evaluation methods that combine and integrate various aspects. The basic question during the evaluation is to what extent the goals that were formulated are met by the plans that have been drawn up. In a GIS, analysis as well as evaluation is performed on models that represent the actual real world, or the real world after the interventions proposed in the plan have been carried out. As the planning process is not a static, linear process, it is possible that views evolved during the planning process will also play a role in the evaluation phase. Evaluation affects all aspects of the socio-physical organization: socio-economic as well as environmental.

example: Environmental impact assessment with the help of an Information System
The Dutch municipality of Zwolle developed a procedure for assessing the impact of industrial activities on the environmental quality. In 1992, the Centre for Geographical Information processing at Wageningen Agricultural University developed an information system based on this procedure (van Slagmaat, van der Meer and van Lammeren, 1992). It consisted of the GIS software GeoPackage* and a database developed with dBase software. In the database common industrial activities are stored, with their hazards regarding smell, dust, noise, danger, and their environmental impact on air, soil and water. The GIS can be used to digitize topographical maps and import them into the system. Based on this information, the information system assesses the integrated environmental impact of actual or proposed industrial activities.

Other applications of GIS in physical planning
The choice of the plan alternative that will be implemented is based on the results of the evaluation, but this is not the sole factor influencing the choice. Political acceptability, influences of pressure groups, tradition, and unforeseen external influences may be the deciding factor for the choice, or may influence how a plan is implemented. The decision support* and expert* systems used to ascertain these factors could include GIS.
The role of GIS in physical planning does not end once the plan alternative has been chosen. Implementation, monitoring and maintenance are aspects of the planning process that have their own GIS requirements and applications. The planning organization makes demands of the way the flow of information between its cooperating departments is organized. Another aspect of the implementation of

GIS in an organization is how to make the vast amount of information available at the right time in a suitable form and how to guide this flow.

When considering the planning process and the planners the question arises of whether the planning process should be re-organized to improve the application of GIS. Should the planning process become more rational and systematic? Should planners change their methods to make the use of GIS easier? Should a GIS be designed to be used by policy-makers too and by other actors in the planning process? The answers to these questions are not straightforward. In Chapter Ten they will be discussed on the basis of experience gained in the case study.

3.4 Expert and Decision Support Systems

Comparable to the concept of GIS, the group of 'Support Systems' also contains many components. Two main concepts are widespread in the field of information systems: expert systems or knowledge-based systems and decision support systems. These two systems will be discussed below.

It is possible to discern formal and informal knowledge in the object of planning (the socio-physical organization) and in planning methodology (Han and Kim, 1989)[19)]. Both formal and informal knowledge can describe regularities in processes and causal relations in the spatial organization. If this knowledge is stored in some type of information system, we can speak of an *expert system* or *knowledge-based system*[20)]. The expert system attempts to solve problems by applying the rules and experience of experts. Such a system is mainly based on a knowledge base containing rules developed by experts, and a 'user interface' to derive the information systematically from the knowledge base[21)]. Between the user interface and the knowledge base is an 'inference engine', which drives the knowledge base through reasoning processes which are similar to the reasoning processes of a human being (Han and Kim, 1989).

Decision support systems (DSS) aim to support decision making processes. A definition of DSS is: 'any device or devices used by humans better to understand the information necessary for making a decision' (Honea, Hake and Durfee, 1990). Thus formulated a DSS could be 'anything from the back of an envelope to sophisticated GIS'. Concentrating on automated information systems, Fedra and Reitsma (1991) point out that there is no generally accepted definition of DSS: 'any computer-based system from database management or information systems via simulation models to mathematical programming or optimization could conceivably support decisions'[22)]. DSS focusing on the spatial planning process are called spatial decision support systems (SDSS)[23)].

The design of a DSS should be based on the requirements of the user, the decision maker. This imposes high demands on the design of the system, which has to incorporate the knowledge and experience of the decision makers, as well as the decision-making process. According to Han and Kim, a DSS consists of a

database which contains data, a model base which contains various models and a user interface to facilitate interaction between the user and the system.
A decision making process, which is in fact a policy-making process, includes factors such as political feasibility and local social and cultural factors. When designing a SDSS to support such a decision making process, these idiographic factors should be taken into account. An SDSS to support a planning process is a system that supports the formulation and evaluation of plan alternatives based on planning factors that can be identified. Integrating GIS with decision support systems and expert systems could lead to powerful systems that support planning and decision-making processes.

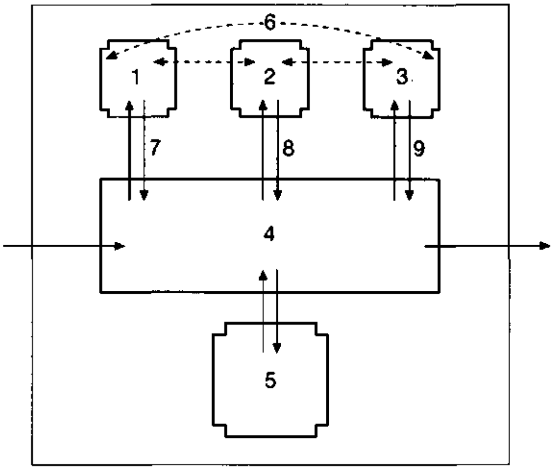
3.5 The *RISOR* planning support system

In 1984 Kleefmann concluded that it was not very feasible to implement the reconnaissance planning approach employing traditional 'manual' means (Kleefmann, 1984, p. 124). He mentioned problems concerning aspects of time, finance and labour, but also the limited human capacities of the planners themselves. This stimulated the Department of Physical Planning to start research on the possibility of developing an information system that could support the reconnaissance planning approach. This research was done by van Lammeren in 1984 and resulted in an information system named *RISOR*. *RISOR* is based on an analysis of the processes and knowledge types that constitute the reconnaissance planning methodology, as described in section 2.4. For an elaborate description of the *RISOR* and its background, see van Lammeren (1994). *RISOR*'s design was guided by the properties of an information system that should support a planning process[24)] and on an analysis of the reconnaissance planning methodology. The system consists of three relational databases (called subsystems), a user interface and a GIS. In the databases, references to knowledge used during a reconnaissance planning process is stored.

The *RISOR* consists of three subsystems (Figure 3.1):
- the project subsystem
- the knowledge subsystem
- the user interface

The project subsystem may consist of any GIS software that can be employed in a process of physical planning, providing the software is capable of registering the GIS commands and re-executing these registered commands. Many GIS software packages are available that meet these requirements. The MAP software developed by Tomlin was initially chosen to development the *RISOR*. The MAP package was developed into the MAP2 package, which evolved further into the GeoPackage, adding digitizing and presentation facilities[25)].

Figure 3.1 Design and use of the RISOR (after van Lammeren, 1994)



1 Normative database
2 Proces database
3 Object database
4 User interface (input, processing, management, output)
5 GIS
6 Indirect usage of techniques for input and selection
7 Input / selection of nomative models
8 Input / selection of process data
9 Input / selection of object data

The knowledge subsystem has been developed using software for designing database management systems (DBMS)[26)]. The knowledge subsystem consists of three related databases, in which the object knowledge, method knowledge and normative knowledge are stored. Unlike knowledge-based systems which give direct access to the information, the *RISOR* gives *references* to the information itself. The factual information can be stored on tape, floppy disk or hard disk. This approach was chosen because of the limited memory capacity of the hardware and the size of the data files. On the basis of its structure and abilities the *RISOR* can be characterized as a Referring Expert System, to support planning.
The user interface (UI) establishes the interaction between the user, the two subsystems and other software related to the *RISOR*. The UI gives access to:
- the project subsystem
- the knowledge subsystem
- GIS software for manipulating data
- digitizing facilities
- conversion of object data
- presentation facilities
- software that supports multi decision analysis (MDA) techniques
- facilities for editing command files in which methods and procedures are registered

At the time of writing, the knowledge subsystem and the project subsystem do not yet form a fully integrated system. They still operate as separate systems, as the user interface only exists conceptually. The research described in this thesis focused initially on the application of the project subsystem (i.e. the GIS software) and subsequently on the prototype of the knowledge subsystem when it became available.

Van Lammeren (1994) mentions various applications of the *RISOR* system:

a. carrying out a planning process with the GIS module, registering the 'acting stages' with the help of 'Macro Command Files';
b. storing the knowledge generated during a planning process in the knowledge base;
c. automatized processing of data, using knowledge already stored in the *RISOR* system.

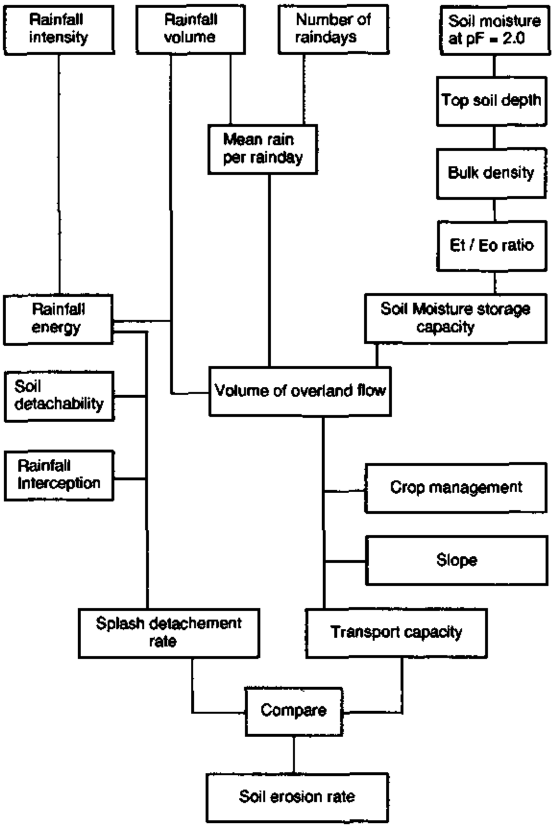
Having examined the theory of planning and Information Systems, I will now turn to more concrete matters. In the case study, which will be described in Part Two, *RISOR* was applied for carrying out a process of reconnaissance planning and for storing the knowledge generated during this process. The models described in Chapter Two provided the basis for the analysis of the object of planning and the planning process itself.

Notes

1. In their book *Geographical Information Systems; Principles and Applications* Maguire, Goodchild and Rhind give a comprehensive survey of GIS textbooks, periodicals and Conference Proceedings (Maguire, 1991, pp. 5-7).
2. Maguire, Goodchild and Rhind (ibid., 1991) use a general classification of socio-economic, physical, environmental and management applications. Under socio-economic applications they have the following categories: land and car information systems, registering ownership as an aid to tax collection and planning, and development and registration of utilities. Physical environmental applications comprise: soil information systems, resources analysis, storage of ecological data. The management applications mentioned are: land resource information systems aimed at the management of land, resource planning and other planning applications.
3. De Meyere describes an information system as: 'a set of data, procedures, tools and people, organized in such a way as to satisfy an identified demand for information'. With this definition he broadens the definition of GIS not only to include the data but also to include the people using the system and the organization of all these aspects.
4. American Farmland Trust - AFT - (1985) *Survey of Geographic Information Systems for Natural Resource Decision Making at the Local Level* (Washington D.C., AFT).
5. The classification based on system architecture by Bracken and Webster, typifies the systems by the way data are processed. The processing model results in the following classification (Bracken and Webster, 1989):
   - the simple map model: operations performed on a database which represents a single map universe;
   - the composite map model: operations performed on a multi-layered map base;
   - the relational map model: treating the layers of a map as independent data sets which can be combined in ad hoc fashion without the need to create permanent composite maps for each query. The maps might have their own attribute table, relating the topographical entities.

6. Burrough P.A. (1986), *Principles of Geographic Information Systems for Land Resources Assessment.* (Clarendon: London), quoted in: Maguire (1991).
7. Carter J.R. (1989), On Defining the Geographic Information System. In: Ripple W.J. (ed.), *Fundamentals of Geographic Information Systems: a compendium.* (ASPRS/ACSM: Falls Church, Virginia) pp. 3-7, quoted in: Maguire (1991).
8. (Openshaw, 1991) quotes Hagerstrand who describes spatial analysis as 'a study in depth of the patterns of points, lines, areas and surfaces depicted on maps of sort or defined by coordinates in two- or three- dimensional space' (Hagerstrand T., 1973, The Domain of Human Geography, in: Chorley R.J. (ed.) *Directions in Geography,* (Methuen: London), pp. 67-87.
9. The CORINE (Coordinated Inventory of Environmental Data) programme was adopted by the EC in 1985. Its objective is the collection and coordination of information on the state of the Community environment and improving consistency. The database has been established under the provisions of Council Decision 85/338/EEC of 27 June 1985, which set up the CORINE programme. The database contains data on biotopes, acid deposition and problems of the Mediterranean region.
10. The procedure for developing the biotope map is described by Jongman as follows (Jongman, 1992):
    1. The biotope point sites are selected by their habitat types for all regions at NUTS I (Nomenclature of territorial units for statistics, EUROSTAT) level (64 regions).
    2. All the biotope habitat types are compared with the potential natural vegetation units, the soil units and with the regional situation concerning the protected areas and additional habitat information if available.
    3. The procedure is followed for each region. In all the regions the information is evaluated using the natural vegetation map and the soil map.
    4. Based on these three steps a map is constructed of areas of Nature Conservation Interest. In this map only the potential delineation of the combined categories is given. After consulting experts in the member states the map is corrected.
    5. The total coverage of the potential areas is simplified, because no data are available on the delineation of biotopes from the CORINE database. The coverage is calculated for all the regions.
11. In note 2, Chapter Two, a formal model was defined as: 'a symbolic assertion in logical terms of an idealized relatively simple situation sharing the structural properties of the original factual system'.
12. Fischer and Nijkamp (1992, p. 218) describe the requirements of such a software configuration as follows: editing, updating, performing algebraic operations, using statistical methods, performing simultaneous queries and geographically displaying all layer information. To support this, a relational database is conditional.
13. As examples for traditional black box models De Jong and Riezebos give the USLE model, described by Wischmeier and Smith (Wischmeier W.H. and Smith D.D. (1978), *Predicting rainfall erosion losses.* USDA Agr. Res. Serv. Handbook 537) and the SLEMSA model, described by Stocking (Stocking M. (1981), A working model for the estimation of soil loss suitable for underdeveloped areas. *Development Studies occasional papers no. 15*). As an example of a quasi-mechanistic model they mention the ANSWERS model, described by Beasly and Huggins (Beasly D.B., Huggins L.F. and Monke E.J. (1980), ANSWERS: a model for watershed planning. *Transactions of the ASAE,* 23, 4, 938944).
14. De Jong and Riezebos describe the MMF model with the help of a flowchart, which was drawn up after a flowchart derived from Morgan (Morgan R.P.C. (1986), *Soil Erosion and Conservation.* (Longman Group: UK).

Flowchart Morgan, Morgan and Finney soil erosion model (after De Jong and Riezebos, 1992).



15.MAP (Map Analysis Package) was developed by Tomlin at Harvard University, USA, in 1977. MAP was the result of a combination of existing GIS packages: SYMAP, GR D and IMGRID with the idea of organizing and processing geographical data on a layer-by-layer basis (see: Tomlin, 1991). The capabilities of MAP were incorporated into a many GIS packages which were derived from the MAP package, such as IBM-PC-MAP, MacGIS, MAPS, MAP2, MAPII, OSU-MAP, pMAP, SAC, SCMAP and GEOMAP.

16.'Cartographic modeling is a geographical data processing methodology that purports to address diverse applications in a clear and consistent manner. It does so by decomposing data sets, data processing capabilities and data processing control specifications into elementary components that can then be recombined with relative ease and great flexibility' (Tomlin, 1991, p. 361). Tomlin describes the method of carthographic modeling extensively in his book *'Geographic Information Systems and Cartographic Modeling'* (Tomlin, 1990).

17.Lee and Wood cite the contents of an EIA proposed by the European Commission to its member states (Lee and Wood, 1984) as described in the *Official Journal of the European Communities*, C169 (1980) and C110 (1982):

- A description of the proposed project and where applicable, of the reasonable alternatives for the site and/or project design.
- A description of the environmental features likely to be significantly affected.
- An assessment of the likely significant effects of the project on the environment.

- In the case of significant effects on the environment, an explanation of the reasons for the choice of the site and/or project design, compared with the reasonable alternative solutions having less effect on the environment, if any.
- A non-technical summary of the items above.

18. In a paper presented at the EGIS'91 conference Carver described a case study of searching for nuclear waste sites, combining Multi Decision Analysis (MDA) and GIS. With the help of the GIS software ARC-INFO candidate sites were sought, which were subsequently evaluated using MDA, exchanging data with the GIS database in a reiterative planning process. The MDA matrices were calculated with FORTRAN routines (Carver, 1991).
19. Han and Kim quote the definition of Burch, Strater and Grudnitsky, who in their book *Information Systems: Theory and Practice* (New York, 1979) describe formal information as: 'the information identified and formalized by society and its institutions regarding how, when and for whom the information will be produced from data'. Informal information may comprise personal judgement, intuition, hearsay and personal experience.
20. A definition of an expert system: 'a computer system that uses a representation of human expertise in a speciality domain in order to perform functions similar to those normally performed by a human expert in that domain' (Goodall (1985), *The Guide to Expert Systems* (Oxford UK), quoted in: Han and Kim (1989).
21. A description of an Expert System is given by Bunce, Howard and Hallam (Bunce et al., 1992) as: 'a computer program that is largely a collection of heuristic rules (rules of thumb) pertaining to a particular subject area. A feature which distinguishes an expert system from other methods solving problems, e.g. mathematical modelling, is that the expert system can explain to the user how it reached the recommended solution'. As an example two expert systems developed at the Institute of Terrestrial Ecology station Merlewood, Cumbria UK can be mentioned. The FOREST system enumerates effects that are likely to occur in a given area by identifying forestry options and listing their effects. The MEADOW and FINDSEED system give management advices to farmers and nature conservation agencies who want to achieve wildflower meadows (Bunce et al., 1992)
22. A comparable definition is given by Kroeber and Watson: 'an interactive system that provides the user with easy access to decision models and data in order to support semistructured and unstructured decision-making tasks', (Kroeber and Watson (1987), *Computer Based Information Systems*, (New York)) quoted in: Han and Kim (1989).
23. SDSS are described by Densham (1991) as systems 'explicitly designed to support a decision research process for complex spatial problems. SDSS provide a framework for integrating database management systems with analytical models, graphical display and tabular reporting capabilities, and the expert knowledge of decision makers'.
24. The properties on which the RISOR was based are described by van Lammeren as follows (van Lammeren, 1994):
    1. The planning activities should be carried out in an efficient, flexible and clear way;
    2. The activities of the planner should be registered corresponding to the phases discerned in the planning process;
    3. The registered activities should be administered;
    4. The planners should be informed and advised on the basis of the knowledge in the RISOR;
    5. It should be possible to automatically carry out the methods that are registered and administered;
25. The GeoPackage consists of four modules: Geodig, Geomap, Geoplot and Geocompiler. Geodig offers facilities for digitizing data, Geomap for rasterizing and manipulating raster data. Geoplot allows data to be presented and the Gecompiler compiles Pascal commands (Geops, 1991).
26. Initially the system was programmed using S1032. In a later phase the system was rewritten using ORACLE.

Part II

Chapter Four and the five chapters following it constitute Part II of the thesis: the case study. In Chapter Four I will introduce the study area and the working process. The planning process started with the formulation of normative knowledge. In Chapter Seven it will become clear that the normative knowledge results from an interaction between the 'system of relevance' (an abstract type of normative knowledge) and the object of planning. However, for clarity's sake I will discuss these two categories of knowledge in separate chapters: object knowledge in Chapter Five and normative knowledge in Chapter Six. The description of object knowledge and normative knowledge is based on the systematics of the *MFO* model, which describes social and natural organization.
I chose to describe the planning process in Chapter Seven, as the main part of this process was based on the normative knowledge and processed the object knowledge. In that chapter the intermediate planning maps which illustrate the process will also be depicted. These maps can be regarded as 'intermediate object knowledge'. The outcome of the planning process, which will be described and discussed in Chapter Eight, is also to be regarded as object knowledge describing the desired future situation. The description of the planning process, schematized in figure 7.4, will make clear how, and in what phases, GIS was used in this research. References to the various categories of knowledge referred to above are stored in the *RISOR* system. That system's performance in this research will be described in Chapter Nine, which concludes this part of the thesis.

4 INTRODUCTION TO THE STUDY AREA AND THE WORKING PROCESS

The choice of the study area was determined by three types of consideration: methodological considerations, features of the study area and the availability of information. In the first sections of this chapter I will discuss these considerations.

In the second section of this chapter, the knowledge used during the working process is outlined. This knowledge was influenced by constraints of time and availability of information. The normative knowledge and process knowledge were based on previous experiences and developed by reading literature, discussion and experimentation.

4.1 The choice of the study area

Methodological considerations

The objectives of this research were primarily methodological: to operationalize the reconnaissance planning to ascertain the feasibility using GIS in such a process, and to examine the ability of the prototype of the *RISOR* system to store information. These aspects can be studied in a study area which is composed by a socio-physical organization. This area can have different shapes which vary on a sliding scale, hypothetical to real. Hypothetical areas can be designed based on information derived from real areas, or on information that has no relation to reality. In the latter approach all subsystems of the natural organization and the social organization are invented. This approach enables the researcher to concentrate exclusively on the methodology, in which case the results of the methodology do not concern an existing area and will not be subjected to discussion. The choices are made during the research process will be based on assumptions. The temptation for the planner to adapt the area, data or circumstances at his whim to suit the abilities of the GIS software or the desired outcome of the methodology is a hazard of this approach. If this happens, the judgement on the methodology or information system cannot be trustworthy, as it gives no clear answer to the question of how the methodology or information system operates in practice.

The other extreme when testing a methodology is to derive all subsystems and processes from the real world. This approach yields reliable insight into the functioning of both the methodology and the information systems. Also, the results of the exercise will offer reliable solutions to planning problems in the area chosen for study. However, this approach requires a group of experts from various disciplines who provide knowledge about the subsystems to the planner; it also requires sufficient finances and time.

The approach I adopted lies in between these two extremes. The experiences gained by others[1)] in the application of GIS in reconnaissance planning justified opting for a realistic case study. However I was constrained by lack of manpower, money and time. The information about the object (i.e. study area) and processes within the object was derived as much as possible from reality. During the planning process, close contact with the provincial planning authorities facilitated an exchange of knowledge. However, when area-specific problems cropped up, I gave priority to addressing methodological problems rather than the substantive problems. There is therefore a danger that the results of the planning process followed in this research might be regarded as a realistic plan for the development of the study area.

Features of the study area

Three main aspects influenced the choice of the study area. They are enumerated below and then elaborated in the subsequent paragraphs.

1. Homogeneity in soil types, nature or types of agriculture.
2. The number of case studies to be carried out. If more than one case study has to be carried out, there must be areas elsewhere that are comparable to the study area.
3. The size of the region, it is possible to study an area on a local, regional, national or european level.

The research area had to comprise a region with a *homogeneity* within the subsystems of the natural organization and the social organization: the abiotic, biotic, economic and cultural subsystems. This was necessary to prevent a complexity which diverts attention from the methodological aspects of the research. Nevertheless, a slight diversity of land-use and related problems within the study area forms an interesting starting point for a planning exercise.

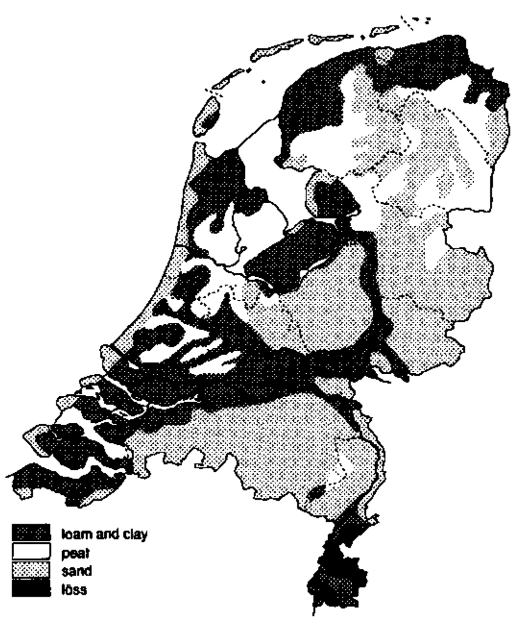
As regards to *the number of case studies*: in section 1.4 it was explained that the initial intention to carry out two case studies was abandoned because of constraints of time and labour. Furthermore, the prototype of the *RISOR* system became available too late to enable a second case study. Nevertheless, in order to keep the options open for a second case study in future, there had to be areas elsewhere, of a comparable socio-physical organization to the study area.

As regards to the *size of the study area*, a regional level was preferred, because of the precondition of homogeneity within the socio-physical organization. Physical aspects were chosen as the aspects determining the study area, in the Netherlands, the physical basis of soil, hydrology and geomorphology is most homogeneous on a regional level. The national and supranational levels are less homogeneous as regards geological, geomorphological or ecological aspects. The economic differentiation within the Netherlands, or the European Community is high. Therefore, a study area on the national or supra-national has to be subdivided into various subareas. In the Netherlands as a whole, not to mention Europe, the cultural homogeneity is questionable too. Generally, it is easier to speak of cultural unities at a regional level than at a national or supranational level. The local level was not of any interest, as many of the aspects of the subsystems transcend this level.

Availability of information

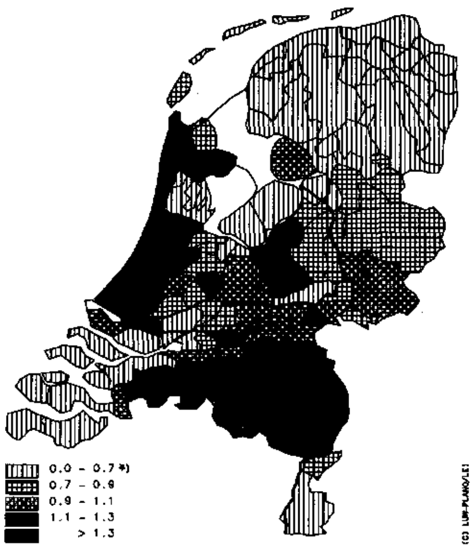
The study area of this research was also studied by a colleague, L. van den Aarsen, who studied the relation between nature and agriculture in areas with sandy soil. The advantages of using the same area are that object data and knowledge concerning the area can be exchanged, thus enhancing efficiency and saving time. Hence, the study area had to be chosen from the areas of sandy soil in the Netherlands (Figure 4.1).

Figure 4.1 Most important soils in the Netherlands (after Hetsen and Hidding, 1991)



Van den Aarsen's research focused on areas with very intensive agriculture (see Figure 4.2). The province of Noord-Brabant contains many such areas, and when the present research was being planned it was working on a revision of its regional plan. Furthermore, the provincial planning department was debating whether to install the same GIS software as I used for this research. I therefore decided to look for a region in Noord-Brabant.

Figure 4.2 Agricultural intensity in 1988 (sbe per hectare, after Hetsen and Hidding, 1991)

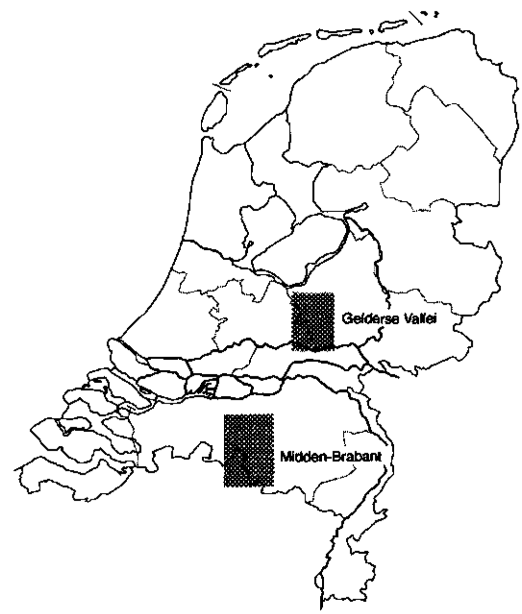


Reasons for choosing Midden-Brabant

In the Netherlands as a whole there are two regions with sandy soil and very intensive agriculture: the 'Gelderse Vallei', in the centre of the country, and an area comprising south-eastern Noord-Brabant and northern Limburg, in the south of the country. When van den Aarsen was selecting her research areas, the presence of important agricultural and natural values was an important criterion. She therefore opted for the Gelderse Vallei and Midden-Brabant (Figure 4.3). Both areas can be regarded as homogeneous in the subsystems of their socio-physical organization. In the 4th Policy Document on Physical Planning (Vierde Nota, 1989), the Gelderse Vallei is indicated as needing active renewal of the spatial structure and Midden-Brabant as requiring active maintenance of the spatial structure[2)].

The decisive factors in the choice between the two suitable areas were the opportunities to exchange information with the provincial authorities of Noord-Brabant and the stage of the provincial plan making. In the Gelderse Vallei, the planning process was already at an advanced stage, whereas in Noord-Brabant, the provincial planning was still in its preparatory stage. The combination of all requisites led to the catchment areas of the lowland brooks Beerze, Reusel and Voorste Stroom being choosen as the study area[3)]. In this thesis I will refer to this area as Midden-Brabant (Figure 4.3).

Figure 4.3 Suitable case-areas: Midden Brabant (1) and Gelderse Vallei (2).



4.2 The knowledge used in the working process

In section 2.1 the technique of modelling was discussed. Formalization of the planning process was assumed to be a prerequisite for applying information systems in a planning process. Formal models, which were defined as a 'symbolic assertion in logical terms' (see note 2, section 1.1), are used in information systems. In the succeeding chapters, I will describe the knowledge categories used during the planning process. These descriptions are to be regarded as theoretical models. The formal models used in information systems will also be described. Once the feasibility of constructing formal models is known, the feasibility of applying information systems can be discussed.
The 'intentions' formed the base of the normative knowledge applied in this research. For this research it was decided to derive the 'intentions' not only from the case area, but also from sources outside the area. In the case of Noord-Brabant this seems acceptable, because the cultural subsystem of Noord-Brabant can be characterized as one that is, within certain limits, receptive to new notions and ideas[4]. The way the normative knowledge was developed illustrates one way 'intentions' can be constructed, described and applied in the methodology of reconnaissance planning.
To ensure an optimal availability of basic data and methods the research focused on the aspects 'agriculture' and 'nature', which were also studied by van den

Aarsen,. Although recreation is an important aspect in the area, it was not elaborated in the plan-generating stage. Because of time constraints, this aspect was only worked out at the level of concrete intentions. Furthermore, the study focused on physical aspects, as information on them was quickly and easily available in a digital form. The object knowledge used in the planning process was mainly derived from maps, and was augmented by economic information derived from economic statistics.

The process knowledge was described systematically with the help of flow charts. To employ GIS and to store the process in the *RISOR* system, segments of the process had to be formalized. This formalization resulted in 'macro command files', which describe the acting moments of the planning process systematically with the help of GIS commands.

Notes

1. See: Van Lammeren (1985), Terpstra (1986), Van Biesbergen and Eweg (1987), Joop and Wessels (1988).
2. In the report following the 4th Policy Document, entitled *'Vierde Nota Extra'* (1991) the notions of renewal and maintenance were elaborated. For the Gelderse Vallei, the renewal was described as a reconstruction of the agriculture towards concentrations of intensive husbandry combined with landscape development and restoration of environmental quality. For Midden-Brabant the maintenance of the spatial structure was described as fostering nature development, recreation and tourism in combination with forestry, recreation and tourism and agriculture.
3. The case area fell within the following coordinates:
   $X_{left,below}$ 124,000 $Y_{left,below}$ 363,000
   $X_{right,top}$ 152,000 $Y_{right,top}$ 407,000
4. Kuypers (1978), describes the drastic change which the province has undergone since 1960, from being a collection of small-scale village communities to becoming a highly industrialized and urbanized province, with large-scale, intensive agriculture. The cultural changes associated with this development were achieved without many problems, which illustrates the flexibility of the cultural subsystem.

5 OBJECT KNOWLEDGE I : THE BEERZE, REUSEL AND VOORSTE STROOM CATCHMENT AREA

The actual situation in the study area, i.e. the object of the planning, will be described according to the systematics of the *MFO* model described in section 2.2., which discerns a natural organization and a social organization. The historical developments that underlie the actual state of the subsystems will be mentioned only when necessary to explain the present situation.
As already mentioned, the case study focused on agricultural and natural aspects. As recreation also formed an important aspect, it too was analyzed, but was not incorporated in the subsequent planning phases. The systematic description of the area, and the maps describing the features of the area are to be regarded as theoretical models of the area. The formal models of the object which were used in the GIS were derived from these descriptions. Both types of models constitute the basic object knowledge used in the case study. The formalized object knowledge can be subdivided into geometrical information which describes the location and shape of the objects, and attribute information which describes their nature. Errors, reliability and accuracy, although important aspects are not elaborated in this thesis[1)].

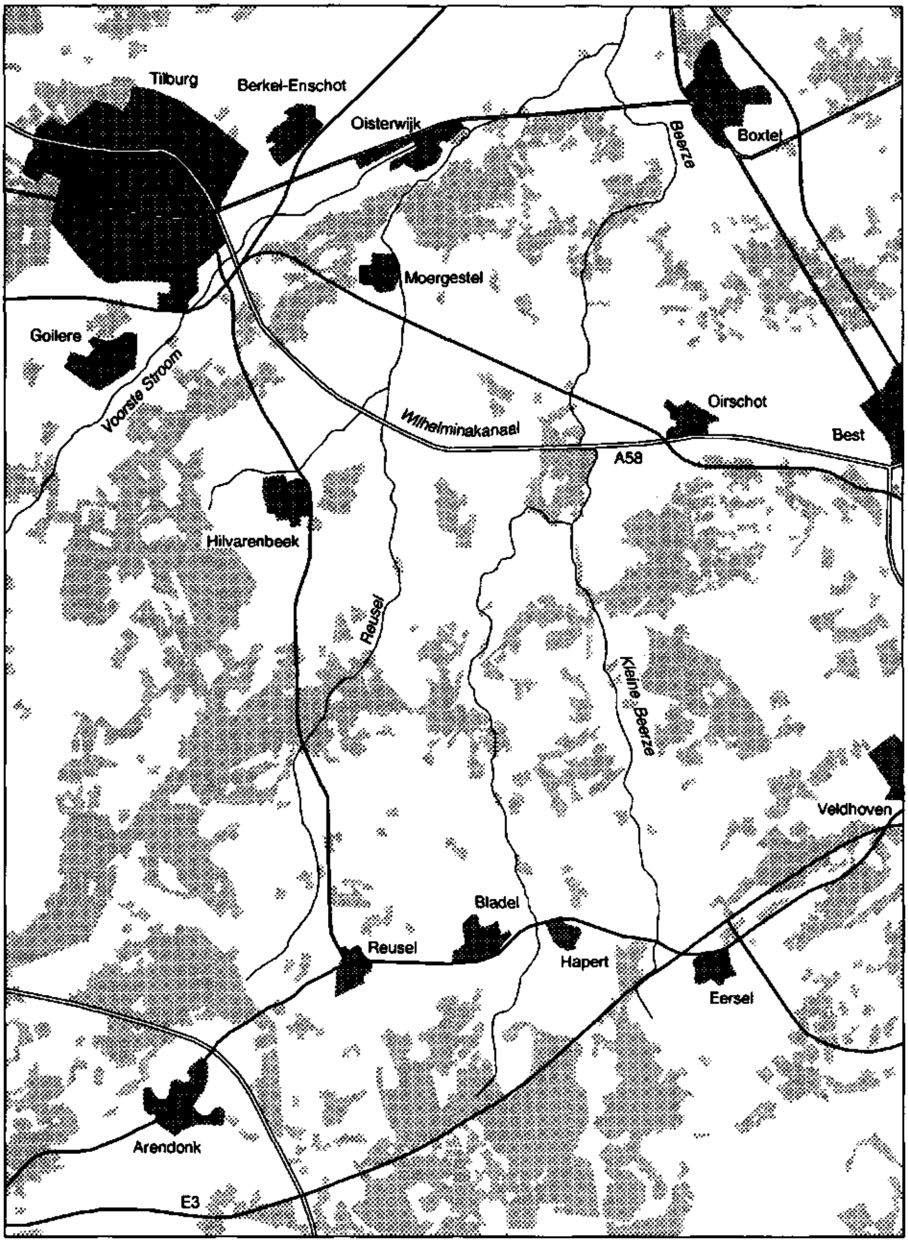
5.1 The natural organization of the study area

The natural organization consists of the abiotic subsystem and the biotic subsystem. In the case study, the object information used in the GIS concerned the geomorphology, soil and groundwater, land cover and elements from the topographical map.

Abiotic aspects

Geomorphology (see geomorphological map, Figure 5.3)
The altitude of the study area varies from 10 - 30 metres above sea level. The main structuring element of the geomorphology of the area is the Feldbiss fault which forms the border between the '*Centrale slenk*' ('Central Rift') in the north-east and the '*Kempisch plateau*' in the south-west. Although not clearly visible in the field, on the geomorphological map the influence of the fault line is clear. South of the fault an undulating landscape developed in which the streams incised relatively narrow valleys[2)]. North of the fault, the Pleistocene cover sand plains, locally with maximum differences in height ranging from 0.25 to 0.5 metres, remained intact, while streams formed broader and shallower valleys[3)]. The course of the streams is also determined by the fault, and is approximately at right

Figure 5.1 The catchment area of Beerze, Reusel and Voorste Stroom in Noord Brabant

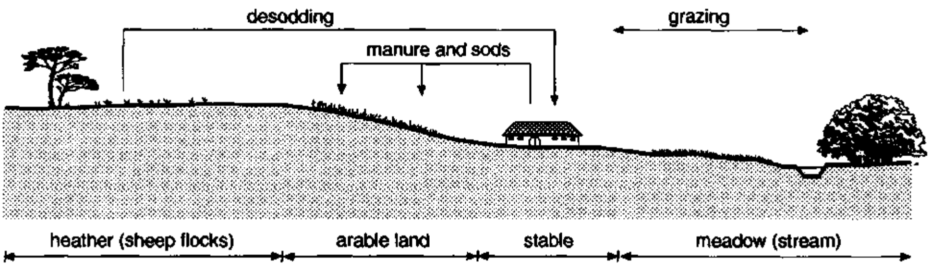


angles to the fault: from south to north in the south part of the area, and from south-west to north-east in the west part.
Pleistocene cover sand ridges, varying in height from 0.5 to 1.5 metres, form a second dominant aspect of the morphology of the area. The north-east to south-west oriented ridges, deposited during the final periglacial period, obstructed the flow of the streams. As a result, the streams north of the Feldbiss fault formed flood plains in which peat developed locally. In the sand ridges, the streams incised deeply, sometimes to a depth of 2 metres.
On the cover sand ridges, younger Holocene sand dunes up to 5 metres high, occur.
Around old villages and homesteads, there are areas that are from 0.5 to 1.5 metres above the surrounding countryside. Their origin is connected with the traditional farming system. From the middle ages until the beginning of this century these areas were raised with a mixture of soil and dung, a process that will be described when discussing the various soils in the area.

Soil (see soil map, Figure 5.4)
The evolution of natural soils in the study area is determined by the parent material, groundwater flow and the depth of the water table. In the higher-lying regions, precipitation infiltrates the soil and podzolized soils have formed. In the lower areas, which are mainly stream valleys, groundwater exfiltrates, allowing Humaquepts or, according to the FAO World Soil Map, Gleysols (FAO, 1988), to form.
De Bakker (1979) gives a detailed description of the soil units typical of the Pleistocene sandy district in the Netherlands. In his book he also gives the international equivalents for the Dutch terms used for the soil units. In the following description, partly based on de Bakker, the Dutch terms will be used. References for the Dutch terms to the international classifications on the Soil Map of the World and the Soil Map of Europe are given in Appendix I.
The podzolized soils consist of the Pleistocene cover sands, which are aeolian deposits. Characteristically these soils have a B horizon showing an accumulation of organic material. In this B horizon Fe or Al associations may be found. The podzolized soils in the area can be separated into *Veld* and *Laar Podzolgronden*, *Haar* and *Kamp Podzolgronden* and *Moder Podzolgronden*. The *Veld* and *Laar Podzolgronden* do not contain any trace of iron, which indicates development under the periodically strong influence of water. The *Haar* and *Kamp Podzolgronden* contain iron coatings because they have developed under dry conditions. Generally, the nutrient-poor podzolized soils used to support heathland. After the First World War, when fertilizers became available, these areas were reclaimed for agriculture. The *Moder Podzolgronden* are considerably richer in minerals and iron.
In the 'wet' areas, with shallow water tables, the *Beekeerdgronden* are the most common natural soils. As with the podzolized soils, the parent material of these soil units is the Pleistocene cover sand. The shallow valleys incised by the

streams in the cover sands are usually cut in these soils. In the valleys there is a constant supply of ground and surface water from the higher-lying regions. As a consequence the soil is continuously enriched, at the cost of the constantly impoverished podzols.
The group of *Associatie Beekdalgronden* forms the transition to the peaty soils. The group is made up of stream valley soils, mainly peat, varying considerably in thickness and type of top soil layer, which may be sand or sandy.
The *Veengronden* and *Moerige gronden* are the peaty and peat soils, found in regions with a water table near the surface and regularly flooded by streams. The parent material of the *Moerige gronden* consists of Pleistocene cover sands. In fact, these soil types developed recently from the podzolized soils in depressions or from the *Beekeerdgronden*, as a result of the high groundwater table. The *Veengronden* are made up of thick layers of organic matter, originating from marshes. The deeper subsoil, beginning one metre or more below the surface, consists of Pleistocene cover sands.
The *Vaaggronden* groups consist of young cover sands. The *Vlakvaaggronden* include a limited number of small groups. The parent materials are aeolian or alluvial deposits, often loamy. The reason for the movement of the sand may be anthropogenic, in which case they are closely related to the *Duinvaaggronden*.
These soils cover large areas made up of recent aeolian sands. The deeper subsoil consists of Pleistocene sand. De Bakker classifies this soil type as an anthropogenic soil, as it is the result of man-induced soil erosion. Nowadays, most of these soil types have been afforested or are covered with heather, although in some areas active dunes still exist.
The *Enkeerdgronden* are important anthropogenic soils in the area. These soils are typical of the farming system in the Middle Ages in the southern and eastern parts of the Netherlands and the north-eastern part of Germany. This largely subsistence farming technique lasted into the last century, in equilibrium with its environment (Figure 5.2).

Figure 5.2 Subsistence farming in the middle ages.



Heathland was essential in this farming system. Flocks of sheep grazed the heather and the heather sods were used as bedding material in the cowsheds and sheepfolds. The sheep droppings and cow dung were collected and together with the heather sods formed an organic manure for the arable land, gradually changing podzolized soils into a plaggen soil. Inland dunes often developed on the heaths, as a result of overuse by sod-stripping, sheep grazing and fires. The *Eerdgronden* can be divided into the *Enkeerdgronden* and the *Beekeerdgronden*, on cover sand ridges in or bordering the small river valleys.

Water (see water table map, Figure 5.5)
In its water management plan, the provincial government of Noord-Brabant describes the alarming situation of the ground and surface water in the province (Provincie Noord-Brabant, 1990). The lowland streams in the area have mostly been canalized, to improve farming conditions. Areas under natural vegetation were reclaimed by drainage and by lowering the water table. Moreover, the water flow was regulated with the help of dams. As a result, very few stretches of stream remain. The fens in the area are affected by acidification, eutrophication and 'drying up'[4]. The Wilhelmina Channel, which traverses the area, on the other hand, is independent from the regional water system, as it is fed by water from the river Maas.

The thick layer of early Pleistocene alluvial sands contains a large amount of groundwater. Large quantities of this water are pumped up, to be used as drinking water and to irrigate fields. This pumping has caused the groundwater level to fall by about 5-30 centimetres on a provincial scale. In some areas the fall in summer is an additional 10-25 centimetres extra. Agricultural drainage can cause the water level to fall by 15-35 centimetres. Combined, the total fall can be up to 40-60 centimetres (Provincie Noord-Brabant, 1990).

The quality of the groundwater is alarming, as it is polluted by phosphate (P), nitrate (N) and potassium (K). As a result of the large amounts of these minerals in the subsurface, the deep groundwater will be seriously affected in the near future.

Biotic aspects

For an elaborate description of the biotic aspects of the study area, see van den Aarsen, (*'Randvoorwaarden voor Natuurlijke Kwaliteit in Pleistocene Zandgebieden'*, 1994, Chapter Six).

Nature (see land cover map, Figure 5.6)
The region comprises landscape units which are typical of the 'small-scale areas' with a sandy soil, each with its characteristic flora and fauna.
The *heathland* with its *fens* and *sanddunes* can be subdivided into 'wet' heather vegetation, mainly consisting of bell-heather (*Erica tetralix*) and 'dry' heather vegetation (*Caluna vulgaris*). In places, the originally oligotrophic fens have evolved into brooks with birch. Nowadays heather is ousted by the grass *Molinea caerulea*, which has invaded because more nutrients are available as a result of acid deposition.
Coniferous forests came into existence when large parts of former heathland were afforested with conifers. Coniferous trees also cover smaller, scattered plots.
There are many large *estates* in the area, which consist of various types of forests. The higher-lying parts are generally covered with coniferous trees, for commercial exploitation. In the lower-lying parts deciduous trees are predominate, e.g. oak and beech. Around the country houses there are belts of deciduous trees, avenues and parks with exotic species such as rhododendrons. Some parts of the estates have become overgrown because of neglect.
In some lower parts of the area natural *deciduous forests* can be found: oak and beech in the dry parts, and poplar, alder and bird cherry in the stream valleys. The natural stream valleys in which the streams meander in a natural way, comprise various ecological communities such as *marshes*, nutrient-*poor grasslands* and *brooks*. In some areas *peat* developed.
In the studied area, the natural wildlife is dominated by species living in the forests and on the heathland. Mammals which can be found are the roe, fox, muskrat, weasel, stoat, hedgehog, rabbit, hare, red squirrel, pine marten and stone marten. Birds belonging to this habitat comprise black woodpecker, golden oriole, harrier, goshawk, wood owl and the black grouse of which only 12 cocks were spotted in 1989 (Post, Braam and Buskens, 1990).
In and along the fens on the heathland amphibians and ducks such as grebe, little grebe and tufted duck are found. The reptiles on the heathland comprise snakes (ring snake and viper) and several types of lizards.
The wildlife of the stream valleys consists of the amphibians and birds mentioned above for the forests and heaths. Kingfishers are occasionally seen in the area: in 1990 only 30 individuals were observed.

In the open grassy areas in and around stream valleys curlews, bean geese and godwits can be found; these are migratory birds. Invertebrates characteristic to running water live in and around the streams.
Nature and landscape have seriously deteriorated over recent decades. The deteriorations have mainly been caused by the harmful effects described in section 5.3. Weinreich and Musters (1989) describe in detail the significant changes in the Dutch landscape caused by these effects. The changes in flora and fauna in the Netherlands which they describe, also apply to Midden-Brabant. These changes can be summarized as follows:

- The landscape has been regularized as a result of land development projects. More than 65% of the area of the Netherlands can be regarded as 'greatly changed land parcels'. Many of the hedgerows and wooded banks along the edges of fields have disappeared and the landscape has become more open. In rural landscapes, the diversity of the landscape has decreased.
- As regards fungi, (notably those growing in dry, poor sandy soils) 170 species have become less common, while 112 species (preferring humic and manured soils) have become more common.
- Lichens have decreased sharply, both those that grow on trees and stones and those that grow on the ground. This decrease is caused by air pollution, intensive recreation, the decrease in the use of natural stone for the protection of dykes, and an explosive growth of grass in nature areas.
- Since 1930, 33 species of higher plants have disappeared. 64 exotic species have been introduced, while many species have become rarer. The decrease is notably high on heathland, peat, arable land, woodland edges, calcareous grasslands, dry acid grasslands, walls, oligotrophic waters and pioneer vegetation of moderately poor soils.
- More than half (48) the number of butterfly species have become less common and eight species have probably disappeared. Most of the species which are on the point of extinction, or have already disappeared, used to live in ecotopes which have vanished: 'blue grassland' (*Sesleria caerulea*), grassland in stream valleys, calcareous grassland, mesotrophic and oligotrophic grassland, woodland edges and swampy sites in forests.
- 144 ground beetle species are increasing, but 96 species are decreasing (many of the latter are from dry ecotopes and woodlands). The changes in the composition of species are related to land reclamation and grass development in dry, oligotrophic vegetation types.
- Sightings of seven species of the 96 dragonfly species have fallen by half. The species associated with streams and marshes declined in numbers.
- Of 46 indigenous fish species, 36 are close to dying out as a result of water management: canalization and damming make spawn locations unreachable, maintenance limits the natural variation, and the vegetation is polluted.
- Of the 15 species of amphibians which can be found in the Netherlands, six have declined seriously. Three species have become rare, whereas the other

species seem to be increasing or are remaining stable. Changes in the landscape, notably the disappearance of pools, are the reason for this trend.

- All seven Dutch species of reptile are declining. The reduction of heathland, urbanization, 'drying up' and the proliferation of grass in nature areas are causing the reduction of reptile ecotopes.
- In the last twenty years about one-third (104 species) of the species of birds have declined, especially those with heathland, agricultural landscape and scrub habitats. On the other hand, one-third are increasing and a few new species have been introduced. Many woodland species are increasing; this has to do with the ageing of forests. One-third of the species of overwintering birds are decreasing, but also one third is increasing.
- A quarter of the mammal species are declining. Another quarter is increasing. Three species of bats have died out. Predators are decreasing while rodents are increasing.

Object knowledge on the abiotic and biotic aspects of the natural organization used in the GIS

Geomorphological geometrical and attribute data

The process of digitizing the 1:50,000 geomorphological map is described in Appendix II. The map was unfolded into three layers, which were reproduced on transparent sheets. The first layer consisted of the largest geomorphological units, e.g. plains. The second layer comprised smaller units within these largest units, e.g. stream valleys and ridges. Finally, the third layer contained small 'islands', e.g. isolated hills and dips. These sheets were digitized separately. Finally, the geomorphological map was developed in the GIS by overlaying the first layer with the second layer and subsequently, by overlaying the second layer with the third layer[5)].

The geomorphological map of the Netherlands is produced by the Staring Centre, Wageningen and based on 1:10,000 contour maps, 1:25,000 topographical maps and aerial photos. Subsequently, a sketch map derived from this information was completed with a field study (see ten Cate and Maarleveld, 1977). The grid map produced during my case study consisted of grids from 100 x 100 metres.

top. map				
contour map				
aerial photos -->	*geom. map* -->	*layers* -->	*digital*	--> *grid map*
field reconnaissance			*vector map*	

Geometrical and attribute data on soil and groundwater

The 1:50,000 soil and water table maps were derived from the Staring Centre, Wageningen as ARC-Info data files. The processing of these files is described in

Appendix II. The files with soil and groundwater data were too large to be incorporated into the GeoPackage. Firstly, the data had to be processed, as described in Appendix II. The soil map of the Staring Centre is based on the 1:25,000 topographical map. The sampling density was 10-25 auger holes per hectare (to a depth of 1.20 metres). The grid size of the grid map produced during the case study was 100 x 100 metres.

top.map
field reconnaissance --> *soil map --> vector --> grid map*
map

The Soil Map of the Netherlands details the main soil types into subgroups, based on texture, soil profile, etc. (Steur and Heijink, 1983) and also indicates the water table of the units[6].

Geometrical and attribute data on the topography
The geometrical information on the 1:25,000 topographical map sheets was converted into coordinates by digitization, as described in Appendix II. To facilitate this the map sheets were divided into project areas and windows. All attributes were digitized for each window and the windows and map sheets then were merged. Auxiliary lines were removed during the rasterizing process. The topographical map was completely digitized for the catchment area of the Reusel. Infrastructure and streams were digitized for the entire study area.
The process of developing a digitized grid model of the real world comprises three stages of information transfer:

real world ---> *topographical map --->* *digital vector ---> digital grid*
map

The topographical maps were drawn by the Dutch Topographical Survey between 1983 and 1988, based on aerial photos taken between 1979 and 1984. The grid maps had a grid of 100 x 100 metres.
During the digitization of geographical information derived from the maps, thematic information was attached to the objects as attributes[7]. The following criteria were formulated for the classification of the thematic information :
- user-friendly: the attributes should give clear information about the object and should not consist of some incomprehensible code;
- it should be possible to attach more than one attribute to the same object;
- accessible: the nomenclature of the thematic information should allow systematic search;
- flexible: the systematics should allow insertion of new attributes later;
- the nomenclature should link up with common systems of description.

The fact that the (grid-based) GeoPackage attached only one attribute to each grid cell and that manipulations could be carried out only on the grid cell values and not on the attributes, was a constraint. However, the module used for the digitization allowed more than one attribute to be attached to an object. Two types of attributes were appended to the objects:

- attributes which gave information about the physical aspects, the 'appearance', of the objects, based on the legend of the topographical map;
- attributes which gave information about the function of the objects, based on the legend of *KADROKAART*, the Spatial Information System of the National Planning Office was adopted.

Geometrical and attribute data of the Land Cover

For the procedure for developing the land cover inventory, see Thunissen, Jaarsma and Schoumans (1992). The land cover inventory (LGN*) is derived from the LandSat Thematic Mapper images. The processing and classification yield a grid map with pixels of 25 x 25 metres. In the case study, the land cover map was generalized to a raster map with grid cells of 100 x 100 metres.

The satellite images were produced on 7 August, 1986. When the land cover data derived from these images were compared with the information from the National Bureau of Statistics (CBS) discrepancies in land use emerged (see table 5.1).

Table 5.1 Land use according to the CBS and the Land cover inventory in the study area

Landuse (ha)	CBS 1988	Land cover inventory (LGN)	Difference (ha)	Difference (% of LGN)
Grass	22,154	29,582	-7,428	25%
Maize	11,142	12,833	-1,691	13%
Arable Land	15,201	1,162	14,039	1208%
total	48,497	43,577	4,920	11%

There are four main reasons for these discrepancies.

a. The boundaries of the study area coincided with the catchment areas, not with administrative areas. The CBS gives its information per municipality. To compare LGN with CBS data, it was necessary to translate the CBS data to catchment areas. For the municipalities that covered only a part of the catchment area, a proportional part of the CBS acreages was assigned to the catchment area. However, this fact can not be responsible for the large discrepancies, as a comparison of the land use, comparing only the municipalities that were completely within the catchment areas, resulted in comparable discrepancies.

b. The category of 'Bare Soil' comprised both Nature and Agriculture. Considerable parts of this category were located within Nature areas. For this reason, 'Bare Soil' was regarded as Nature. The total area of 'Bare Soil' amounted to 2315 ha.

Therefore, the difference of 14038 ha in Arable Land can only slightly be influenced by this factor.
c. The CBS assigns agricultural land to the municipality in which the farm is located. If large areas of a farm are located in a different municipality, differences between Satellite and CBS data occur. Nevertheless, as the case study concerned a large region with 24 municipalities, the total amount of agricultural land will not be influenced by this factor significantly.
d. The land cover map was developed by generalizing the LGN data with a grid cell size of 25 x 25 metres, to a land cover map with a grid cell size of 100 x 100 metres. Small areas were lost during this procedure. These could be Arable Land.
A comparison between the land cover map used in the case study and the CBS data, allows conclusions to be drawn about the accuracy of the land cover map. The amount of agricultural land in 1986 was according to the CBS 4920 ha. more than the amount of agricultural according to the LGN, which is an inaccuracy of 11%. Furthermore, it can be concluded that on the land cover map a large area of arable land is considered to be grass and a smaller area of arable land is considered to be maize. This conclusion confirms the findings of Thunnisse et al., who found a low reliability for horticultural crops[8]. The CBS data are assumed to be reliable.

5.2 The social organization

The social organization consists of the economic subsystem, the political subsystem and the cultural subsystem. The object information used in the GIS concerned administrative boundaries, statistics on agriculture and elements from the topographical map.
A detailed account of reconnaissance planning would at this point describe the three subsystems. In this thesis, however, the description is restricted to a characterization of the economic subsystem, because the cultural and political subsystems were not studied in detail. Instead, I will give a brief overview of the relevant national, provincial and local spatial policy. I will describe the economic situation of the area, but not how the economic subsystem and its actors function, because this was not part of my research.

Economic subsystem

The most important spatial aspects of an economic subsystem are: agriculture, industry production, housing, services, recreation and transport. The case study focused on agriculture and recreation, which are the most important social aspects of the spatial organization in the study area. The urban areas of the cities of Eindhoven, Tilburg and Den Bosch which are adjacent to the study area, will not be discussed.

Agriculture

In their thesis Hetsen and Hidding (1991) describe the current state of the agricultural sector in the Netherlands. For the southern part of the country, the province of Noord-Brabant, they identify the following as the most important agricultural sectors: market gardening (nurseries and vegetables), dairy farming and intensive husbandry (pigs and poultry)[9]. In the study area, the most important agricultural sectors correspond to the three sectors mentioned above. Part of the case study was an analysis of the economic strength of the agricultural sector, which will be discussed in section 7.3.

The agricultural sector in the province not only supplies the national market, but also exports agricultural products. The important position of the agricultural sector is related to the development of strong 'geographical agribusiness complexes'[10]. This position, combined with the location of the study area close to three conurbations, and its well-developed infrastructure, gives the area a substantial economic advantage compared to other rural areas in the Netherlands (Provincie Noord-Brabant, 1989). Together with the Randstad region in the west of the Netherlands and the Gelderland province, Noord-Brabant is at a competitive advantage compared to other regions. (Hetsen and Hidding, 1991)

As a result of technological development, interventions, and EC subsidies production has increased considerably which resulted in overproduction in some sectors of agriculture[11]. In the country as a whole, market gardening expanded by 11% between 1973 and 1988, whereas the acreage of this sector fell by the same percentage. This illustrates the significant nation-wide intensification, which also took place in Noord-Brabant. A corresponding development can be observed for the dairy farming (production level down by 1% but acreage down by 4%). In the Netherlands, production of intensive livestock husbandry increased between 1973 and 1988 by 87%, a growth to which Noord-Brabant contributed considerably. However, this increase in production was accompanied by a decrease in employment.

Intensive husbandry and dairy farming cause environmental problems which will be described in section 5.3[12]. As general legislation on spatial development in rural areas has hardly influenced pasture or arable farming (ten Pas and van der Ploeg, 1990), the government issued directives on specific aspects: the Manure Law, restrictions concerning the spreading of manure, an obligation to plough the manure into the soil, the Soil Protection Law and the Ecological Directive (de Leeuw, 1991).

Recreation[13]

In the Netherlands, in the last decade, leisure activities have increased, as a result of flexible working times and a shorter working week. Leisure has become big business[14].

Buysman (1991) carried out a brief inventory of recreation in the study area. The area contains a tourist attraction of national significance, the *'Beekse Bergen'* leisure park. This park cooperates with three other leisure parks in the province to

develop the intensive recreation in the area. The heath and fen area in the north is of regional significance. Sport facilities of regional importance lie scattered over the area. Holiday recreation is the most important recreation activity in the area. The province of Noord-Brabant predicts a gloomy future for guest houses and accommodation aimed at group activities. The camping sector has good prospects, provided it is modernized and scaled up. Summer bungalows and hotel facilities are expected to prosper (Provincie Noord-Brabant, 1989).
Cars have a stimulating effect on recreation: more than half the recreational movements are carried out by car. Walking and cycling are in second place. The latter type of recreational movements mainly take place near where people live. Long distance hiking and cycling are increasing, but their development is obstructed by infrastructural barriers. Furthermore, the province has identified problems concerning the location of recreational facilities in relation to natural areas. Almost half the facilities are located in or adjacent to important natural areas, which is understandable when one regards the attractiveness of these areas for recreation.

Relevant spatial policy

National
The Dutch government describes its policy on the spatial development of the Netherlands up to the year 2015 in two reports: the 'Fourth Policy Document on Physical Planning' (1989) and the 'Fourth Policy Document on Physical Planning Extra' (1991). The starting points of the government's policy on spatial development are:
- to strengthen the strong components and potential of the country by economic and spatial measures;
- to increase the spatial diversity;
- to employ and to enhance the specific qualities of the regions.

The government detailed its policy for the area Midden-Brabant by describing a way of adapting the spatial structure in order to 'support nature development, recreation and tourism in combination with forestry, recreation and agriculture' (*Vierde Nota Extra*, 1991).
Government policy on the rural areas is elaborated in two policy plans which concern environment and nature[15]. The policy plans on environmental policy[16] characterize agriculture both as a source and a victim of environmental problems. The government formulates legislation on agricultural activities, aimed at the reduction of manuring, a reduction in the emission of ammonia and a reduction in the application of herbicides and pesticides. This legislation interferes in the agricultural management and obliges farmers to adopt environmental measures. The report on nature policy operationalizes the concept of the national ecological

network, and details the concept on a national and a regional scale. Within this concept three types of natural elements are discerned: core areas, development areas and connective zones. The aim of the ecological network is to develop a stable ecological framework as a basis for dynamic activities. The nature areas in the study area are characterized as ecosystems of national or international interest, which should be connected by development zones along the streams in the area.

Provincial
The provincial government supports the premises of the national government. The province describes its spatial policy in its regional plan (Provincie Noord-Brabant, 1991)[17]. According to this plan, the main part of the study area is characterized as an area with an 'accent on nature'. The northern part receives a combined accent on nature, tourism and recreation. In these areas, the provincial policy focuses on nature conservation and nature development; the development of the recreational and tourist potential will also be furthered. Development of the agricultural sector focuses on dairy farming, favouring expansion. The agricultural sector as a whole is constrained by landscape, nature and environment.
The national ecological network is elaborated in the provincial 'Nature Policy Plan' (Provincie Noord-Brabant, 1991). In this plan, the province describes its strategy and points out which parts of the national ecological network have to be in place by the year 2020. Currently, most of the areas which have to be developed as nature are being used for agriculture. These areas have to be purchased or voluntary agreements with farmers have to be concluded. The purchased areas will be rearranged, concentrating on existing core areas and stream valleys.

Local
In the Netherlands, the spatial plans of local government authorities play an important role. In its detailed zoning schemes the municipality describes the spatial interventions which are not permissible. The national and provincial plans have to be implemented through these local zoning schemes[18].
In 1990, the province of Noord-Brabant investigated the state of the local spatial planning. The province examined 225 zoning schemes for rural areas, in 130 municipalities. The conclusion was that 177 plans did not meet the formal standards, and 176 did not correspond with provincial policy on agriculture (Provincie Noord-Brabant, 1990). The investigation showed that for most local authorities, the planning for rural areas had no priority. Local planning is frequently politically controversial, as it often restricts agricultural possibilities, and farmers are an influential lobby in rural municipalities. As a result of their investigation the provincial authorities induced the municipalities to put more energy into rural planning[19].

Object knowledge on the economic aspects used in the GIS

Geometrical and attribute data of the administrative boundaries
Municipal borders were derived from the *NLKAART* database (Boonstra and Bloemberg, 1987). Data on the municipal boundaries of the Netherlands were digitized by the Geographical Institute of the University of Utrecht, based on the administrative organization on 1 January 1983. The data were input directly in the GeoPackage and were then rasterized to 100 x 100 metre grids.

Economic data
Digital data on agricultural production, farm size and area of land use per municipality, were derived from the National Bureau of Statistics (CBS), for the year 1986.

5.3 Relationships between the social organization and the natural organization

Social activities and the natural organization and its abiotic and biotic subsystems are mutually related. The nature of this relationship can be characterized in three ways:
- *Conflicting*: social activities might exploit the biotic or abiotic subsystems, causing a deterioration of these aspects; conversely, natural processes can damage the social organization;
- *Sustaining*: social and natural processes can support each other if processes benefit both systems;
- *Indifferent*: processes within the social organization or the natural organization may not have any impact on the other organization, if they influence only the organization in which they occur.

It goes far beyond the limits of this research to describe all the processes between and within the social organization and the natural organization and their subsystems. In this section, I will focus on conflicting socio-economic processes and the natural organization, as they currently form a serious threat to the long term functioning of both organizations.
In the national report on environmental policy (Ministerie van VROM, 1989) the government categorizes the problems caused by socio-economic processes into eight themes: climatic change, acidification, eutrophication, diffusion of pollutants, removal of waste materials, disturbance, 'drying up' and wastage.
The themes most relevant to the study area concern the effects of agriculture: acidification, eutrophication, 'drying up' and disturbance[20)] (de Leeuw, 1991).

Acidification
Acidification of the natural organization is caused by sulphur dioxide (SO_2), nitrogen oxide (NO_x), ammonia and ammonium (NH_x) and organic chemical sub-

stances. The mean acid deposition in 1989 in the Netherlands amounted to 4800 mol $H^{+}ha^{-1}year^{-1}$ of which the percentage of NH_x was 46%. Almost all (90%) of the emission of NH_x can be ascribed to dairy farming and intensive livestock husbandry. The acid deposition in the study area considerably exceeds the national mean. The acid deposition on a nature area in the north of the study area rose to 6000-7000 mol $H^{+}ha^{-1}year^{-1}$ in 1989 (van den Bosch, 1991)[21]. The acidification causes the disappearance of vegetation characteristic of heathland, fens and forests. It also influences the agricultural crops.

Eutrophication
Eutrophication of soil and water is caused by the accumulation of phosphorus (P) and nitrogen (N). The percentage of NH_x in the total nitrogen deposition amounts to 60%; in areas with a concentration of intensive husbandry the percentage is even higher. The eutrophication stimulates the growth of grass on heathland and the disappearance of heather. The variety of flora and fauna diminishes. The eutrophication of fens and streams causes the loss of valuable ecosystems.

Drying up
The drying up of nature areas is caused by the use of groundwater as well as surface water for agriculture, irrigation and drinking water. The withdrawal of water results in an average lowering of the water table by 30-40 centimetres. Locally, the lowering can be 40-60 centimetres. The lowering of the water table causes flora and fauna species to die out in streams, stream valleys, heathland and forests.

Disturbance
Primarily, the fauna is affected by disturbance caused by noise, odour, vibrations and local air pollution. Furthermore, damage to flora is caused by trampling by people. In the study area, most of the disturbance to nature is caused by intensive recreation.

In addition to the themes mentioned by the national government, the provincial government indicates the *fragmentation* and *fading away* of natural elements as two harmful spatial effects to ecosystems, inducing the decline of both vegetation and fauna.

Notes

1. For error handling in GIS, see Burrough (1986): *Principles of Geographical Information Systems for Land Resources Assessment*, Chrisman (1989): Model Error in Overlaid Categorical Maps (1989), In: Goodchild M.F., Gopal S. (eds), *Accuracy of Spatial Databases*, or Veregin (1989): Error Modelling for the Map Overlay Operation (1989) In: Goodchild and Gopal (eds).

2. Notions such as 'stream valley' and 'incising' should be placed in the context of the flat and undulating Pleistocene sandy landscapes in the Netherlands. Usually, stream valleys refer to broad, shallow valleys with local divergences in height of up to one metre. Incised stream valleys can result in differences of height up to a maximum of two metres, and a width of hundreds of metres.
3. Most of the geomorphological description of the area is based on an interdisciplinary land development study, which was coordinated by the ICW - the Institute of Land and Water Use - (Werkgroep Methodologie, 1983).
4. 'Drying up' is the english translation of the dutch term '*verdroging*', which is used to describe the drying up of wet habitats, caused by the decline in water tables.
5. This laborious procedure had to be carried out, because the digitizing software which was available had no abilities to incorporate the boundaries of 'islands' in the larger units of which they were a part. In a later version of the software, this abilities were added.
6. The Dutch classification of groundwater levels (see table below) gives information about the mean highest groundwater level (*GHG*) and the mean lowest groundwater level (*GLG*). The classification gives the distance from groundwater level to the surface level in centimeters.

   Classification of groundwater levels

Class:	I	II	III	IV	V	VI	VI
GHG	<20	<40	<40	>40	<40	40-80	>80
GLG	<50	50-80	80-120	80-120	>120	>120	>160

7. The GeoDIG software, used in this case study, attaches the thematic information to the objects digitized. Other GIS packages (e.g. the ARC-Info software) digitize polygons and attach the thematic information to the area surrounded by the polygons, by placing 'label points' in these areas.
8. The Staring Centre classified and processed the LandSat TM image with a majority filter to derive the LGN map, by . Thunissen et al. (1992) assessed the accuracy of the LGN map. For a test site in Noord-Brabant, they found the following reliabilities (percentage of land cover on LGN of the known reference):

	without maj. filter	with majority filter
Grass	87.9	92.8
Maize	79.4	91.0
Horticultural crops	5.7	-
Deciduous woodland	91.7	93.5
Coniferous woodland	63.6	72.0
Open natural area	6.4	9.5
Built-up area, roads	46.2	67.0

   One of their conclusions was that horticultural crops were confused with grassland and maize and could not be classified satisfactory.
9. In this respect the situation in the province resembles the situation in the Netherlands as a whole. Dairy farming is the most important agricultural land use in the Netherlands. In 1986 this sector made up 37% of agricultural production (See Table below) grassland accounted for 55.2% of the area of agricultural land, arable farming (mainly maize) amounted to 26.9% of the agricultural land. In total, 61% of the Netherlands was used for agriculture. The percentage of total agricultural land decreased by 13% from 1960 to 1986 (ten Pas and van der Ploeg, 1990). However, the proportion of feed crops (maize and grass) increased significantly. In the arable farming sector, cereal crops decreased and land use was intensified: sugar beet and potatoes became more important. Market gardening covered 6% of the agricultural land and cultivation under glass covered 0.4%.
   Production shares of the agricultural sectors in the Netherlands in 1986 (ten Pas and van der Ploeg, 1990)

	Production share (%)
Dairy farming	37.0
Intensive husbandry	15.0
Arable farming	15.0
Market gardening	15.0
Other agriculture	18.0

10.The National Agricultural Economics Institute (LEI) gives as a definition of an 'agribusiness complex': 'a gathering of vertically coherent economic activities, connected with the production, processing and marketing of an agricultural product or a group of agricultural products, including the businesses connected with supply and service to the agricultural production, of which the firms have their main relations among themselves'. A 'geographic agribusiness complex' is described as 'an agribusiness complex of which the location of the vertical coherent activities is characterized by a regional concentration with mutual dependency of these activities'.

11.Quota's have been introduced for dairy farming and sugar beet production.

12.The large number of animals results in a huge manure production. The amount of minerals in this manure depends on the animal species. The composition of the manure (Janssen, 1982) and the number of animals in the Netherlands are stated below.

Composition of manure (Janssen, 1982) and number of animals (CBS, 1983 and 1993)

	%N	%P_2O_5	%K_2O	animals, 1982 x 1000	animals, 1992 x 1000
Turkeys	4.3	3.0	1.6	554	1364
Table Poultry	2.3	2.1	1.6	39823	46525
Chickens	0.9	0.94	0.45	29408	33150
Pigs	0.7	0.47	0.4	10254	14161
Cows	0.44	0.2	0.5	5241	4920
Horses	0.5	0.2	0.6	59	86
Sheep	0.5	0.2	0.6	776	1954

The breeding of fur-bearing animals (mink and ermine) also contributes to pollution. The manure of furbearing animals contains four times as much Nitrate and Phosphate as that of chickens.

13.This description of the situation of the recreational aspect is mainly based on the publication *Recreatie met beleid*, by the Foundation for Recreation (Stichting Reccreatie, 1988).

14.In 1987, the Dutch spent 11 billion guilders on holidays, of which 2 billion was spent in the country itself. At the moment, the economic importance of the sector of recreation and tourism, expressed in its employment rate, is equal to the agricultural sector: six per cent. There is a decline in the hotel and guest house business and the tourist camping industry. The water recreation, bungalow and caravan sector is increasing. In 1987, 19 billion guilders were spent on day trips, visiting villages and cities, cultural activities and leisure parks. The market is particularly saturated in holiday recreation. The volume of trade of the eleven biggest leisure parks was 9 million guilders in 1987. In this branch, competition is keen. Companies are continuously forced to make new investments. Some parks have chosen to focus on educational subjects. (Stichting Recreatie, 1988)

15.The policy on nature as described in the 'Nature conservation policy plan' (Dutch: *Natuurbeleidsplan* (Ministerie van Landbouw, Natuurbeheer en Visserij, 1990) was translated into concrete measures in the 'working programme on nature and landscape 1992-1996' (Dutch: *Meerjarenprogramma Natuur en Landschap*, (Ministerie van Landbouw, Natuurbeheer en Visserij, 1991)).

The policy on the environment is described in the 'National environmental policy plan' (Dutch: *Nationaal Milieubeleidsplan* (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 1989)). This report was supplemented one year later by the 'National environmental policy plan-plus' (*Nationaal Milieubeleidsplan plus* (Ministerie van VROM, 1990)).

16.The policy in the reports was based on the recommendations of the World Commission on Environment and Development, the 'Brundtland commission'.

17.The discussion of the regional plan (in Dutch: '*streekplan*') in this section is based on the final draft of the plan submitted for public discussion in September 1991. Meanwhile despite the vehement protests of farmers the plan has been approved by the provincial parliament, without fundamental changes.

18.The local zoning schemes are usually drawn up in consultation with the provincial authorities, who have to sanction the plans. The national government as well as the provincial authorities have the power to oblige a municipality to include aspects which are of provincial or national interest (section 37, *Wet op de Ruimtelijke Ordening* - Law on Spatial Planning).

19.If these consultations have no effect, the province can oblige the municipallity to draw up a zoning scheme, or to have a plan drawn up at the municipality's expense (section 40, *Wet op de Ruimtelijke Ordening* -Law on Spatial Planning).

20.The remaining themes concern the following problems (Ministerie van VROM, 1989):

a. climatic change
    Decomposition of the ozone layer
    Greenhouse effect

b. diffusion
    Diffusion of chemical substances
    Use of herbicides and pesticides

c. removal of waste materials
    removal of unusable waste matter
    amelioration of waste collection
    amelioration of waste processing
    amelioration of storage of waste materials which cannot be processed
    recycling and prevention of waste matter

d. wastage
    closing the processing circuits of raw materials
    saving energy
    supporting a higher quality of products

21.One of the conclusions by Van den Bosch is that the Province has few possibilities for reducing acid depossition in order to meet the national target of 2400 mol $H^{+}ha^{-1}year^{-1}$ in 2000 and 1400 mol $H^{+}ha^{-1}year^{-1}$ in 2010, as the deposition originating from sources beyond the control of the provincial authorities already greatly exceeds these values.

Figure 5.3 Geomorphological map

Figure 5.4 Soil map

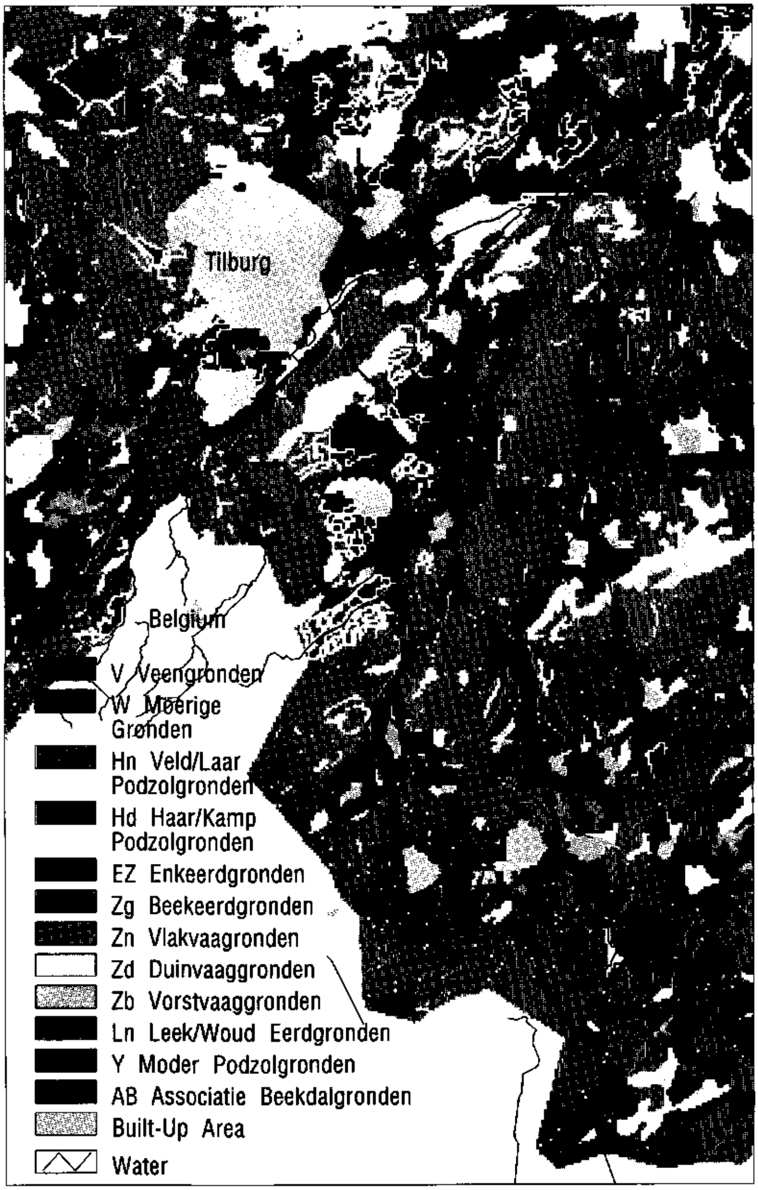


Figure 5.5 Groundwater map

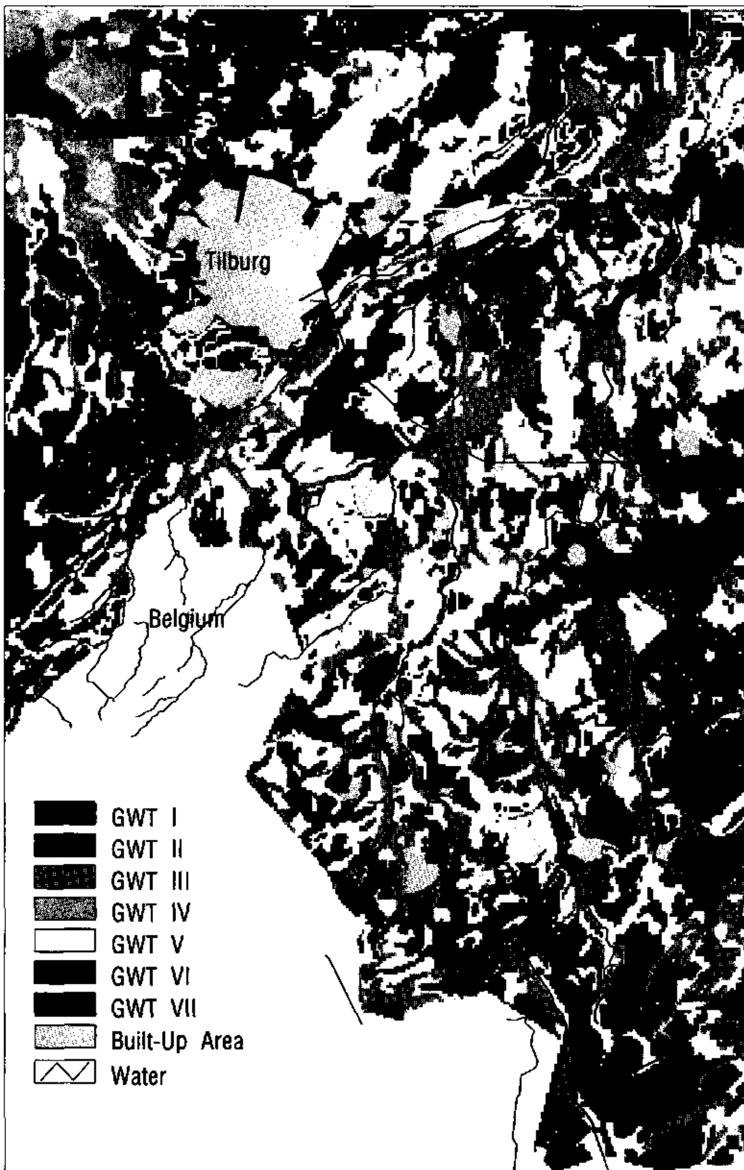
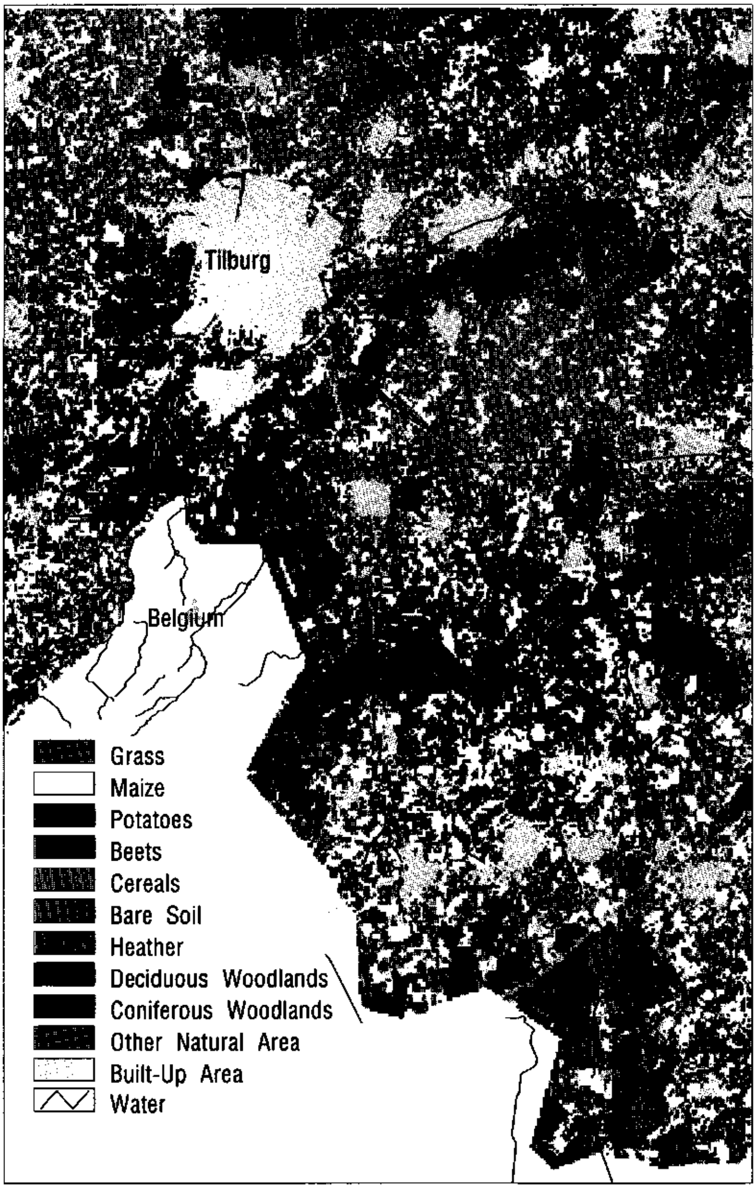


Figure 5.6 Land cover map



6 NORMATIVE KNOWLEDGE: AN ANTHROPOCENTRIC AND AN ECOCENTRIC INTENTION

Three types of normative knowledge were discerned in this case study. Firstly, the intentions were developed. A study of literature provided the 'system of relevance' of the intentions. Subsequently, the problems in the area were stated, interpreted and the intentions were elaborated into concrete intentions*. These concrete intentions provided the planning statements and criteria which were used in the planning. The formulating of these statements and criteria was strongly interwoven with the plan generating. Therefore, they will be described during the description of the planning process, in Chapter Seven.

6.1 Systematics of the normative knowledge

Normative knowledge plays a role in all planning processes, explicitly or implicitly, in various forms, at various stages. In the reconnaissance planning approach, normative knowledge is stated explicitly. It can be described at different levels of abstraction. In his *RISOR* concept, van Lammeren describes the normative knowledge at three levels, starting on a level at which aspects of the spatial facets are integrated (see section 2.4). In this study, I started the drafting of the normative knowledge on a high level of abstraction. Obviously, in other exercises the normative knowledge may be stated at different levels of abstraction, depending on the planning context.
The study of literature[1] revealed that premises of spatial and environmental relevance can generally be reduced to a paradigm of the ideal relationship between man and nature. Premises of how this relationship should be and the consequences of this premises for the socio-physical organization form the forces driving the planning process, i.e. the intentions. I chose these premises as starting points in the case study. These premises touch upon the cultural subsystem of the *MFO* model (see section 2.2).
There are two main types of economic subsystem, depending on whether privately or collectively owned means of production is considered to be the best. To be realistic, private ownership of the means of production was chosen for both intentions.
Each intention also assumes a particular position of government in the social organization, which determines the political subsystem of the *MFO* model. The Dutch Science Policy Council discerns a *technocratic* and a *sociocratic* position of government[2] (WRR, 1983).
The two intentions worked out can be characterized as *anthropocentric* and *ecocentric (see Figure 6.1)*:

1. an anthropocentric intention, with privately owned means of production and a governing body that 'follows' the market, from a technocratic position,
2. an ecocentric intention, with privately owned means of production and a governing body that 'guides' the market in a sociocratic way.

Figure 6.1 Systematics of intentionalities within the groups of anthropocentric and ecocentric notions, based on the *MFO* model.

	anthropocentric	ecocentric
technocratic	*	
sociocratic		*

These two intentions are to be seen as descriptions how the physical organization and the social organization and their internal and mutual relations should function. Normative knowledge can be elaborated at various levels of abstraction. The case study started with a basic premise on the relation between man and nature, on which each intention was based. Subsequently, the intentions were elaborated into concrete intentions, from which planning statements and criteria were derived. The relations between these types of normative knowledge are described by the diagrams in Appendix III.

In the case study, the intentions have an 'objective' description of the situation in common. However, for each intention a 'subjective' interpretation was made of this description, emphasizing different aspects. One might argue that each intention analyses the situation from its own point of view, and that an 'objective' analysis is impossible.

The most concrete normative knowledge is the planning goals and criteria. Here, the intentions are related to the specific area in which the planning process takes place. Specific circumstances, such as geomorphology, infrastructure, economic and social statistics etc. determine the way the intentions are translated into planning goals and criteria. This normative knowledge is strongly interwoven with the formulation of the plan and will be discussed in Chapter Seven, which describes the process knowledge.

6.2 Intentions

The anthropocentric intention

The anthropocentric premise (ANINT)[3)]
The attitude of the anthropocentric intention can be characterized by the 'Utopian model', as described by Burch (1971):

'The Utopian model suggests that there was a crude past, that has constantly evolved towards the difficult but hopeful present, which is the next stage before a glorious future of unending perfection'.

According to the anthropocentric attitude, the natural substratum is an object which is at man's disposal. Man is not a part of nature, but is separated from it (Westhoff, 1985). The basis of this attitude lies in Christianity which states that nature was created for man. In contrast to preceding religions, in Christianity nature was not sacred, it did not possess an intrinsic value. The value of nature is attached to it by man[4)] (Schoonenboom and Rabbinge, 1992). The position of man with respect to nature can result in exploitation of nature or in good stewardship of nature (Schuurman, 1985, Verhoog, 1985, Boers, 1985). During the Age of Enlightenment, starting in the eighteenth century, man's alienation from nature was strengthened by the faith put in reason, reverting to the ancient Greek philosophers. This resulted in the notion that a maximum level of need can be satisfied by rational politics and scientific control of nature.

The economic subsystem (ANINT2)
Economic interests and developments determine the functioning of the economic, political and cultural subsystems. As mentioned before, the governing body follows developments in the market and means of production are privately owned.

The political subsystem (ANINT3)
The government does not regulate the socio-physical organization. Its task is to support the economic subsystem. Within this limiting condition the authorities guide social processes. Basic environmental quality has to be safeguarded. Production processes may not affect the environment to such a degree that the production processes themselves are threatened. The functioning of the economic subsystem is legitimized by the cultural subsystem. Social processes may not form a threat to the stability of the social organization itself. Therefore, the political subsystem has to ensure that certain claims from the cultural subsystem i.e. social goals, are rewarded.

The cultural subsystem

The norms and values of the cultural subsystem describe what the socio-physical organization 'should look like'. These norms and values comprise the attitude towards nature and notions on the relation between man and his environment. This research focuses on agriculture, recreation and nature. Therefore, the premises on these aspects will be described below.

Nature *(ANINT4)*

The intention refers to pristine nature. Optimization of nature which is strictly separated from economic activities is regarded as the only way nature can be preserved.

The paragon of many 'modern' nature development projects in the Netherlands is the *Oostvaardersplassen* area[5]. According to the anthropocentric intention, nature has to be developed in combination with an optimization of agricultural production. The premise that it is possible to 'construct' nature can be regarded as part of the Dutch technocratic tradition. Fauna will be restored to this pristine environment. This fauna might comprise beavers, storks, deer, and even elks! (de Bruin et al., 1987).

Agriculture *(ANINT5)*

The general attitude towards the agricultural sector of this intention is described by de Zeeuw and Albrecht (1990). The government hardly intervenes in agriculture. Markets are liberalized and no subsidies are granted, as they disturb the market system. Technological developments are to be regarded as autonomous processes inherent to modern agriculture (Kerkstra and Vrijlandt, 1988). Agriculture is a way of intervening in nature, for the benefit of specified plants or animals. Thus, nature is exploited for the benefit of production, which means agriculture is carried out at the expense of nature. On the other hand, agriculture has an interest in the well-being of nature, because agricultural processes must be enduring[6]. The environmental quality may not adversely influence agricultural production. Therefore, production processes are constrained by basic environmental quality[7].

Recreation *(ANINT6)*

Man as a dynamic and economic being needs nature for relaxation. To relax in untouched nature or to measure his strength against 'the wilderness', e.g. during survival excursions. The notion of 'wilderness' is strongly promoted by product advertising, which portrays wilderness as being without human influence, stable and impenetrable. The opportunity to escape from 'hectic urban life' is, according to Boerwinkel (1985), the most important aspect of recreational quality. The second aspect is 'wilderness'[8]. Boerwinkel concludes that the most natural environment best meets recreational. In this view, the goal of recreation is to restore, improve and experience one's physical and psychological growth potential. Encountering true wilderness is, of course, only achieved by a privileged few.

Most people seek their relaxation in 'cultivated wilderness', but the real wilderness is in their minds.

The ecocentric intention

The ecocentric basic notion (ECINT1)
The attitude of the ecocentric intention can be characterized by the 'Arcadian model', as described by Burch (1971):

'The Arcadian model suggests that there was a more perfect past, where relations between man and his societies and nature were in harmony. Since that happy period all has been deteriorating up to the terrible present. This will end. Then rebirth of a more simple and more perfect future will re-establish homeostasis between man and nature'.

The ecocentric attitude regards the natural substratum as a product of a broad system, of which man is a small part. The ecocentric premise considers society as a whole, questioning production processes and the relation between these processes and nature. Existing production processes have to change, in order to reach the necessary harmony between man and nature. This requires fundamental changes in society.
Taylor (1980, p.197) discerns four main components in what he calls a 'Biocentric notion':

'1. Humankind is thought of as a member of the Earth's community of life, holding that membership on the same terms as apply to all non-human members.
2. The Earth's natural ecosystems as a totality are seen as a complex web of interconnected elements, with the sound biological functioning of each being dependent on the sound biological functioning of others.
3. Each individual organism is conceived of as a teleological centre of life, pursuing its own good in its own way.
4. Whether we are concerned with standards of merit or with the concept of inherent value, the claim that humans by their very nature are superior to other species is a groundless claim and, in the light of elements 1, 2, and 3 must be rejected as nothing more than an irrational bias in our own favour.'

The economic subsystem (ECINT2)
If the aim is to preserve ecosystems, than economic processes must be subordinated to rigid limits. The function of economy is to meet the needs of man, within boundaries laid down by nature and environment. The demands of man are less important than these boundaries. In the ecocentric intention, the government guides the market developments, and means of production are privately owned.

The political subsystem (ECINT3)

The task of the authorities is to supervise production processes which may not develop at the expense of nature or environment. The interests of nature are the basis of the functioning of the political subsystem. If conflicts occur, they are preferably solved by guiding and stimulating processes in a sociocratic way.
Nature-friendly behaviour of society is achieved by influencing human behaviour and by education.

The cultural subsystem

As in the case of the anthropocentric intention, this subsystem will be described by its premises regarding nature, agriculture and recreation.

Nature *(ECINT4)*

It is impossible to separate man from nature. Man is part of a large ecosystem (Verhoog, 1985). The integration of man and nature is an important goal within this intention. All elements of the ecosystem have an intrinsic value. Extreme examples of this notion can be found in American Indian and Buddhist philosophies, which strive for complete harmony and mutual respect between man, animals, plants, soil, water, and air[9]. Diversity is an important aspect on which the functioning of ecosystem is assessed. A decrease of the diversity indicates a decline of the ecosystem (Westhoff, 1990). The entire Netherlands, including its valuable nature areas, is the result of an interaction between man and nature. Valuable historic landscapes have to be preserved and natural ecosystems have to be developed.

Agriculture *(ECINT5)*

Agriculture may not be separated from nature, because it is regarded as an element and manager of nature. In order to function as part of ecosystems, agricultural production is restricted drastically. The norms for environmental quality are higher than in the anthropocentric intention[10]. Alternative methods of production are developed in cooperation with the farmers. Small-scale agriculture enriches nature. Within this premise there are various premises about the desirability of agricultural methods. Both biological and integrated agricultural practices are advocated and are stimulated by the government.

Recreation *(ECINT6)*

Within the ecocentric intention recreational motives are characterized as 'enthusiasm and respect for nature' (Boerwinkel, 1985). Boerwinkel refers to Roman poetry, in which the basic tenet was nature as a master.

6.3 Interpretations and concrete intentions

Based on a description of actual developments in the area (see Chapter Five) and an interpretation of these developments, the intentions were elaborated into concrete intentions for the study area. It will become clear that the two intentions give different priorities to the various aspects. The anthropocentric intention regards economic aspects as the main issue, while the ecocentric intention focuses on the relation between agriculture and nature. Notice that both intentions attach a negative value to the phenomena described in section 5.3 (acidification, eutrophication, 'drying up' and disturbance). To be able to achieve the intended scenario a rehabilitation strategy must be followed, in order to reach 'basic environmental quality'. However, the two intentions employ different definitions of this 'basic environmental quality'.

The anthropocentric interpretation of the situation in the study area

Agriculture

Technological developments will result in higher production per hectare and per animal. Meanwhile the demand for agricultural products within the EC will scarcely rise. Therefore, large surpluses will accumulate if the growth continues. It is expected that the EC will try to reduce agricultural subsidies and seek ways to reduce production without raising the costs to EC. This will result in a market-oriented policy, which in turn will result in more competition and a lowering of prices[11]. Production will be left hardly any room to increase. Farmers and growers will look to quality products, to raise their income. Exports to markets outside the EC will have to be developed further.
At present, dairy products, pigs and veal calves, vegetables and potatoes are the most important Dutch agricultural exports. Intensive husbandry, which is already under pressure from environmental regulations, faces a particularly difficult future. If EC subsidies disappear, it is important to strengthen the competitiveness of the most important branches of agriculture.

Nature

Until the publication of the Fourth Policy Document on Physical Planning in 1988, the interweaving of nature and agriculture formed part of Dutch national policy. Nature continued to deteriorate largely because of developments in agriculture under this policy, and therefore it can be concluded that this concept failed. It is in the interest of nature to separate nature from economic, agricultural functions, by four reasons:

- economic claims will always be more powerful than ecological claims;
- economic functions have led to a deterioration in the 'ideal' nature, which is based on pristine nature;

- society will be reluctant to spend large sums of money on nature, because this does not lead to any financial gains;
- nature has to function according to its own intrinsic rules, undisturbed by human influences[12].

Recreation
If welfare increases and the flexibility of working hours continues, the fragmentation of leisure time will augment. The need for space for hobbies, small jobs and allotment gardens will grow. Earlier, it was concluded that hotel accommodation and the camping branch will not grow. Holiday recreation and leisure parks do have options for expansion, but new markets have to be opened, the sums that need to be invested are also growing. There is still a demand for recreation in and around nature, there is still a demand. However, recreation aiming at relaxation in nature (walking and cycling close to residential areas) as well as those aiming doing sport in nature (canoeing, hiking, cycling), meet with barriers.

The anthropocentric concrete intentions

Agriculture (ANPER1)
Lowering the prices of dairy products will improve the balance between supply and demand. Competitiveness and export position have to be strengthened.
The Dutch Agricultural Economics Institute (LEI) calculated the spatial consequences of reducing the price of milk from Hfl 740 to Hfl 700 per ton (de Graaf and Tamminga, 1990). As a starting point they chose the situation in 1983, just before the superlevy was introduced. I adopted this scenario for the anthropocentric intention. The scenario assumed that there are no limitations regarding the employment and mobility of production. Although de Graaf and Tamminga looked at the Netherlands as a whole, their scenario also applies to Midden-Brabant, as in this area dairy farming is an important sector.
The calculations of the scenario had the following results (de Graaf and Tamminga, 1990):
- a 12% reduction in dairy livestock;
- a shift from maize to quality grass for roughage, with a lower yield per hectare;
- a 5% total decrease in the acreage of roughage, of which a part will be used by beef cattle and market gardening on arable land;
- marginal changes in the over-manuring of grassland;
- a decrease in nitrate leaching and ammonium emission;
- no desirable changes in the vegetation in and around fields;
- desirable changes regarding the eutrophication of nature areas in areas with a sandy soil;

- an increase in the negative effects on the grassland due to accumulation of copper and potassium;
- a decrease in the number of small farms, an increase in scale towards farms that can produce more cheaply.

According to the LEI, a market-oriented policy will result in a lowering of cereal prices, which is important to intensive husbandry. Imported food products such as tapioca will be replaced by European grain products. The position of Dutch intensive husbandry will weaken compared to that of intensive husbandry in grain-producing areas. Provisions for the disposal of manure in areas without over-manuring have to maintain the position of Dutch intensive husbandry. Also, facilities will be developed to process granular manure.

Nature (ANPER2)

Functions which are a threat to natural processes will be separated from nature in order to achieve an optimal nature (i.e. pristine nature). Very dynamic functions (e.g. agriculture) will be disconnected from low dynamic functions (e.g. nature). This could be achieved by applying the 'framework planning concept', described by Kerkstra and Vrijlandt (1988 and 1989). The framework concept discerns a framework and spaces inside it. Functions like nature, forestry, small-scale recreation and drinking water supply are situated within the framework itself. Nature areas will be developed by mutual connections. Thus, an ecological infrastructure will be created. In the agricultural areas, the connecting zones are combined with dry and wet infrastructural elements.

The spaces inside the framework are available for agricultural production, urban land use and intensive recreation. In these spaces the standards of the basic environmental quality apply. The lay-out of the agricultural areas will be flexible, because room must be left for technological and economic developments.

According to Kerkstra and Vrijlandt the authorities will play an important role in establishing the framework. On the other hand, the spaces inside the framework will leave maximum room for private initiatives. Here, the authorities should only play a stimulating role.

Recreation (ANPER3)

In order to improve efficiency, there must be further privatization of recreational facilities and closer cooperation between the private and public sectors. A scaling-up and specialization is necessary for each region. Presenting the recreational potential of a region as a 'package', will encourage growth in holiday recreation. Leisure parks can be a component of such a package, which aims to reach the European market. The regions must therefore be easily accessible by public transport and car.

In the surroundings of residential areas, more space is needed for walking, cycling, fishing, sailing and riding. Other types of recreation connected with 'wilderness' experiences will be situated far from residential areas. Recreational areas near urban areas will be developed on former agricultural land that has been withdrawn from agricultural production. Recreational areas combined with natural functions will be developed on former agricultural land far from urban areas.

The ecocentric interpretation of the situation in the study area

Agriculture

The European policy is an important cause of the actual agricultural problems. This policy leads to overproduction, intensification, reduced employment, and dumping of surpluses on the world market. A completely free market system will only increase these problems. Solutions have to be found in developing production methods which aim at the well-being of man, animals and environment. In such a system, prices will cover production and environmental costs, production will be restricted and production rights will be equally divided among farmers (Kritisch landbouwberaad, 1988).

Nature

The decline in the diversity of ecosystems is serious. A separation of nature and agriculture will not stop this process, as ecosystems are threatened by influences from their surroundings. Since natural and agricultural areas form coherent ecosystems, they have to be studied as integrated systems.
The lay out of agricultural areas has to be carried out within ecological limits. If agricultural development is employed as a guideline, environment, nature and landscape will deteriorate (Driessen, 1990).

Recreation

From the ecocentric point of view, positive as well as negative developments can be discerned in the recreational sector. The growing interest in recreation focusing on nature and education is applauded. On the other hand, leisure parks are condemned because of their high consumption of energy and space. Growing car mobility is also decried. Intensive recreation forms a threat to nature and disturbs ecosystems and autochthonous social systems as well.

The ecocentric concrete intentions

Agriculture (ECPER1)

In the long term, intensive husbandry will disappear. All agricultural production will be directly related to agricultural land, there will be no inputs into the system from outside. Agriculture will produce mainly for the 'regional' market.
The concept of sustainable agriculture leaves room for various production methods: integrated, ecological, biological methods and agriculture directed at nature management. Employment in the agricultural sector is an important way of

ensuring the quality of life in rural areas. It is accepted that certain types of agriculture in specific areas will structurally depend on subsidies.
The Agricultural Economics Institute calculated a scenario of an agricultural policy of quotas related to land parcels for the Netherlands, I adopted this for the ecocentric intention in the case study. This scenario gives the following results (de Graaf and Tamminga, 1990):
- a 15% decrease in dairy livestock;
- a withdrawal of land, which will partially be used for the production of grass and arable products.
- a shift from maize towards grassland;
- if the current manure legislation is maintained a risk of increasing damage due to over-manuring;
- a decrease in the risk of eutrophication of nature areas by phosphate;
- an improvement of the situation in higher-lying natural areas: a decrease in the supply of minerals in nature areas;
- regionally, an improvement in the development of vegetation along streams and on grassland.

Thijs (1989) calculated a scenario of measures which limit production by quotas, a policy which I adopted in the ecocentric scenario. She predicts the area of agricultural land which would not be needed for roughage production for dairy herds in the year 2000 in the Netherlands:
- 20-35 % for the west and north of the country;
- 15% in the southern (Noord-Brabant!) and eastern sandy districts;
- 40% for the central river area;
- 25% for the south of Limburg.

The ecocentric intention advocates integrating nature and agriculture. The area not needed for roughage production will be used for a radical extensification of agriculture. The authorities will have to introduce and maintain regulations to protect nature and landscape, for example by forbidding a lowering of the water level or the conversion of grass into arable land.

Nature (ECPER2)
Nature will not be restricted to areas which are reserved for nature. Nature areas have no sharply defined borders with agricultural or urbanized land. The transition is gradual. Landscape development and nature are integrated, and 'culture landscapes' (e.g. heathland) are regarded as valuable nature areas. Landscape is the visualization of an ecosystem, in which agriculture and nature are interwoven.
The four landscape types discerned by Westhoff (1990), are adopted as possible landscapes in the ecocentric intention:
- agriculture with restrictions;
- maintenance of historic, valuable landscapes;
- nature development;
- farming systems aiming at nature development and maintenance.

Ecological connections between important nature areas are not achieved via distinct corridors, but by an 'intricate structure of natural elements'. As monofunctional timber production conflicts with nature goals, timber production is combined with nature goals.

Recreation (ECPER3)

Within the ecocentric intention, the working hours will be flexible and short, and therefore there must be opportunities for recreation near residential areas. Recreation will be small-scale, mainly directed at experiencing nature: walking and cycling. Nature and recreation will be interwoven, provided the recreation does not form a threat to ecosystems. Agriculture and recreation will be interwoven by giving public access to agricultural land, camping on farms etc. The accessibility for cars will be reduced by the closing off roads and stimulating means of public transport.

Notes

1. The following literature provided the 'system of relevance' for the normative knowledge:
Boers, C. (1984), *Natuur in techniek en wetenschap*;
Boerwinkel, H.W.J. (1984), *Natuurbeleving, -waardering en -betrokkenheid: van deskundige produkt analyse naar participerende relatie-synthese*;
Bruin, D. de, D. Hamhuis, L. van Nieuwenhuize, W. Overmars, D. Sijmons, F. Vera (1987), *Ooievaar. De toekomst van het rivierengebied*;
Burch, W.R. (1971), *Daydreams and nightmares. A sociological essay on the American Environment*;
Driessen, P.P.J. (1990), *Landinrichting gewogen. De plaats van de milieu-, natuur- en landschapsbelangen in het landinrichtingsbeleid*;
Europese Commissie (1985), *Perspectieven voor het gemeenschappelijk landbouwbeleid. Groenboek van de commissie*;
Graaf, H.J. de, and G. Tamminga (1990), *Produktiebeheersing in de melkveehouderij. Verkenning van de gevolgen voor landbouw, natuur en milieu*;
Hetsen, H., and M. Hidding (1991), *Landbouw en ruimtelijke organisatie in Nederland; Analyse en toekomstverkenning van een regionaal gedifferentieerde betrekking*;
Kerkstra, K., and P. Vrijlandt (1988), *Het landschap van de zandgebieden. Probleemverkenning en oplossingsrichting*;
Kerkstra, K. and P. Vrijlandt (1989), *Cascolandschap; Nieuwe perspectieven voor landschapsontwikkeling*;
Kritisch Landbouwberaad (1988), *'Kritisch landbouwberaad wil breed platform voor andere landbouwpolitiek'*
Leeuw, P.H.J.M. de, (1991), *Beleidsondersteuning door een informatiesysteem. Aanzet tot een beleidsondersteunend informatie systeem voor de milieuproblemen veroorzaakt door de veehouderij*;
Pas, H.C. ten, and B. van der Ploeg (1990), *Een vergelijking van de agrarische ontwikkeling in Denemarken en Nederland*;
Schoonenboom, I.J. and R. Rabbinge (1992): *Concepties van duurzaamheid*;
Schuurman, E. (1984), *Religieus-wijsgerige achtergronden van het milieuprobleem*;

Stichting Recreatie (1988), *Recreatie met beleid. een verkenning van ontwikkelingen in de recreatie*;

Taylor, P.W. (1980), *The ethics of respect for nature*;

Thijs, H.M.E. (1991), *Changes in land use as a result of the restriction of milk production*;

Verhoog, H. (1984), *Milieu-ethiek en de natuurfilosofie van Goethe*;

Weinreich J.A. and C.J.M. Musters (1989), *Toestand van de natuur. Veranderingen in de Nederlandse Natuur*;

Westhoff, V. (1984), *De verantwoordelijkheid van de mens jegens de natuur*;

Westhoff, V. (1990), *'Voor die dennebossen heb ik een heel eenvoudige oplossing: in brand steken'*;

Wetenschappelijke Raad voor het Regeringsbeleid (WRR) (1980), *Beleidsgerichte toekomstverkenning, deel 1: Een poging tot uitlokking*;

Wetenschappelijke Raad voor het Regeringsbeleid (WRR) (1983), *Beleidsgerichte toekomstverkenning, deel 2: Een verruiming van perspectief*;

Zeeuw, D. de, and W.G. Albrecht (1990), *Duurzaam samengaan van Landbouw, Natuur en Milieu*;

2. The Science Policy Council (WRR, 1983, p. 12) describes the two positions of government with the notions 'technocratic' and 'sociocratic', the suffix 'cratic' being derived from the Greek verb meaning 'governing'.
   The technocratic position is described as the notion that the government participates in the social intercourse, being a driving force in social processes. The government is active, positioned in the centre of society. Governing tasks have to be performed skilfully, rationally and systematically. The emphasis is put on the pushing and performing capabilities of the government and on the executive power in society.
   The sociocratic position departs from a different position of the governing body. The government is regarded as a mediator instead of a 'driving force'. Problems first have to be solved by self-regulation of the free society. The government has to give society the opportunity to assume and carry out its own responsibilities. Processes of power are not directed at gaining parliamentary majorities, but on creating relations in which minorities have the freedom to possess and express their opinions. The desire of the executive force to steer has to be restrained.
3. The codes in *italics* refer to the diagram in Appendix III. The normative knowledge is stored in the *RISOR* system under these codes.
4. Schoonenboom and Rabbinge (1992) state that 'if nature can not be defined without man, and if nature cannot be objectified, it is impossible to take nature as an absolute standard'.
5. The *'Oostvaardersplassen'* is a valuable nature area in *Flevopolder*, which developed when land was reclaimed from the sea (the *IJsselmeer*). The area is often cited as an example of how valuable nature areas can be developed as a result of human interference.
6. Sustainability contains the aspect *time*. In this intention, sustainability is defined by the limits which ensure the continuation of economic and societal processes in the future.
7. The basic environmental quality is defined as the quality of the abiotic environment: soil, water and air. Pollution by production processes may not affect production or public health.
8. Boerwinkel bases his conclusions on research by Rossman and Ulehla: Rossman B.B. and Z.J. Ulehla, Psychological Reward Values Associated with Wilderness Use. A functional-reinforcement approach, *Environment and Behavior*, vol. 9, no.1 March 1977.
9. Related to this subject, Boers (1985) refers to Coolen and Kleiss, who point out the so-called 'paradox of the ecological standard': 'on one side man is regarded as part of a natural system, and thus is included in the necessary processes of ecology. On the other hand, demands from ecology are derived to prescribe human behaviour. According to the ecocentric starting point, man cannot act as a free being, making his own decisions but can only act according to ecological rules.' (Coolen and Kleiss in the *Algemeen Nederlands Tijdschrift voor Wijsbegeerte*, 73:20-43.
10. 'Basic environmental quality' is defined as the quality of the 'green' environment. Pollution of soil, water and air may not form a threat to ecological processes in nature.
    The notion of 'sustainability' is defined as the creating of preconditions to ensure the continuation of ecological processes in the future.

11.Besides lowering prices, there are other options for controlling production:

- a system of production quotas connected parcels of land;
- a system of free saleable quotas;
- a system of levy taxes and subsidies in which producers receive lower prices if they produce above their quota and higher prices if they produce within the range of their quota.

Within the preconditions chosen in the intention, these options are rejected because of disadvantages mentioned by the European Commission (1985): problems are the negotiations about the quotas, the freezing of a production structure, slowing down the development of productivity and loss of flexibility, the creation of capital in the form of production rights, and the risk of re-nationalization. The fear is that eventually a quota system will be necessary for all agricultural products.

12.The notion that nature has to function according to its own intrinsic rules, without human interference, could also be part of an ecocentric intention. In this research this notion is classed in the anthropocentric intention, because it is part of a concept of extreme separation between nature and 'culture'. In this concept, minimizing human interfering in one area results in a concentration of human interference in other areas. Thus, human actions are not subordinated to nature; this is an anthropocentric approach.

7 PROCESS KNOWLEDGE: IMPLEMENTING THE RECONNAISSANCE PLANNING APPROACH IN MIDDEN-BRABANT

In accordance with the *RISOR* study, the process knowledge in this research comprises 'action moments' and 'action phases', in which normative, object and method knowledge are integrated (see section 2.4). The basic object knowledge which was used and generated in the case study was described in Chapter Five, and in Chapter Six the intentions and concrete intentions (which are the basis of the normative knowledge) were described. In this chapter, I will describe the planning process. This systematic description can be regarded as a theoretical model of the planning process and is described by the activities which constitute this process. Various methods and techniques[1] were employed during these activities.

The planning goals and criteria constitute the normative knowledge in the plan-generating phase. This normative knowledge was closely interwoven with the plan-generating, and will therefore also be discussed in this chapter.

The four phases of intention, definition, planning and decision-making, which were described in section 2.3, constitute the 'action' described by Kleefmann. In the case study the 'action' was unfolded into six phases:

a. development of intentions (which preceded the planning process),

the planning process itself, unfolded into

b. description (comparable to the 'definition' phase described by Kleefmann),
c. interpretation,
d. concrete intentions,
e. plan generating,

successively, the planning process was followed by

f. the decision-making phase.

These six phases will be taken as a guideline for the systematic description of the planning process in Figure 7.4. Obviously, these phases only roughly outline the process that was carried out. Moreover, not all phases were carried out fully (notably, the decision-making, which can be regarded as of interest to policy study rather than to the main topic of this study).

7.1 Characterization of the activities

A systematic description of the process, i.e. a theoretical model[2], has to explicitly state the various methods and techniques used during the planning process.

Each of the phases of intentions, description, interpretation, concrete intentions and plan-generating, will consist of several activities, to be carried out by using various methods and techniques, each of which can be related to the fundamental stages of an acting process as described by Schutz: what do we want? what is the situation? what are the possible actions to be carried out? and which action do we choose?

Many authors have classified planning and design methods. In order to inventory available planning and design methods and techniques and functional descriptions of them, I consulted Dessing[3], Foqué[4] and Jones[5] as well as the typology described by Kleefmann.

To describe the planning process I grouped the activities into five categories, based on the nature of the methods and techniques and schematized them in a flow chart (Figure 7.4) with an appropriate legend. As mentioned earlier, the process was cyclic rather than linear. The cycles have been depicted in the flow chart. When an activity was carried out with the help of GIS, this has been indicated. All GIS actions were performed as depicted in the flow charts in Appendix II. This description forms a phase in the formalization of the process. These flow charts were used to draw up the command files[6], i.e. formal descriptions of the planning process (for an example of such a command file, see Appendix IV).

The five main categories of activities

a. Formulating ideas and strategy

Activities:

- A discussion or brainstorming session in which a problem is formulated roughly. The participants express their opinion on the problem and possible ways solving it.
- The planner forms ideas, based on discussion, literature search and experience.
- A strategy is developed on how to apply the methods to a defined problem. This may involve evaluating the merits of certain tools, e.g. GIS software.

b. Exploration and gathering of knowledge

Activities:

- Gathering knowledge by interviewing specialists.
- Gathering knowledge from literature or maps.
- Obtaining external data (this is often time-consuming).

c. Processing knowledge in a systematic way

Activities:

- Structuring a certain amount of information or data according to a well-defined model or classification system which involves the digitization of maps.
- Analyzing data to derive information from them.
- Pre-processing computer data to make them suitable for the GIS software.
- Constructing a plan by combining, adding, restructuring and manipulating data.

d. Description and presentation i.e. transfer of knowledge
Activities:
- Summarizing information derived from literature in such a way that it can be used in the planning process.
- Reporting the results of a discussion.
- Visualizing spatial models in a map or by other means, in a comprehensible way.

e. Reflection and evaluation
- Discussing the results with specialists or people who are involved in the process.
- Comparing the results with other experiences.

Each phase of the planning process involves the activities described above. Nevertheless, in the case study it became clear that not all activities are always explicitly present in each phase, as is clear from the flow chart describing the case study.

7.2 Systematic description of the process

The activities represented by each symbol on the flow chart (Figure 7.4) will be described briefly below. The contents and structure of the normative and basic object knowledge were described in the Chapters Five and Six, the resulting plans will be described in Chapter Eight.

1. Discussion and brainstorming
The topics discussed concerned both the methodology and the contents of existing notions and opinions. Three central themes were discussed:
a. the sources from which the intentions were derived;
b. how the intentions had to be described and systematized;
c. the role the intentions had to play in the process.

2. Orienting literature search
A literature search was carried out, based on recommendations and references[7)] and concepts used in comparable studies were examined[8)]. Sometimes, it is difficult to discern statements and notions clearly in literature because they can be described in various, often indirect ways. For example:
- notions about a sector are often formulated negatively, contrasting one sector with another;
- notions may appear as statements in the form of 'solutions' to certain 'problem-s' that have been identified;
- a notion may be a perception of the internal functioning of a system;

- a notion may be a description of a certain situation, its problems and the implications of its future development;
- a notion may be a broad, holistic philosophy.

3. Reporting

Abstracts or copies were made of the relevant passages of the literature which was studied. These were then incorporated into a preliminary report which was discussed.

4. Designing a structure

In order to make the intentions and the process accessible to discussion, the intentions had to be described clearly and succinctly. They also had to give leads for planning decisions, all this while remaining in touch with reality and not becoming caricatures.

5. Processing normative knowledge: drawing up intentions

At the highest level, an intention was described as a philosophical notion, describing viewpoints about how the subsystems in the social organization should function. The intention also described the attitude towards the natural organization. At this level the intentions are not yet related to a specific area. The intentions are based on the orienting study of literature.

A systematic study and description of intentions derived from the variously shaped normative notions and statements cannot be accomplished without some underlying precept. In this study, the systematics of the social organization of the *MFO* model were followed, discerning three subsystems: economic, political and social. Norms and values, and opinions about 'how things should be' can be considered to be part of the cultural subsystem. The contents of these notions provide statements about how other subsystems and their relations should be organized.

6. Description of the intentions

The intentions were described systematically (see Chapter Six).

7. Analysis of the case study area

The study area was analyzed in various phases. The first was the 'description', in which the area and processes within the social organization and the natural organization of the area were examined. Furthermore, moments of analysis could be identified in the plan-generating phase, which is a cyclic process of analysis, construction and analysis/evaluation. The description included a study of literature and provincial reports, discussions with provincial planners and experts, and field trips.

A rough study of the area provided information which was used to compose the concrete intentions and the planning statements. The concrete intentions concerning the region cannot be disconnected from the characteristics of its socio-physical

organization and the economic, political, and cultural subsystems involved. The analysis was also important to examine the factuality of the intentions. As a basis of the planning process, the intentions for the area have to be relevant to the particular socio-physical organization of the area.
Student projects carried out parallel to the underlying research contributed to the analysis[9] (see section 1.1, Appendix II). They used a GIS and digitized data derived from activity 15.

8. Reporting the analysis
Since the results of the rough analysis were mainly a part of separate projects, they were reported as parts of these projects. The policy statements of the province were systematized and stored in a Cardbox database. The field trips resulted in a collection of slides, the descriptions of which were also stored in a Cardbox database. A GIS was used for the geographical presentation of the results, as described in section 1.2, Appendix II.

9a. Description of the object
The circumstances of agriculture, nature and recreation were described, using the results of activity 7 (analysis), and additional research. These descriptions were not influenced by the two intentions, which had the descriptions of the aspects in common.

10a. Presentation of the description
The results of activity 9a. were described (see Chapter Six).

9b. Interpretation of the situation
The descriptions of the aspects in the study area were interpreted from the viewpoint of the intentions, stating the problems and conflicts in the area. Thus, the interpretations were coloured by the intentions.

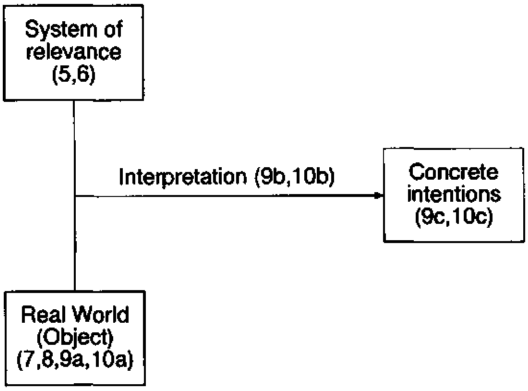
10b. Presentation of the interpretation
The results of activity 9b. were described (see Chapter Six).

9c. Concrete intentions
The spatial perspectives were derived by confronting the intentions, which were derived from a 'system of relevance', with the object of planning, the socio-physical organization of the area or the 'real world' (Figure 7.1). This organization of the area also comprises the cultural subsystem which describes the range of public opinion present in the region.

10c. Presentation of the concrete intentions
The results from activity 9c. were described (see Chapter Six).

11. Strategy on retrieval and systematization of data

Figure 7.1 Concrete intentions are derived from a combination of the intentionalities and the description of the socio-physical organization of the area.



In consultation with van den Aarsen (the colleague studying the same area) it was decided which data would be required to handle the questions which were expected during the case study. This decision was based on experiences with other projects and available data. The data were digitized by several people. In order to ensure a consistent set of data, criteria and choices regarding the digitization process were formulated in advance. The following aspects required attention when the dataset was composed:

- the availability of the data;
- the required scale;
- procedures for obtaining existing data;
- systematization of the data that were digitized;
- data reliability.

12. Orientation on data

The orientation on data focused on the aspects mentioned above. The availability of existing data was checked with the National Planning Department, Consultancy Agencies and the Provincial Planning Department of Noord-Brabant. In addition, literature on scale and reliability was studied. The legends of *KADROKAART*[10)], topographical map and soil map were studied, to arrive at a systematization comparable with existing systematizations. A pilot project was carried out, by digitizing a small area of the topographical map. From this it was concluded that the topographical map and the geomorphological map had to be digitized, whereas the soil map and land cover map could be derived from external sources.

13. Preparations for the digitization of the maps

Subsequently, the digitizing process was planned, by answering the following questions:

- which objects should be digitized?
- which attributes are to be assigned to the objects?
- according to what systematics should the attributes be stored?
- what is the minimum area of objects to be digitized?

The contents of the basic object knowledge were already discussed in Chapter Five.

During the work, which was done by various people, a log was kept to record details and comments.

14. Retrieval of external data

Two digital map files could be retrieved from external sources: the soil and water table map and the *LGN* data (Landcover Inventory of the Netherlands). More information about these was given in chapter five. The retrieval of data from external sources took a long time. An important lesson is that negotiations and procedures to retrieve external data should be started as early as possible[11].

15. Structuring, digitizing and pre-processing vector and raster data

Within the process of plan generating the spatial models were constructed as raster maps. The process of correcting and transforming the 'coarse' data into the required raster format demanded time and inventiveness. Arc-Info* and GeoPackage specialists were consulted to find out the most efficient way to handle the large data files. Part of the digital data were used in student projects, which detailed and supplemented the phase of description (activity 7).

The digitization process of the topographical map is described in flow chart 1.3.1, Appendix II. The area of digitized infrastructure and streams was 771 km^2. It took 60 hours to digitize this. The complete topography, 1:25,000 of the catchment area of the Reusel was digitized (165 km^2., time taken: 155 hours[12]).

Looking back at the case study, it can be concluded that of the topographical data only the linear objects (streams and infrastructure) and the built-up areas were actually used. The land cover inventory which became available later, gave sufficient information on the land use for the case study to be carried out[13]. This experience stresses the importance of considering carefully *which data* have to be digitized and to *what extent*, before starting a laborious digitizing exercise!

The digitization process of the geomorphological map is described in flow chart 1.3.2, Appendix II[14]. The geomorphological map was unfolded into three layers, because of the complexity of the map. Each layer was digitized separately and merged before rasterizing.

The soil and water table data derived from the 1:50,000 soil map, were retrieved as an Arc-Info export file. The maps were transformed to vector files for the GeoPackage software (module: GeoDIG) and subsequently rasterized with the GeoPackage (module GeoMAP): flowchart 1.3.3, Appendix II. Because the files were too large to be transformed to the GeoDIG format, they had to be divided into layers, which were rasterized separately and merged using the GeoMAP module. The highly detailed soil and water table maps were generalized.

A different approach was followed for the land cover inventory (*LGN*). The binary data 25x25 data were rasterized to the Arc-Info .SVF 100x100 raster files[15)] and transformed to GeoPackage raster files. The processing of the *LGN* files is described in flow chart 1.3.4, Appendix II.

16. Developing planning goals and criteria
Planning goals and criteria can be regarded as very concrete normative knowledge. They form the basis of the plan-generating phase, in which future spatial models are developed to serve as a goal of the plan generating. Some of these goals are developed during the plan generating itself. The activities during which the plans were generated with the help of GIS were registered in the macro command files. The goals and criteria were stated in these command files.

17. Strategy for the developing of spatial models
With this activity the actual phase of plan generating started. In this phase, the data prepared during activities 11 to 15, were processed with the GIS software. Plan generating is a process of alternating analyzing and constructing activities, in which evaluating activities can be regarded as similar to analyzing activities.
Each planning statement was converted into one or more questions about the area, which had to be answered during the analysis. The questions were characterized by *What?*, *Where?* and *How?*. 'What?' referred to the subject of the statement, 'Where?' related to its location, and 'How?' to the (spatial)measures that had to be taken to meet the goal that had been formulated.
For example, the statement 'The competitiveness of strong branches of agriculture in a free-market economy should be strengthened' led to the following questions:
- *What are the strong branches of agriculture in the area?*
- *Where are they?*
- *How can their competitiveness be strengthened?*

The latter question not only concerns spatial policy, but also refers to other sectoral policies. Spatial measures involve the organization and layout of an area at a more detailed level than this research. Criteria must be formulated so that these questions can be answered. The statements, questions and criteria are noted as comments in the command files which describe the GIS methods used. For each statement was determined:
- which data and information were necessary to carry out the analysis,
- how the data had to be combined to answer the questions raised by the analysis.

18. Gathering information
If activity 17 revealed that the information resulting from activity 7 was insufficient to perform the analysis, additional information was collected. This additional information concerned:
- knowledge regarding the social aspects: agricultural-economic;

and knowledge regarding the physical and spatial aspects:
- soil suitability (abiotic);

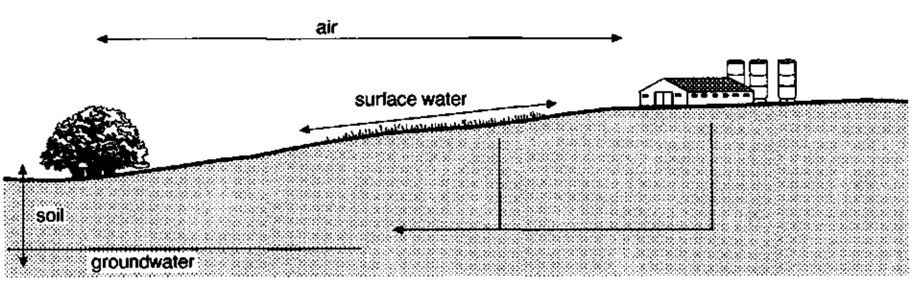
- ecological potencies (biotic).

19. Analysis
The GIS processes during which the data were analyzed, are described by flow charts 1.4.1 and 1.4.2, Appendix II.

Analysis of the anthropocentric notion (see: flow chart 1.4.1, Appendix II)
Data used in the analysis:
maps: municipal boundaries;
LGN land cover inventory;
soil and water tables;
statistics: agricultural production / municipality (SBE)[16]
average farm size / municipality (SBE)
area of agricultural land / municipality (Ha)
The statistics were retrieved at the municipal level and later detailed with the help of the land cover data.

Analysis of the ecocentric notion (see: flow chart 1.4.2, Appendix II)
A list of ten ecotopes, each described by its vegetation and its physiology, was drawn up on the basis of the ecological knowledge that was collected. For each of these ecotopes it was determined where the physical conditions in the study area were suitable for that to develop.
This suitability was determined by vertical and horizontal relations (Figure 7.2). The soil, groundwater level and land use in a specific area represented the vertical relations. Agricultural areas influence ecotopes by horizontal relations via air, surface water and groundwater. This horizontal relation was translated into a zoning around the ecotopes.

Figure 7.2 Potencies depend on horizontal or vertical relations



20. Description of the results

The results of the analysis were presented as maps, an activity described in flow chart 1.5, Appendix II. For presentation purposes, the legends and colours of the maps had to be modified. The procedures and criteria used were described.
In the case study, the procedures of the construction followed immediately after the analysis. Although analysis and construction are separated in this description, in reality they were closely connected.

21. Evaluation of the results of the analysis

The economic and biological aspects of the evaluation were discussed with experts. These evaluative discussions are not described in this thesis.

22. Strategy for the plan construction

The strategy for the construction phase was mainly based on the normative statements resulting from activity 16. The plan construction was a learning process, of experimenting and exploring. Decisions about the process were often made while carrying out the process. Occasionally, new criteria had to be formulated. During the construction phase the GIS must have optimal flexibility, as it is in this phase that there is maximum interaction between software and planner. Each GIS command resulted in an intermediate map, which was evaluated and interpreted by the planner on the screen. The option of evaluating each step with the help of a map visualization on the screen proved to be indispensable. The following cyclic procedure was carried out for each map:

- formulating planning criteria and goals;
- choice of GIS technique to manipulate the data;
- processing the data with the GIS software;
- on-screen evaluation of the map and if not satisfactory: modifying the criteria or goals.

The GIS technique consisted of one or more GIS commands.

23. Obtaining oral and written information

The information from earlier stages of orientation was supplemented with:

- an orientation on criteria used by the Province of Noord-Brabant when making regional plans;
- consulting experts about which criteria and options should be explored during the plan construction.

24. Processing data and construction

The GIS procedures of the plan construction are described in flow charts 1.6 of Appendix II. The criteria and goals developed in activity 16 formed the normative base of the plan construction. Some of this normative knowledge was a spin-off from the plan construction, as some of the goals and criteria were developed during this activity.

25. Presentation

The resulting maps were transformed to the Arc-Info software, in which the final lay-out was determined. The presentation with the help of the GIS is described in flow chart 1.7, Appendix II.

26. Reflection

The resulting maps were discussed with disciplinary experts. The outcome of this discussion contributed to Chapter Eight.

27. Choosing the aspects to be evaluated

The plans were evaluated on three aspects:
- the area of land available for the various types of land use;
- financial implications of the reconstruction of the area, based on the report of Groen, Bosveld and Ottens (1989);
- implications for the agricultural production of the area.

The results of this evaluation can be found in Chapter Eight.
Multi-Criteria Evaluation methods would have been useful for more elaborate evaluation.

28. Orientation on literature and available data

The literature was studied to find information about the costs of spatial changes. Data from the National Bureau of Statistics (CBS) were consulted and current statistics on the branches of agriculture in the area were ordered.

29. Analysis

The GIS procedure for the analysis of the plans in this activity is described in flow chart 1.8, Appendix II.

30. Reporting the evaluation results

The results of the evaluation were presented in a table, which was the output of spreadsheet software.

31. Reflection on the evaluation results

In this final stage the resulting plans are assessed in the light of the intentions which formed the basis of the plan. In Chapter Eight the resulting plans are described and the costs of implementing them estimated roughly.

This was the last activity in the planning process. The resulting plans can only be considered as intermediate results. In a complete planning process there would then be three options:

a. The plan construction could start again, with various activities: gathering additional data, more analysis or modifying goals and criteria.
b. Earlier phases could be repeated by developing new intentions, descriptions, interpretations or concrete intentions, or modifying existing ones.

c. If the spatial models are found suitable for the decision-making phase, the intentions and spatial models can be subjected to broad discussion.

A complete planning process will pass through several cycles before the final plans are established and ready for the decision-making process.

7.3 A closer look at the analysis and construction

The GIS was mostly used during activities 19 (analysis) and 24 (construction). This justifies a more detailed description of how knowledge was integrated during these activities, and how new knowledge was developed.

In this section I will elaborate upon the most concrete type of normative knowledge, the planning goals and criteria and the new intermediate object knowledge generated during the process. Table 7.1 illustrates the knowledge categories related to analysis and construction, which are discussed in this chapter. The normative knowledge, i.e. the planning goals and criteria, is described in this section, but only the newly developed object knowledge is mentioned (the maps shown in figures 7.5-7.42 are mentioned in the table, the basic object knowledge was described Chapter Five). The methods and techniques (the 'method knowledge', i.e. flow charts 4 and 6) are described in Appendix II. Appendix III describes the relations between the object knowledge, the method knowledge and the normative knowledge.

As described under activity 17, each statement was broken down into three questions: *What? Where?* and *How?*. The *Where?* question is described on maps which form the result of a GIS action. These maps are shown in the figures 7.5-7.42. All maps are related to a planning goal. The map names are given next to the 'where' questions, below.

Planning goals and maps of the anthropocentric intention

1. Strengthening strong agricultural areas

The position for competitiveness of strong branches of agriculture has to be strengthened. *(ANPLA1)*

what: The following criteria were employed as indicators of economic strength, partly based on comparable indicators used by the province when planning[17]:

- the share of the municipal production of the provincial production, two classes:
  a. large: >=1% of the provincial production;
  b. small: <1% of the provincial production
- the average farm size per municipality, three classes[18]:
  a. small farms: x < provincial mean - 15%
  b. moderate farms: provincial mean - 15% =< x =< provincial mean + 15%
  c. big farms: x > provincial mean + 15%

Table 7.1 Classification of the knowledge used at the analysis, activity 19, and the construction, activity 24.

Normative knowledge (planning goals)	Method knowledge (MCF files)	Object knowledge (maps)
ANPLA1	ANLA1	MEPROV, IVPROV, BOPROV
	ANLA2	MEBEDRK, IVBEDRK, AKBEDRK, BOBEDRK
	ANLA3	MEINTK, IVINTK
	ANLA4, AGRGB1	AKSTERK, IVSTERK, BOSTERK, OTSTERK, GLSTERK
	AGRGB2, TMP, AGRGB3	MESTGB3, IVSTGB3, BOSTGB3
ANPLA2	GESCH	-
	EXPTMP	-
	EXPROD	-
	EXPROD3	DGESAN
	EXPROD5	EXPROD
ECPLA1	ECOSTR	GEOMBE, BEEKZO, ECOBEK, ECOBEK5
ECPLA2, ECPLA3	ECOVEN	ECOVEN
ECPLA4, ECPLA5	ECOVEE	ECOVEE
ECPLA6, ECPLA7	ECOHEI, ECOHEI2	NHEI3, HEIDEN
ECPLA8	ECOZAN	STUIFZA
ECPLA9	ECOBOS, ECOBOSX	INBO
ECPLA10	ECOBOS3	BOZON
ECPLA11	ECOWAL	HOUTW
ECPLA12	ECOJEN	JEBESZ
ECPLA13	ECOSTR	AVOE, AGWT, STRUWEEL
ECPLA14	ECOGRA	GRAZUIN, WVGRAS, WVGRAS1
ECPLA15	-	-

- the average intensity (SBE/hectare) of the farms per municipality, three classes[19]:
  a. low intensity: $x <$ regional mean - 15%
  b. moderate intensity: regional mean - 15% $=< x =<$ regional mean + 15%
  c. high intensity: $x >$ regional mean + 15%

Areas were classified per branch of agriculture as follows:

very strong = in the highest class for all three criteria;
strong = in the highest class for one or two criteria;
moderate = at least one moderate class, nowhere a highest class;
weak = lowest class for all three criteria;

To derive the agricultural strength for the areas, the classification was integrated per branch. Areas which scored at least one 'strong' or 'very strong' in a branch were regarded as 'strong agricultural area'.

where?: maps: MEPROV, MEBDERK, MEINTK, MESTREK
IVPROV, IVBEDRK, IVINTK, IVSTERK
BOPROV, BOBEDRK, BOSTERK
OTSTERK, GLSTERK, AKSTERK

During the planning process the whole study area emerged as satisfying the criteria of 'strong agricultural area'. In order to maintain the option for nature development by withdrawing agricultural land, an extra criterion was introduced: The agricultural production structure in the area will only be strengthened for the branches: intensive husbandry, dairy farming and nurseries[20)].

where: maps: MESTGB3, IVSTGB3, BOSTGB3

how: The strong and moderate areas will be improved for the benefit of the strong agricultural branches present in the area by land development and agricultural engineering. In the weak areas, the circumstances of the branch of agriculture can be modified to benefit recreational functions or nature.

2. Nature development

Nature will be developed in areas which can be withdrawn from agricultural production. *(ANPLA2)*

what: Soils which are unsuitable or marginally suitable for agricultural land use and which are in weak agricultural areas will be withdrawn from agriculture. The suitability is determined as suitability for grassland and for arable farming, according to suitability tables included in the soil maps. The following assumptions were made regarding the suitability: suitability of grassland corresponds to suitability for dairy farming, suitability of arable land corresponds to suitability for intensive husbandry (maize growing) and nurseries. Only actual grassland will be withdrawn from production, as arable farming is more profitable and is needed for the production of maize.

where: maps: DGESAN, EXPROD

how: The grassland which can be withdrawn from the agricultural land, can be developed and organized as nature. No detailed lay-out of the nature area was made in this study, however for an example of how this could be done, see de Craen (1992), who has developed several scenarios for nature development in the area.

3. Integration
Strengthening the economic position of agriculture and nature development within the limits of agricultural production (Map Figure 8.1, see also Chapter Eight).

Planning goals and maps of the ecocentric intention

The principal planning goal of the ecocentric intention is to integrate nature, landscape and agriculture within the constraints of the functioning of natural ecosystems. The following ecotopes were considered:

1. streams and stream valleys
2. fens
3. peat
4. ecotopes for heather
5. sand dunes (i.e. sands that are still moving)
6. woodland
7. hedges and wooded banks ('*houtwallen*')*
8. ecotopes for juniper[21)]
9. ecotopes for shrubs
10. meadows

The demands which the ecotopes make of the abiotic subsystem were derived from literature (Bink et al., 1979). The goals that formed the basis for the planning were described for each ecotope.

1. Streams and stream valleys
Streams will regain their natural meandering course. The stream valleys will contain groves of trees, shrubs and grassland. *(ECPLA1)*
what: Stream valleys are the geomorphological areas 'stream beds, flood plains, and stream banks' within the boundaries of the nearest paved roads on both sides of the streams. Streams in nature areas are regarded as the most valuable.
where: maps: GEOMBE, BEEKZO, ECOBEK, ECOBEK5
how: Restructuring and removing artificial obstacles in the streams, extensive management of the grasslands.

2. Fens
Isolated fens are potentially oligotrophic and need special protection. *(ECPLA2)*
what: Water indicated as 'fen' on the topographical map is regarded as such. Fens at a minimum distance of 200 metres from streams are regarded as isolated.
how: The agricultural activities will be restricted within a zone of 500 metres around these fens.

Management around fens has to be directed at the maintenance of fens. *(ECPLA3)*
what: Water indicated as 'fen' on the topographical map is regarded as such.
where: maps: ECOVEN

how: Any agriculture within a zone of 500 metres around fens has to be ecological agriculture. Nature management within a zone of 100 metres has to be subservient to the maintenance of fens, e.g. the zone has to be kept free of trees.

3. Peat and marshes

Peat and marshes have to be encouraged to develop. *(ECPLA4)*
what: Wet areas will be encouraged to develop as peat and marshes.
how: The water table in the areas will be raised, and parts will be dug off.

Actual and potential peat are not to be affected by agricultural activities. *(ECPL-A5)*
what: The soil units V and W are regarded as actual peat. These areas are combined with the peaty areas which will be developed as such.
where: maps: ECOVEE
how: Around the selected areas a zone of 500 m will be created in which agriculture must be ecological agriculture.

4. Ecotopes for heath

Actual heathland has to be maintained by sheep grazing. *(ECPLA6)*
what: Actual heathland can be *Erica tetralix* or *Calluna vulgaris*. The land-use 'heathland' on the *LGN* map is regarded as the actual heather. *Calluna vulgaris* occurs on the soil units[22]: *Haarpodzolen* (Hd21), *Holtpodzolen* (Y23) and *Duinvaaggronden* (Zd21). *Erica tetralix* occurs on the soil units: *Veldpodzolen* (Hn23, Hn30), *Moerige Podzolen* (kWp,zWp).
In order to sustain a large flock of sheep (about 500 animals), there must be at least 500 ha of heather within a limited radius in a certain area.
how: Heathland which is too small will be enlarged, at the cost of agricultural land.

Heathland is not to be threatened by agricultural activities. *(ECPLA7)*
what: Actual heathland on the LGN map and the extension of existing heathland are taken into account.
where: maps: NHEI3, HEIDEN
how: Around the heathland a 500 metre zone will be created in which existing agriculture must be transformed into ecological agriculture.

5. Active dunes

Existing active dunes have to be maintained; potential active dunes have to be encouraged to develop. *(ECPLA8)*
what: Soil units: *Vlakvaaggronden*, Zn21, *Duinvaaggronden*, Zd21, and *Vorstvaaggronden* Zb21 combined with the land-use 'bare soil' from the *LGN* map, are regarded as potential active dunes. The geomorphological unit 'sand dune' is regarded as actual active dunes.
where: maps: STUIFZA

how: The selected existing and potential active dunes are indicated as such on the map and managed accordingly.

6. Woodland

Woodland ecosystems are not to be threatened by agricultural activities. *(ECPLA9)*

what: The land use 'deciduous woodland' and 'coniferous woodland' on the *LGN* map is assumed to be a woodland ecosystem;

where: maps: INBO

how: Around woodland lying in water infiltration areas a 500 metre protection zone will be created, in which existing agriculture should adopt the methods of ecological agriculture.

The diversity of woodland margins has to be stimulated by grazing. *(ECPLA10)*

what: Pine and deciduous woodlands on the *LGN* map which are larger than 100 ha have margins large enough to support grazing.

where: maps: BOZON

how: A 200 metre zone within the selected woodland will be reserved for grazing.

7. Hedges and Wooded Banks ('houtwallen')

In areas with a small-scale landscape, wooded banks and hedges (*'houtwallen'*) will be further developed. These features can be best developed at boundaries between different types of agricultural land use on the *LGN* map and alongside water, roads and built-up areas. *(ECPLA11)*

what: The density of these edges determines an area's suitability for the development of wooded banks and hedges. The areas have to be larger than 100 ha.

where: maps: HOUTW

how: The edges within the selected areas will be developed.

8. Ecotopes for Juniper

The evolution of Juniper will be stimulated. These areas are not to be threatened by agricultural activities. *(ECPLA12)*

what: Areas suitable for juniper are areas indicated as heathland and sands from the *LGN* map, and as soils which are dry, acid and infertile on the soil map. Soil types: Zn21, Zn23, Zd21, Zb21, Zb23, with water table: GWT IV,V,VI,VII.

where: maps: JEBESZ

how: On the selected areas juniper will be reintroduced. Agriculture within a 500 metre zone round the areas will have to be ecological.

9. Ecotopes for shrubs

Shrubs will be allowed to develop, as they contribute to valuable ecosystems with high diversity. *(ECPLA13)*

what: Thorny shrubs (e.g. brambles) can develop on dry, fertile soils, marsh shrubs (alder: Alneta Glutinosae, reed) can be developed on wet fertile and infertile soils, broom (Sarothamnus scoparius) can be allowed to develop on dry, infertile soils. Shrubs can be allowed to develop at the edge of nature areas and pasture.

Fertile soils are: V, W, H, E, pZ, *Z, A, R pL[23)]

Infertile soils: Z

where: maps: AVOE, AGWT, STRUWEEL

how: Shrubs will only be allowed to develop in a selected area. Only marsh shrubs and broom will be allowed to develop.

10. Meadows

Natural meadows and herb vegetation will be encouraged to develop. *(ECPLA14)*

what: The best prospects for developing natural meadows are offered by gradations: dry-wet, fertile-infertile soil, calcareous-neutral/acid soils, agriculture-nature. Grassland on southerly-facing areas is most species rich.

where: maps: GRAZUIN, WVGRAS, WVGRAS1

how: Areas which contain all four of the gradations mentioned above will be managed as natural meadows.

11. Agriculture

Areas not claimed by the ecotopes described above are left for agriculture. *(ECPLA15)*

what: Historical arable grounds ('Enkeerdgronden' EZ, (eng.: plaggensol)) will be used for arable farming, because of their suitability and cultural value; other land will be used for pasture for dairy and beef cattle.

how: These areas are reserved for agricultural activities which are in balance with their environment, which leaves no room for intensive husbandry.

12. Integration

Integration of ecotopes, based on priorities[24)] and agricultural production within ecological and cultural and historical limits.

what: The individual ecoptopes were combined according to a priority list based on a tolerance matrix that indicated the feasibility of combining ecotopes (Maps: Figures 8.2 and 8.3, see also Chapter Eight).

Notes

1. A definition of 'methods and techniques' was given in note 10, Chapter Two: a collection of prescriptions and rules which are employed in reality (descriptive) or which should be used (prescriptive). 'Techniques' were defined as:
   - means, possibly instruments, to perfom methods;
   - aids which are used, or skills which should be learned to perform methods.
2. For a definition of theoretical and formal models see section 2.1.

3. Dessing (1979) made a broad inventory of methods used in Dutch physical planning. She describes 192 methods, and characterizes each method according to:
   1. Scientific function;
   2. Property of the method;
   3. Phase in the planning process, during which the method can be employed;
   4. The activities of the process which can be carried out, using the method.
4. Foqué (1975) discerns five types of methods.
   1. Reconnaissance methods e.g. Literature Searching.
   2. Methods that make intuition explicit e.g. Writing, Brainstorming (Delphi method).
   3. Systematic methods e.g. input-output analysis.
   4. Catalysing methods e.g. Interaction Matrix.
   5. Strategic Control.
5. Jones (1974) discerns six groups of methods.
   1. Prefabricated strategies, e.g. Value Analysis, Boundary Searching.
   2. Strategy Control Methods.
   3. Methods of exploring design situations e.g. Literature Search, Questionnaires.
   4. Methods of searching for ideas e.g. Brainstorming.
   5. Methods of exploring problem structure e.g. Interaction Matrix.
   6. Methods of evaluation e.g. Checklists, Ranking and Weighting.
6. In the case study, these command files were 'MCF-files', which are files for registration and commands of the GeoPackage. Comparable in the Arc-Info package are the 'AML' (Arc-Info Macro Language) files.
7. An overview of the literature which formed the basis for the normative knowledge is given in note 1, Chapter Six.
8. The comparable studies examined were the studies of the Scientific Policy Council (WRR, 1980 and 1983) and the *NNAO* (van der Cammen ed., 1987).
9. The following student projects contributed to the analysis of the area:
   Cleveringa, R. and D. Keeman (1990), *Het Ris in opmars*, which describes the application of GIS in the analysis of ecological aspects;
   Buysman, J. (1991), *Toepassingsmogelijkheden van GIS bij de ruimtelijke planning van recreatie*, which describes the application of GIS at the planning of recreation;
   Leeuw, P.H. de (1991), *Beleidsondersteuning door een informatiesysteem*, which describes the setting up of an information system to analyze and handle the environmental problems caused by intensive husbandry.
10. *KADROKAART* forms a part of the *INSYRON* system, an information system of the national planning agency, for spatial planning in the Netherlands. It gives a registration of elements which are of relevance to spatial planning.
11. No funds were available for the case study, so the acquisition of data depended on the benevolence of the owners of the data.
   The soil map was acquired through the Province of Noord-Brabant, from the Winand Staring Centre, Wageningen. The Province had passed the data to a consultancy, TNO-Delft, for a study commissioned by the Province. To retrieve the data the Province had to receive the data from TNO and hand them over to the Department of Physical Planning. This transaction had to be approved by the Winand Staring Centre. This procedure took about one year.
   To retrieve the *LGN* data, an agreement between the Centre for Geographic Information processing and the Winand Staring Centre had to be signed. Eighteen months elapsed between the moment it was concluded that the data were necessary and the moment of receipt.
12. The digitizing was carried out by M. Penning, L. van den Aarsen, J. van Nieuwenhuize and R. Eweg.
13. Note that the case study concerned the development of spatial models at a regional level. The maps that were processed and produced had a grid size of 100 m^2.
   More detailed planning applications may require more accurate information about land use or the

boundaries of objects and plots. This can be obtained by combining topographical information and land cover information derived from satellites. More about these applications can be read in:

- Janssen, L.L.F., M.N. Jaarsma and E.T.M. van der Linden (1990), Integrating Topographic Data with Remote Sensing for Land-Cover Classification, *Photogrammetric Engineering and Remote Sensing*, Vol. 56, No. 11, pp 1503-1506.
- Molenaar, M. and L.L.F. Janssen (1991), Integrated Processing of Remotely Sensed and Geographic Data for Land Inventory Purposes, *Proceedings of ACSN/ASPRS/Autocarto* 10, Baltimore, Maryland, USA, March 1991, pp 75-90.
- Janssen L.L.F. and D.M. Keeman (1992), *Integration of Remotely Sensed Data and Cadastral Ownership Boundaries for Land Inventory Purposes*. Department of Surveying and Remote Sensing, Wageningen Agricultural University.

14.The geomorphological map was digitized by R. Braat, M. Buil and P.H. de Leeuw.

15. .SVF is the extension of grid files of the Arc-Info software.

16.In the Netherlands, SBE was used until 1988 as a standard unit to describe the size of farms. The unit is derived from the labour, area and capital attached to a specified animal type or crop.

17.The provincial authorities used a comparable classification for the selection of important agricultural areas when developping their regional plan (Provincie Noord-Brabant, 1990III).
Areas which produced at least 1% of the provincial production were regarded as important areas. For smaller branches of agriculture the province raised this percentage to 3%. The province classified the intensity, which was expressed in sbe per hectare, using a lower limit of 1.31 times the provincial average for dairy farming and intensive husbandry, and a lower limit of 3.93 times the provincial average for other branches of agriculture. The farm size was not taken into account.

18.The choice of the class boundaries was arbitrary, although specialists were consulted.

19.The intensity was calculated by assigning all the grassland to dairy farming. The maize land had to be divided among dairy farming and intensive husbandry; this was done using the empirical formula given by 't Jong (1989) who determines the acreage maize which should be assigned to dairy farming as 0.11% of the acreage of the grass land. The acreage of the maize which has to be assigned to the intensive husbandry equals the total acreage of maize minus the acreage of the maize assigned to dairy farming.
The regional average intensity is the summation of animals within the study area divided by the acreage of grass land and/or maize. The intensity was only calculated for dairy farming and intensive husbandry. No information about the acreage of grass was available for the municipalities Alphen & Riel and Baarle Nassau, thus the intensity is not reliable for these municipalities.

20.Dairy farming and intensive husbandry are the most important contributors to the export of agricultural products. At the national level the province of Noord-Brabant is an important producer in dairy farming, intensive husbandry and nursery products. The most important areas of the province for greenhouses, market gardening and arable farming are not present in the study area.

21.Juniper (*Juniperus Communis*) in the Netherlands is a shrub of high cultural-historic value. The Juniper shrubs are the result of a period of intensive grazing of heaths by sheep and the abrubt end of this practice by the end of the ninetheenth century. Juniper shrubs form ecotopes with an abundance of plant species, mosses, lichen and mushrooms.

22.For a translation of the Dutch soil classification terminology into the Soil Map of the World and the Soil Map of Europe, see Appendix I.

23.The most common of these soils are described in Appendix I.

24.The integration of the ecotopes and vegetation types was based on the succeeding priorities:

1. Streams
2. Enlargement of heathland
4. Marsh shrubs
5. Peat on non-agricultural land
6. Broom shrubs
7. Stream valleys in nature areas
8. very valuable meadows
9. Grazing zones of woodlands

Figure 7.5 Dairy farming (production)
meprov

Figure 7.6 Dairy farming (farms)
mebedrk

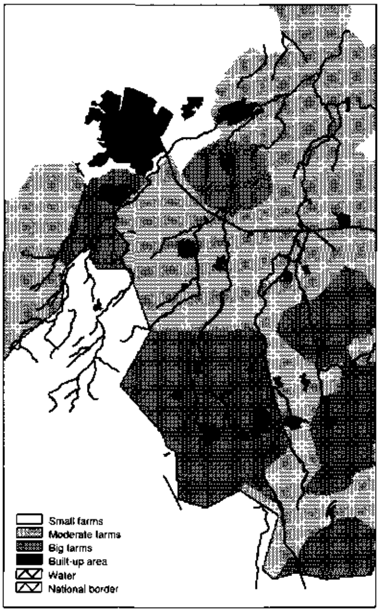


Figure 7.7 Dairy farming (intensity)
meintk

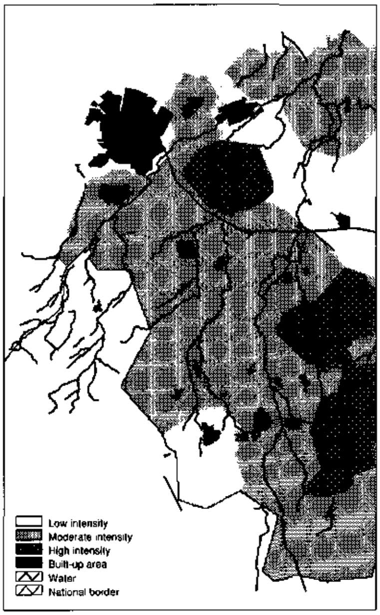


Figure 7.8 Dairy farming (strength)
mesterk

Figure 7.9 Intensive husbandry (production)
ivprov

Figure 7.10 Intensive husbandry (farms)
ivbedrk

Figure 7.11 Intensive husbandry (intensity)
ivintk

Figure 7.12 Intensive husbandry (strength)
ivsterk

Figure 7.13 Nursery (production)
boprov

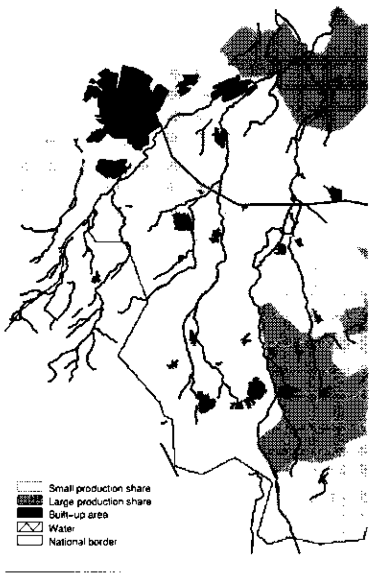


Figure 7.14 Nursery (farms)
bobedrk

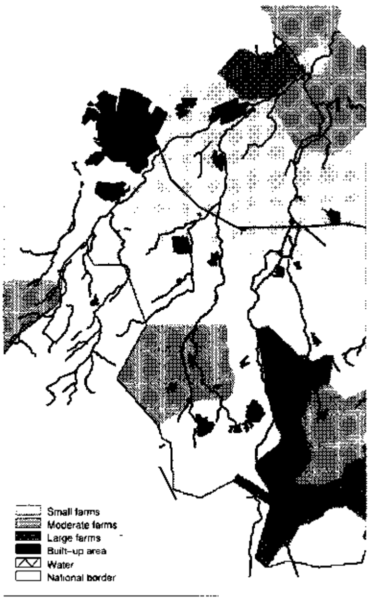


Figure 7.15 Nursery (strength)
bosterk

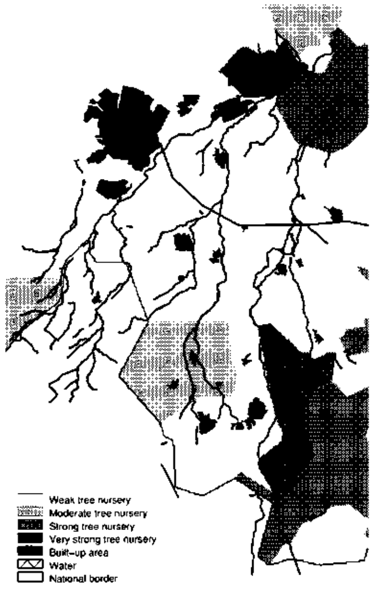


Figure 7.16 Market gardening (strength)
otsterk

Figure 7.17 Greenhouses (strength)
glsterk

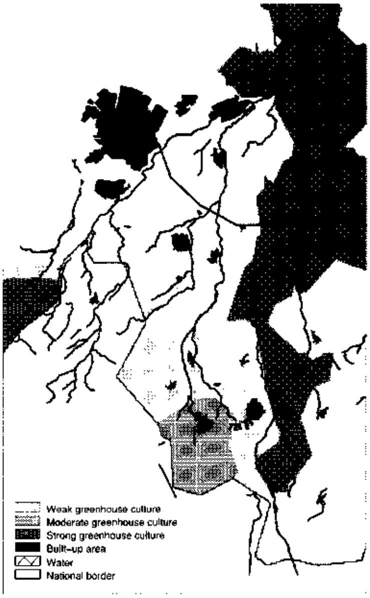


Figure 7.18 Arable farming (strength)
aksterk

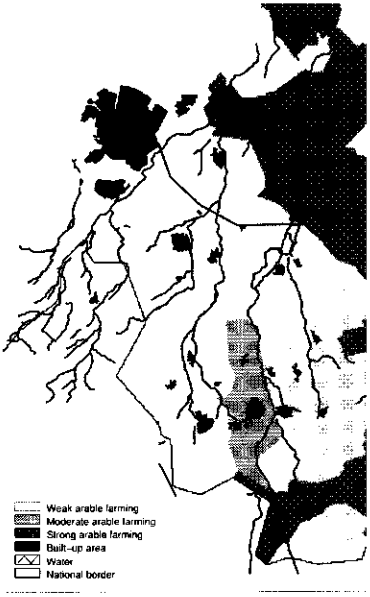


Figure 7.19 Strong areas - dairy farming
mestgb3g

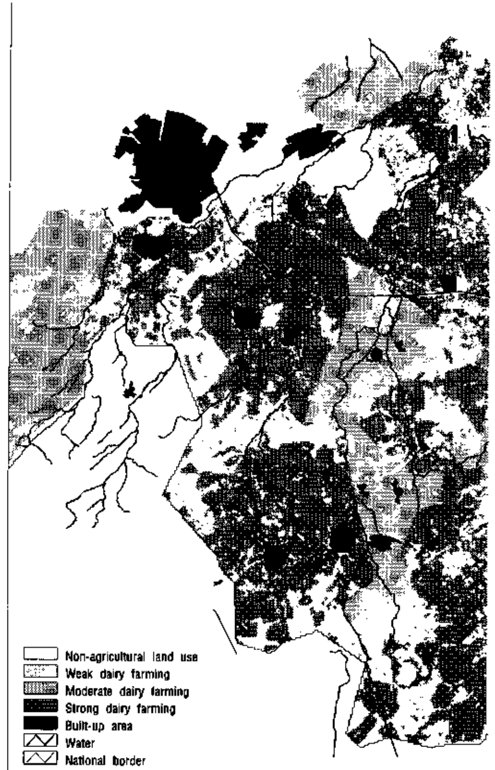


Figure 7.20 Strong areas - intensive husbandry
ivstgrid

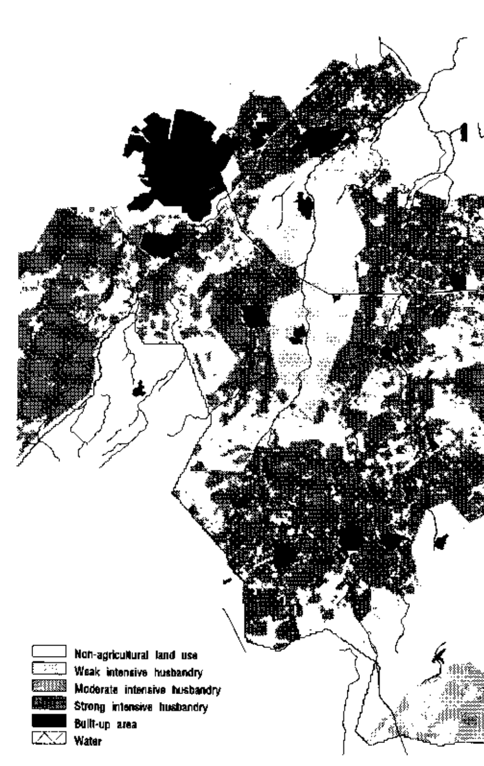
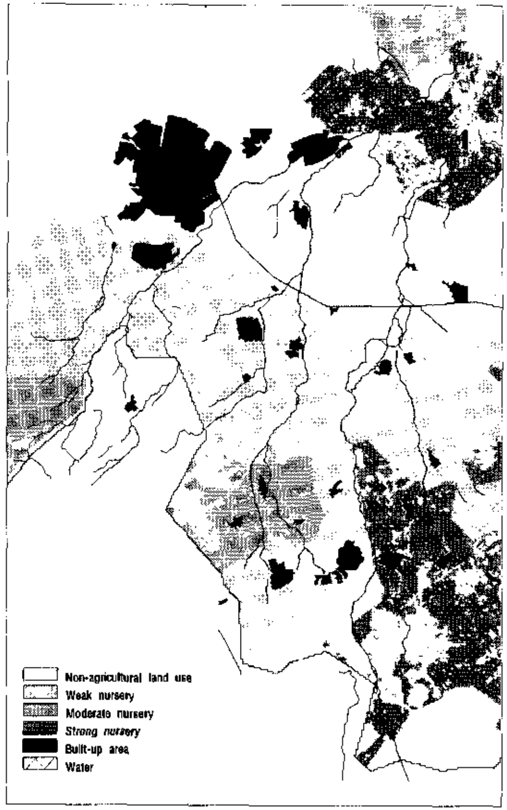


Figure 7.21 Strong areas - nursery
bostgrid



Unsuitable ground in 'weak' agricultural areas
dgesan

Figure 7.23Grassland withdrawn
exprod

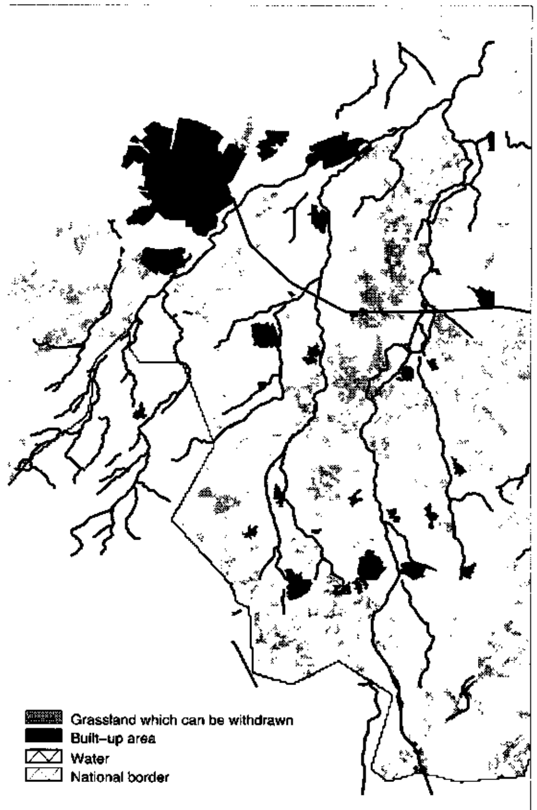


Figure 7.24Zones around streams
beekzogr

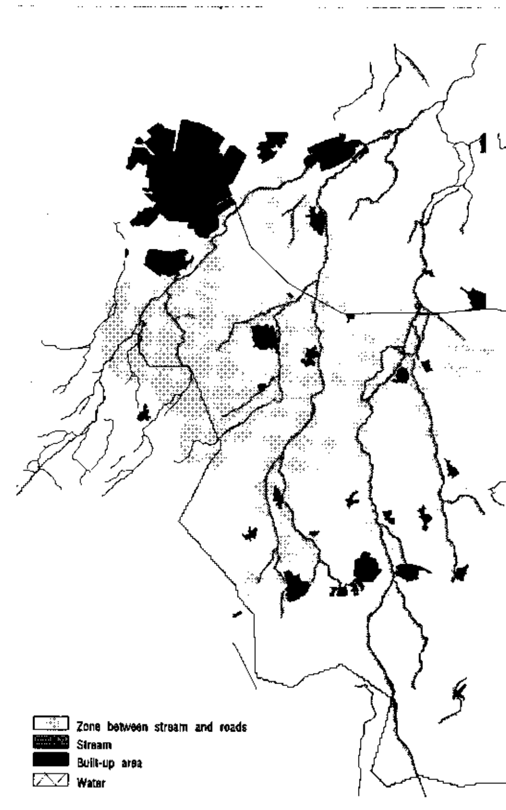


Figure 7.25Stream valleys
geombe

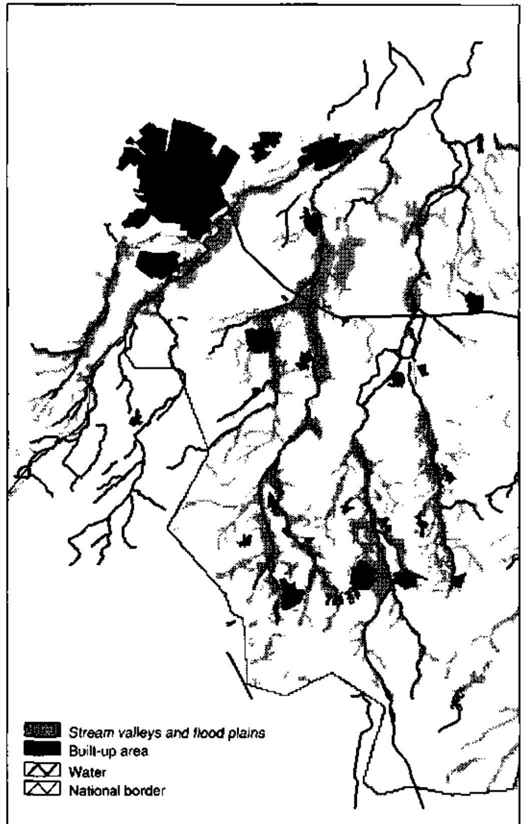


Figure 7.26Landuse of streamvalleys
ecobek

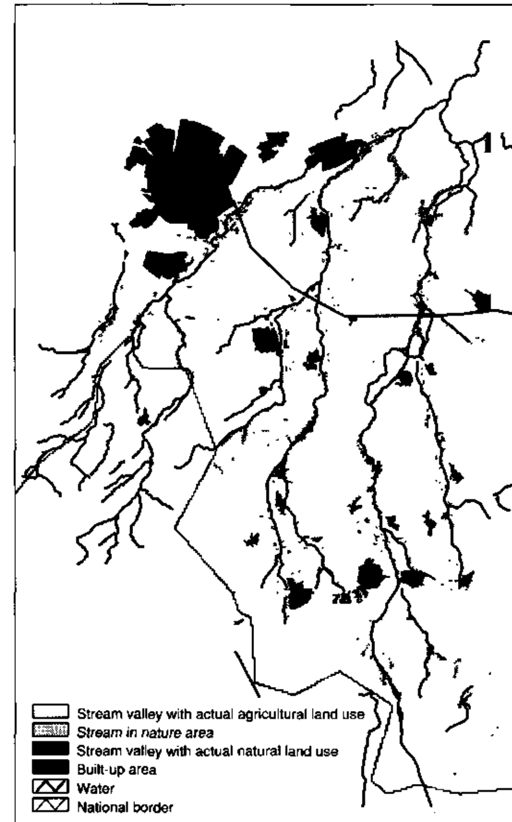


Figure 7.27Landuse of stream valleys
ecobek5

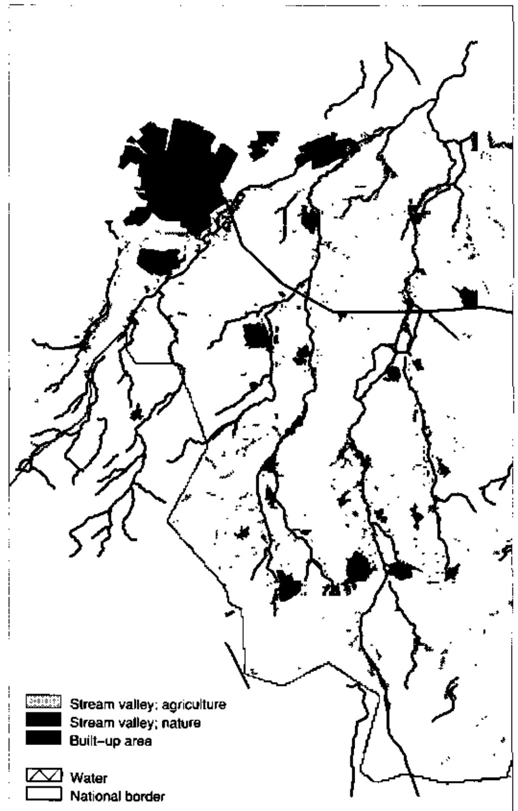


Figure 7.28Fens and zones
ecoven

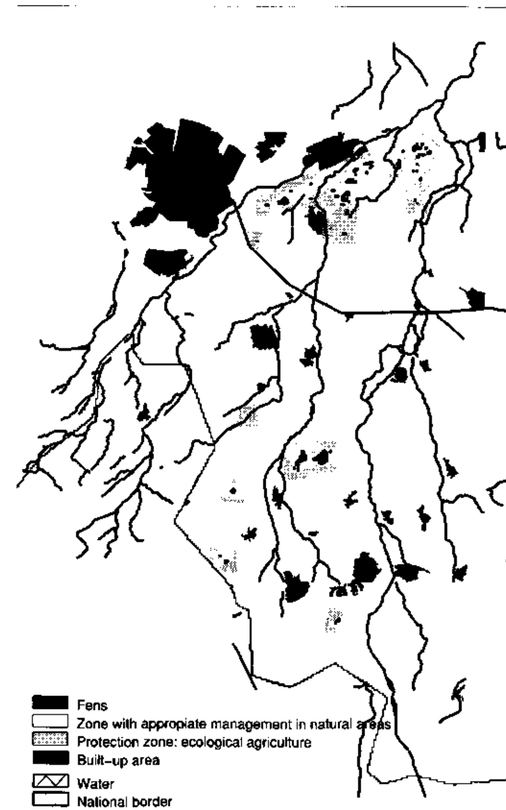


Figure 7.29Peat and zones
ecovee

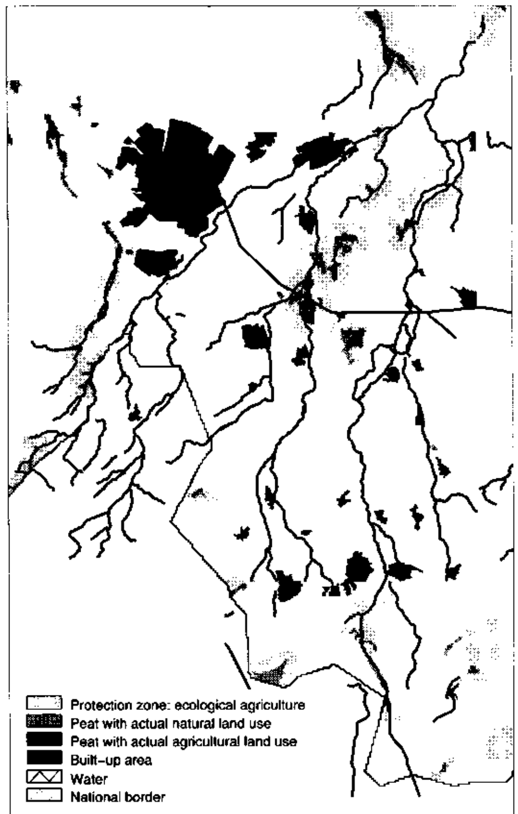


Figure 7.30Interactive design of heath
nhei3

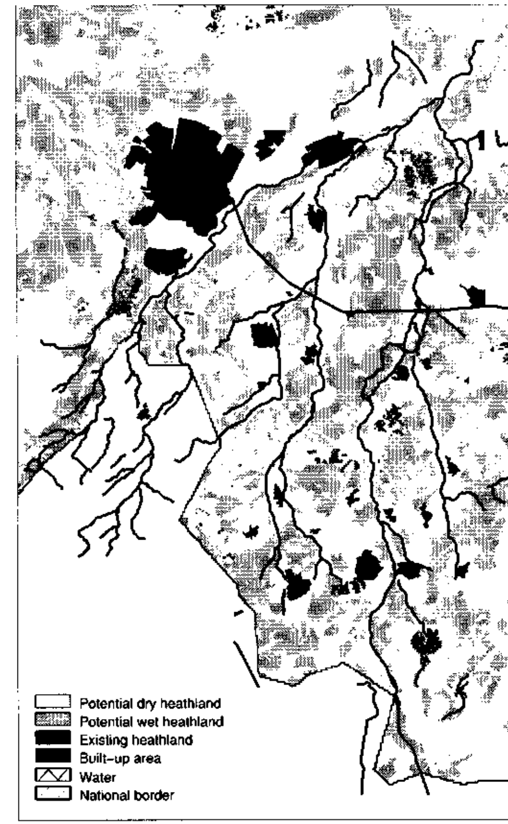


Figure 7.31New and existing heathland
heiden

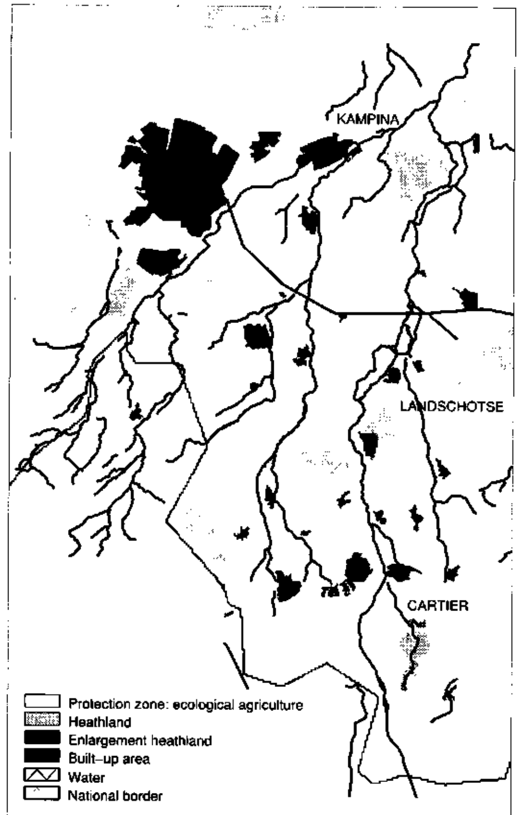


Figure 7.32 Sand dunes
stuifza

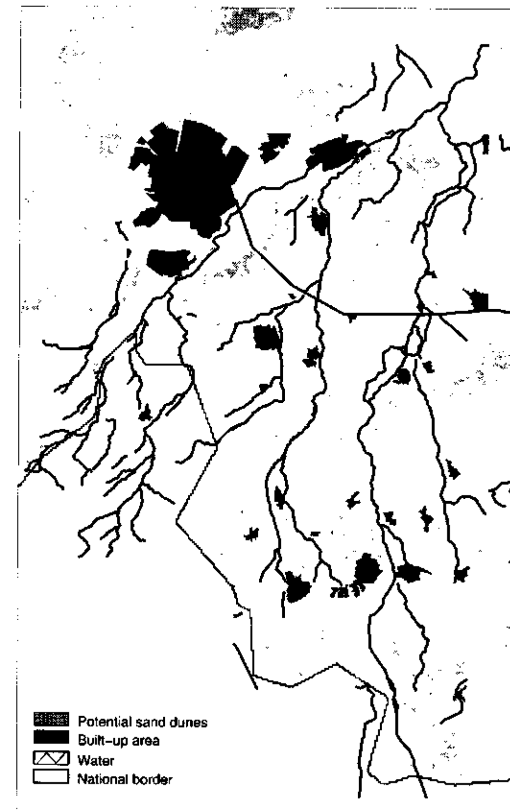


Figure 7.33 Woodlands and zones inbo

Figure 7.34 Grazing zones in woodlands bozon

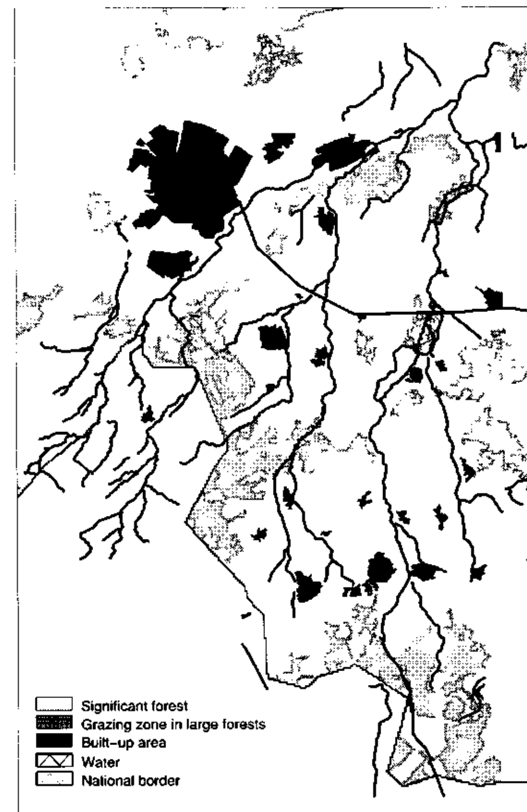


Figure 7.35 Development 'houtwallen'
houtw

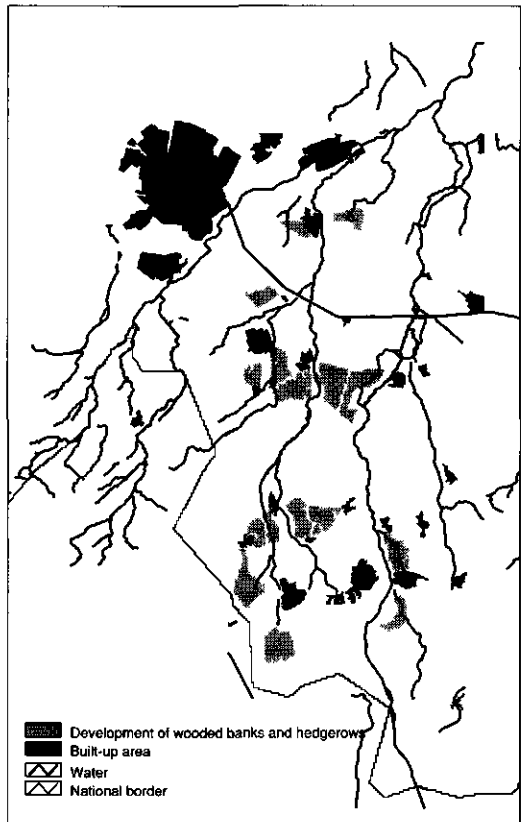


Figure 7.36 Juniper shrubs and zones
jebesz

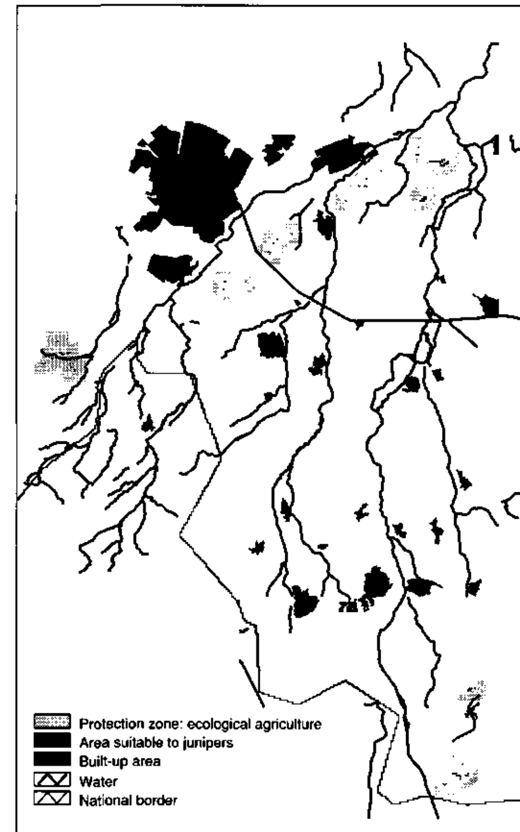


Figure 7.37 Nutritious soils
avoe

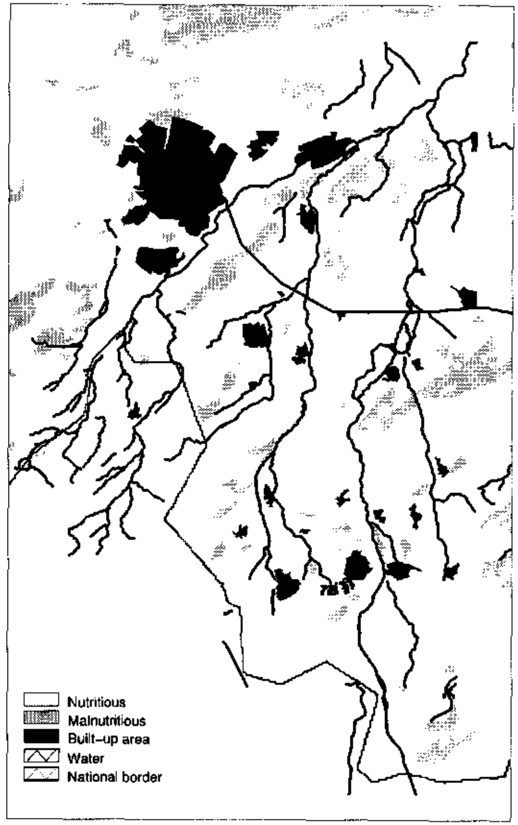


Figure 7.38 Groundwater
agwt

Figure 7.39 Potential shrubs
struweel

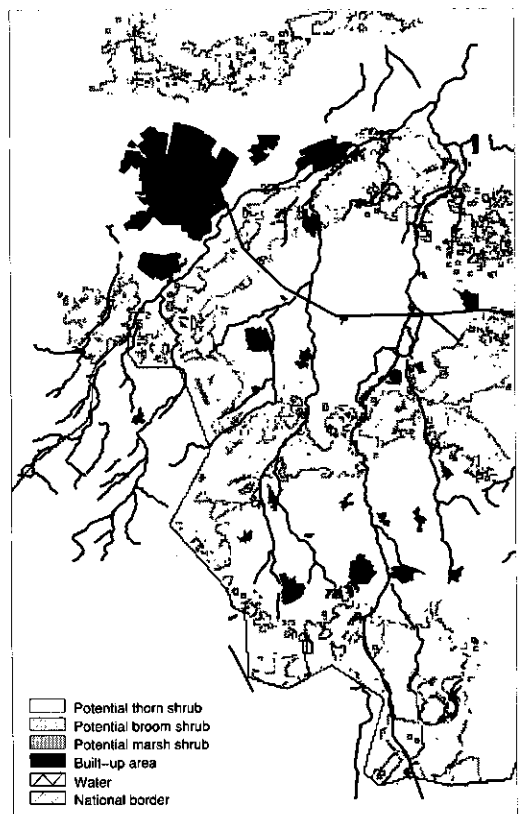


Figure 7.40 Orientation grassland
grazuin

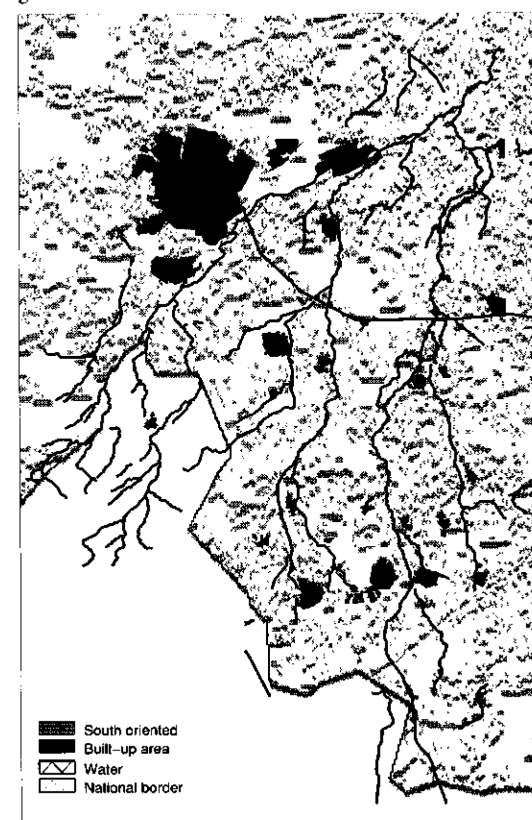


Figure 7.41 Gradations grassland
wvgras

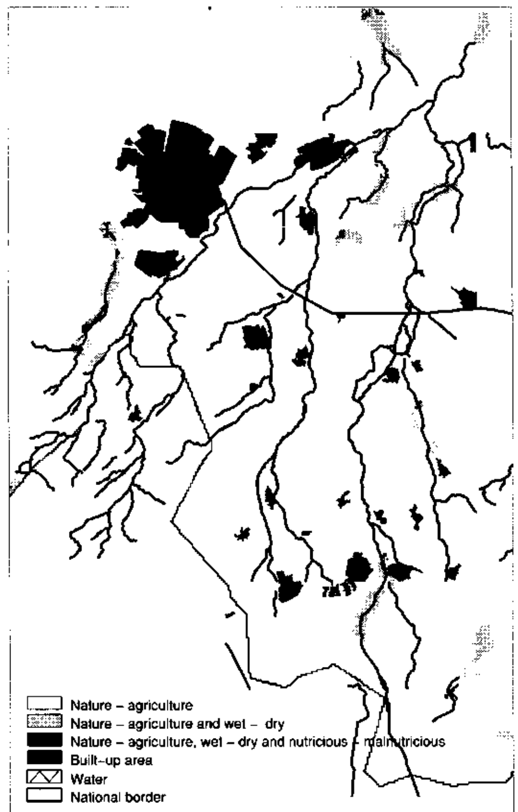
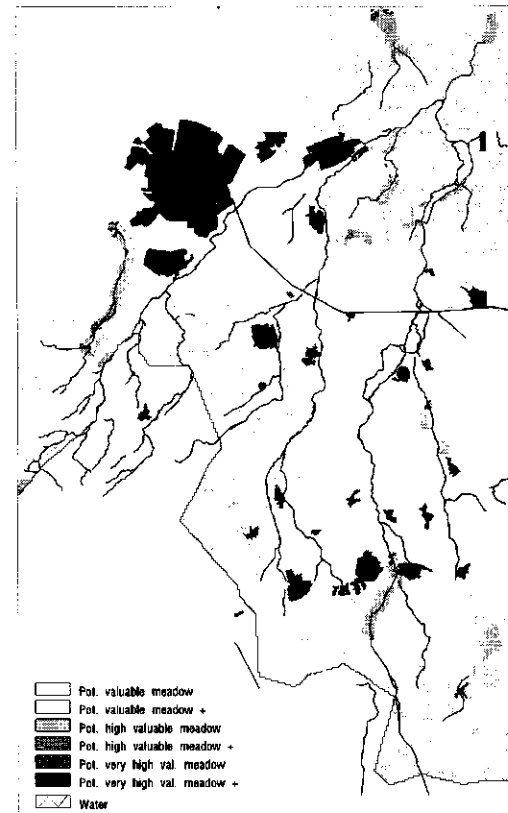


Figure 7.42 Value of grasslands
wvgras



8 OBJECT KNOWLEDGE II: THE PLANS FOR THE CATCHMENT AREAS OF BEERZE, REUSEL AND VOORSTE STROOM

According to Kleefmann, a reconnaissance planning process should result in a map, a description of the future spatial organization including management aspects, and an evaluation plus financial analysis. In Chapter Six, the social subsystem of the future spatial organization was described, according to the intention. In this chapter, I will focus on the plans which resulted from the case study. These plans can be regarded as object knowledge, as they describe the object, i.e. the spatial organization of the study area. Moreover, they can be regarded as theoretical models which depict a future concrete object. As these theoretical models refer to the spatial organization, they will be referred to as 'spatial models'. When assessing the plans, it must be remembered that the main aim of this study was methodological. No in-depth study was done on the aspects.

8.1 The planning results of the anthropocentric intention

The basic premise in the plan generating of the anthropocentric intention was that the position for competition of strong agricultural branches should be strengthened[1]. The interests of nature were fully subordinated to this starting point, and hence only a small area remained available for an ecological framework, even though such a framework is intrinsic to the anthropocentric intention. In real life, this would have stimulated a debate on whether the main goal to strengthen agriculture can be maintained if an ecological framework simultaneously has to be developed. Indeed, inciting such a debate is one of the aims of reconnaissance planning. If the outcome of this debate were a decision to develop an ecological framework, the concrete intentions and planning goals would have to be altered or modified at the expense of agricultural goals, and the cyclic planning process would start again.

This example shows how the results of the planning process reveal conflicting statements in the normative knowledge and how they encourage debate about changes in this normative knowledge. It also emphasizes that the planning process is a learning process.

The analysis of the area resulted in the conclusion that according to the criteria applied, the whole region had excellent agricultural potentialities. The intensive husbandry, dairy farming and nurseries are high producers with well-developed farms and enterprises although there is some regional variety. To comply with the anthropocentric intention, this agricultural strength should be developed even further.

Figure 8.1, map EIND5, shows the spatial model that forms a possible projection of the anthropocentric intention on the spatial organization of Midden-Brabant. In the plan for the area, six subareas are discerned, each of which has been allocated a specific lay-out and management. The areas were discerned on the basis of agricultural economic strength and soil suitability. The landuse management in these areas depends on which types of agriculture have a relatively strong economic position. The spatial organization has to be adapted to the types of agriculture which are important to the area, by scaling up farms, improving accessibility, organizing the processing of manure, organizing the market and stimulating technological developments.

Intensive husbandry
Intensive husbandry is the most important sector in the area. The plan envisages that improvements to enable this sector to compete in an environmentally friendly way will be carried out throughout the area, except for the areas in the centre around the stream Reusel, in the south-east, and in the north, where only dairy farming and nurseries will be developed. The latter areas have more potential to be developed for nature and recreation (of course subordinate to agricultural production).

Dairy farming
The plan provides for dairy farming to be developed throughout the area, except for a few areas in the north, which will concentrate on intensive husbandry or nurseries. The plan is based solely on economic strength and soil suitability, and therefore takes no account of the population density. If population density had been considered, the policy to concentrate on intensive husbandry in the northern highly urbanized area around Oisterwijk might have been altered.

Nurseries
In the south-east and north of the area, the burgeoning nurseries will be further developed. In the northern part, a small area has been designated solely for nurseries in combination with some small-scale agriculture.

Land withdrawn from agriculture
As a consequence of the market-oriented agricultural policy, although over large areas agriculture will be developed further, land will also become available to be withdrawn from agriculture. The plan assumes that in the study area 3696 hectares will be withdrawn from agriculture, which equals 8,5% of the total agricultural land[2)]. Most of the land earmarked to be withdrawn from agriculture lies in the northern part of the study area along the water divide of Beerze and Reusel. A report written under the aegis of the provincial government of Noord-Brabant describes possibilities for areas withdrawn from agriculture on watersheds: '.. a pattern of densely afforested strips can support the need of ecological corridors (for example of butterflies), recreational facilities, housing in rural areas and the

reintroduction of a small scale landscape" (*Raamplan Beerze-Reusel*, DHV and HNS, 1991).
Other agricultural areas to be withdrawn lie scattered over the area, mainly in locations where nature has recently been transformed into agricultural land. Generally, these areas have infertile, dry soils. Transforming these areas back to a more natural landscape will enlarge and strengthen the adjacent nature areas. Small, isolated areas that can be withdrawn from agricultural production provide possibilities for the development of small connection zones and stepping stones that will enable a natural structure to become established in the area. In a succeeding cycle of the planning process, the natural structures can be elaborated, based on the areas which can be withdrawn from production. Table 8.1 gives an overview of the area of actual and future types of land use, the area of land which has to be transformed and the costs of the transformations[3]. The overview is limited to the costs of spatial investments. Other costs (e.g. social costs) are not included. Also an estimate of the milk production under the scenario described above was made[4].

Table 8.1 Acreage and costs of the realisation of the Anthropocentric plan.

from:	to:	acreage (ha)	costs / ha (HFL x 1000)	total costs (HFL x 1000)
High scale agriculture	High scale agriculture	39,881	54.1	2,157,562
High scale agriculture	Nature	3,696	73.8	272,764
Nature	Nature	20,943	7.8	163,355
Built-up area	Built-up area	6,085		
total:		70,605		2,593,681

If we compare the resulting plan from the case study with the regional plan of Noord-Brabant, differences and similarities can be discerned. The provincial government decided to develop an ecological network along the streams in the area. The aim is for streams to regain their natural character and for grassland alongside the streams to be withdrawn from production. However under the anthropocentric plan, the land to be withdrawn from production is on the ridges (watersheds), and only in the centre of the study area. This choice was based on economic circumstances and soil suitability for agriculture. Generally, the land alongside the streams is in economically strong agricultural areas or is very suitable for agriculture. However, the research for the '*Raamplan Beerze-Reusel*', mentioned above, also mentions the possibility of withdrawing land from agriculture on watersheds.

The estimated costs of the realization of the Anthropocentric plan are high, as is shown in Table 8.1, although the bulk of the costs are maintenance costs. The costs of transforming land from agriculture into nature (3696 hectares) amount to 272 million Dutch guilders.

8.2 The planning results of the ecocentric intention

The ecocentric intention takes the development of ecotopes as a starting point. The development potential for each ecotope was studied. Only the fens, active sand dunes and juniper shrubs are to be allowed to develop in existing nature areas. The edges of woodlands are not enlarged either, and are assigned a specific type of management. It is envisaged that stream valleys, peat and wooded banks will be developed in the area, and heathland will be extended. Of the potential shrub vegetations, only broom and marsh shrubs will be allowed to develop, and thorn shrubs (e.g. bramble) will be discouraged. Finally, in order to integrate the various ecotopes, a decision matrix was drawn up, based on a priority list[5)]. Of course, all these assumptions are normative. Other choices would result in different spatial models.
The spatial model of the ecocentric intention regulates agricultural activities in more detail than in the anthropocentric plan. This is because the ecocentric intention sees the political subsystem as having the obligation to supervise production processes (see section 6.2); however, this can cause tension because of the preference for a sociocratic approach.
The spatial model of the ecocentric intention for the study area is depicted in two maps: the map ECONAT in figure 8.3 for the nature aspects, and the map ECOAGR in figure 8.2 for the agricultural aspects. Well functioning ecosystems are the basis of the ecocentric intention. Nevertheless, this still leaves room for elaboration, as ecosystems can function at various levels of human interference. For example, in the Netherlands, heathland only survives if it is regularly burnt of grazed.
The vegetation which results from ecological agriculture (as well crops as flora in pastures) can also be regarded as an ecosystem. The ecotopes that will develop under this scenario were derived from Bink, Meltzer, de Molenaar, van Rossum and Saaltink (1979). However, guidelines for their detailed lay-out and management are not discussed in this thesis.

Streams and stream valleys
In the envisaged plan the streams will regain their meandering natural course, within the limits of the area designated as 'stream valley' or 'peat'. To allow this, the number of dams in the streams will be reduced as much as possible. The banks of the streams will be vegetated with shrubs and trees. Large areas of the stream valleys will be covered with extensive grassland grazed by cattle. Stream

valleys in nature areas will receive extra attention, as valuable vegetation could re-establish in this grassland.

Fens

Existing fens will be protected by active management. In order to prevent the nutrient status of the water being enriched by falling leaves, a zone around the fens will be kept free of trees.

Peats and marshes

Peaty soils will be allowed to develop as peat. In the northern part of the area, on the floodplains of the Reusel, considerable areas will be allowed to develop as peat. There will be two other such areas, in the centre of the area and in the south on the Belgian border.

Heathland

At present there are three complexes of heathland on the higher-lying sands in the area, which will be conserved by active management. The plan stipulates management by means of three flocks of sheep. A sheep flock of 500 animals requires a minimum area of 500 ha[6]. Therefore, the existing heathland will have to be increased. During a field visit it was found that the Dutch Nature Conservation Foundation which owns the northern heathland also intends to expand the heathland, on areas earmarked for heathland expansion in the case study.

Active dunes

In the Netherlands, active dunes inland are the result of over-exploitation, overgrazing or burning. The sand dunes are valued because they are relicts of historical land use. Furthermore, they support valuable vegetation (lichens). Existing areas of heathland or sands will be protected and managed in order to conserve and promote the development of active dunes.

Woodland

The existing woodland will be stabilized and developed by management and by supporting nature development in adjacent areas. Woodland in areas where the water infiltrates into the subsoil will receive extra protection, to prevent pollution of the groundwater which exfiltrates in the stream valleys or reaches the deep groundwater. Forest edges are important refuges for animals. These edges will be managed by means of extensive grazing by cattle.

Hedges and wooded banks ('houtwallen')

There are suitable areas for developing wooded banks in the centre and south-eastern parts of the area. In this area a small-scale landscape will develop because field boundaries will be planted with hedges, shrubs and trees.

Ecotopes for Juniper
At present, juniper is a rare species in Noord-Brabant and the Kempen area in Belgium. The presence of juniper will be fostered on existing heathland and active dunes.

Shrub vegetation
Broom will be encouraged to develop scattered over existing heathland. Marsh shrubs will be rare in the area. They will occur along the banks of streams in nature areas along the Beerze and the Poppelse Leij.

Meadows
There are no natural meadows on the map. This is because of the list of priorities on which the integration was based. All potential natural meadows were subsumed under natural stream valleys or other ecotopes, which were regarded as more important.

Ecological agriculture
The plan assumes that ecological agriculture will be practised in areas that have a direct influence on important nature areas. The water table will be natural and no human interference to lower it will be permitted. The permitted agricultural activities will be assessed for the risk of discharge of polluted water, spreading of fertilizer and manure, and emission of acidifying substances. Meanwhile the agriculture will support the development of ecotopes by extensive grazing where grassland adjoins stream valleys or woodland. Ecological agriculture will also be practised in the small-scale landscapes where wooded banks will be allowed to develop. Note that the term 'ecological' still leaves room for a variety of agriculture, varying from biological agriculture to high-tech integrated farming.

'Intensive' agriculture
The term 'intensive' is deceptive, as the agriculture which is indicated is not comparable to the intensive agriculture in the anthropocentric intention. Within the ecocentric intention the meaning of the term is relative. It refers to a more intensive agriculture than ecological agriculture. However, this intensive agriculture is still in balance with the soil and this means that intensive husbandry will not be permitted.

Arable farming and pasture
Both types of land use are indicated on the maps. Arable farming is concentrated on the ancient fields where the soil has been developed and raised by centuries of arable farming. These fields are concentrated around ancient settlements in the area. The remaining land, less suitable for arable farming, is used as pasture.
Table 8.2 gives and overview of the area of actual and future land use, the area of land which has to be transformed and the cost of the transformations[7)]. The costs of achieving the transition from agriculture into nature in the ecocentric intention

are less than those in the anthropocentric intention. Nevertheless, the plan as a whole is approximately twice as expensive, because a large sum is necessary to transform intensive agriculture into ecological agriculture.

Table 8.2 Acreage and costs of the realisation of the Econcentric plan.

from:	to:	acreage (ha)	costs/ha (HFL x 1000)	total costs (HFL x 1000)
High scale agriculture	High scale agriculture	13,945	54.1	754,424
High scale agriculture	Ecological agriculture	26,962	158.6	4,276,173
High scale agriculture	Nature	1,337	73.8	98,670
Nature	Nature	22,276	7.8	173,752
Built-up area	Built-up area	6,085		
total:		70,605		5,303,019

Like the provincial policy, the spatial model of the ecocentric intention creates an ecological network along the streams in the area. However, whereas the province intends to realize this ecological structure by nature development, the ecocentric plan prefers extensive grasslands in stream valleys, managed by extensive grazing. The detailed planning of the agricultural land use is noticeably different from the anthropocentric intention.

8.3 Continuation of the process

The plans described in this chapter form the results of the case study and depict possible spatial consequences of the concrete intentions and planning statements. However, in a full reconnaissance planning exercise they would not be the ultimate results, because planning is a cyclic process. In such a process, the results from the case study would have to be discussed in the light of the intentions and the social organization of the study area. This discussion may result in a decision to develop alternatives, or to seek for compromises by modifying the intentions, concrete intentions or planning statements. In either case, the planning process, which is a learning process, will start again, using the experiences of the previous planning exercise. This cycle will be repeated until the resulting plans are ready to be presented for public approval[8)].

Notes

1. This statement can also be found in the Provincial Report on Spatial Planning. The conflicts which emerged between the agricultural sector and the provincial government when the policy plan was released arose because of the difficulties of reconciling the statement with the development of a provincial ecological network.
2. In Chapter Six, section 6.3, two model calculations are mentioned. The Agricultural Economics Institute predicts that if a scenario of lowering milk prices is chosen there will be a 5% reduction in the area reserved for roughage production. Thijs gives a 15% reduction in the area used for roughage production if measures to limit the milk production by means of quotas are implementented.
3. The costs are based on a study by Groen, Bosveld and Ottens (1989), who calculated the costs of investments to reach the planning goals of the Fourth Policy Document on Physical Planning. In the calculations of the two plans, water (fens, pools and streams) was regarded as nature. Maintenance costs concern the maintenance necessary if no changes are made. In their study, they computed the costs as follows (costs/ha, HFL x 1000, exc. 18.5% VAT, including 20% of the costs of new civil engineering works:

from:	to:	acquisition	demolition	new constructions	maintenance	total
high scale agr.	high scale	-	-	45.0	0.1	54.1
high scale agr.	nature	55.0	-	6.0	0.6	73.8
nature	nature	-	-	6.0	0.6	7.8
high scale agr.	small scale agr.	35.0	-	77.0	0.2	158.6

4. These calculations were carried out with the help of a spreadsheet program. The numbers of milk cows in 1986 per municipality were known, as well as the milk production and the number of animals per hectare. The milk production for 1986 was calculated from this information.
   For the anthropocentric plan the area of grassland was calculated with the help of the model calculation of the Agricultural Economics Institute (De Graaf and Tamminga, 1990) which, for a market-oriented policy in the areas with a sandy soil, based on 1983 statistics, predicted that 41% of the actual (1983) area under maize would be converted to grass and there would be a 22% decrease in the production of milk.

	CBS 1986	Anthropocentric plan	Ecocentric plan
Milkcows	53,856	47,393	40,594
Cows/ha	2.6	2.6	2.0/1.5
Milkproduction/cow (kg/year)		5784	4909
Milkproduction (kg/year)	312.10^6	274.10^6	199.10^6

5. See note 24, Chapter Seven.
6. Only the northern heathland ('Kampina') will be large enough for a flock of 500 sheep. The heathland in the middle and the south ('Neterselse heide' and 'Cartierheide') will only give room for flocks of about 250 sheep.
7. The costs are based on the study by Groen et al. (1989), see note 3.
8. In the Netherlands, the public has possibilities to influence a regional plan: everybody can study the draft plan during a period of two months, and is entitled to put forward objections to parts of the plan. These objections will be discussed during the political decision making in the provincial parliament. Appeal is possible.

Figure 8.1 Spatial model for the anthropocentric intention eind6

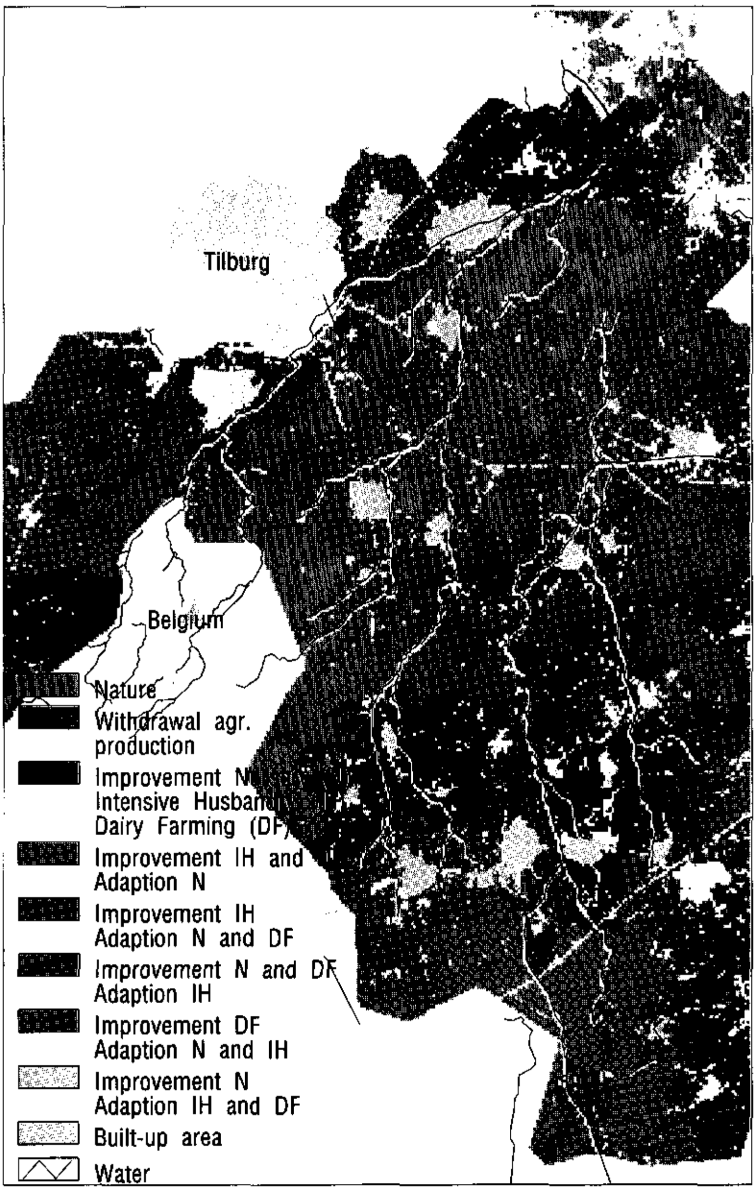


Figure 8.2 Spatial model for the ecocentric intention aspect: agriculture (ecoagr)

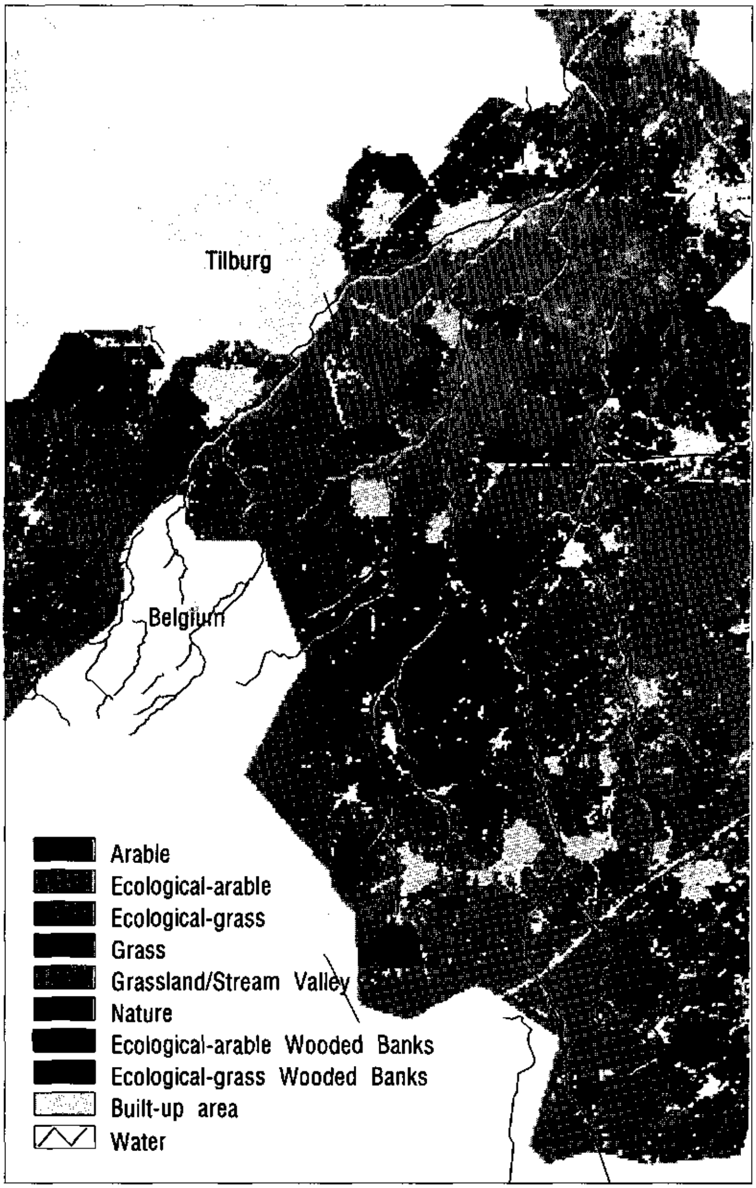
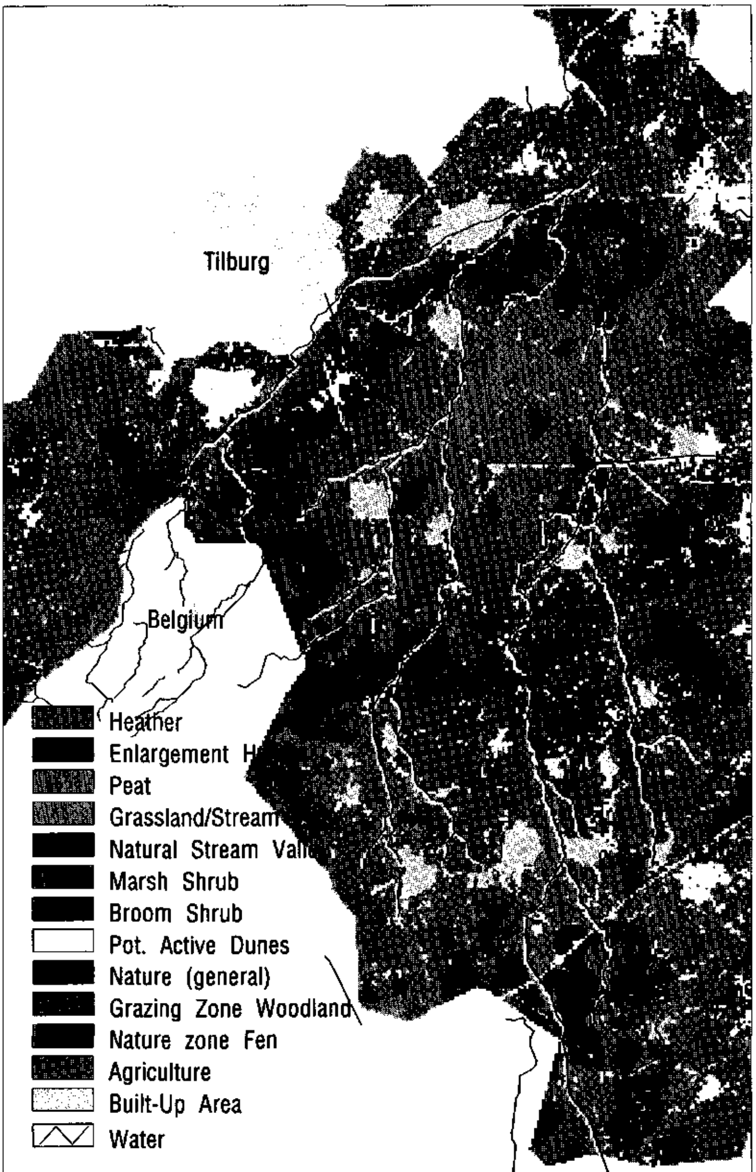


Figure 8.3 Spatial model for the ecocentric intention aspect: nature (econat)



9 STORING KNOWLEDGE IN THE RISOR SYSTEM

In the preceding chapters, I described how knowledge, consisting of normative, object and process knowledge, was developed and applied in the case study. In the *RISOR* system, information about this knowledge can be stored. This information can be characterized as 'metaknowledge', because it describes the knowledge.

The structure of the *RISOR* system itself is described by van Lammeren (1994) in his thesis *Computergebruik in de Ruimtelijke Planning*. In this chapter, I will describe how the metaknowledge about the knowledge from the case study was stored in the knowledge-oriented subsystem of the *RISOR* system. This experience will be evaluated in Chapter Eleven. As the *RISOR* system employed was still a prototype, there were teething problems. Below, after the description of the functions of each module, these problems will be stated under the heading '*remarks*', in the hope that these will be addressed by the system developers.

9.1 The knowledge subsystem and the standard forms

As described earlier in section 3.5 the knowledge subsystem of the *RISOR* system consists of three related databases of the *RISOR*, in which the information about the normative, object and process knowledge is stored. In the same section three possible applications of the system were also mentioned. My research was limited to the testing of the storage capacities of the system.

The storage of knowledge could best be carried out by commencing with the object knowledge followed by the process knowledge, and concluding with the normative knowledge. The planning process carried out can be described by the object knowledge, process knowledge or normative knowledge, as illustrated in Appendix III. In the *RISOR* system, the three knowledge categories are related. The information about the process refers to the object knowledge which was stored previously. Subsequently, the information about the normative knowledge is related to the processes in which the spatial models connected with this knowledge are developed.

The user communicates with the databases, which are programmed in the ORACLE database language, with the help of standard forms. These forms are invoked by the following procedures, which should be handled in the sequence described:

OBJECTIN:	for input of object information
OBJECTVIEW:	for viewing the registered object information
PROCORG:	for input of origin of processes
PROCESIN:	for input of process knowledge

NORMORG: for input of origin of normative knowledge
NORMIN: for input of normative knowledge
NORMVIEW: for viewing the registered normative knowledge

Menu screens as shown in Figure 9.1 enable the user to feed the information into the database of the system. The menu screens determine the sequence in which the information is fed into the system, as they have a strict order which is described in the sections below.

Figure 9.1 Example of a menu screen of *RISOR*

```
INPUT OBJECT-DATA

OVERVIEW OBJECT-DATA

  FILENAME TMP2                               OFILE#
  EXTENSION# 2                             LOCATION# *
  OBJECT_TYPE# 8                           FILE_SIZE 12
                                           SIZE_UNIT K
                                          INPUT_DATE 23-AUG-91
  FILE_TYPE# 1                          INPUT_PERSON# 3
  THEM_DATA_GROUP#
  MAININFO_CAT# 3


  ORIGIN# 1                                    AREA# 3
                                              COORD# 1


ACTION:       INPUT OK ?       PRESS 'PF3'
PRESS <PF3> TO SUBMIT CHANGES; PRESS <PF4> TO QUIT; PRESS 'H' TO CHANGE INPUT
          Char Mode: Replace  Page 13                  Count: *0
```

9.2 Storing references to the object knowledge in *RISOR* (OBJECTIN)

The object knowledge in the *RISOR* system is described in four aspects:

1. the files in which the data are stored,
2. the content of the data,
3. the origin of the data,
4. the storage features, where the files can be found.

The object data give information about the spatial organization, which is the planning object. This information may be about the present-day organization, but also the future situation according to the intentions. It may also concern spatial models which are intermediate results of the planning process.

Sequence of input of object knowledge:

1. Input of information about the files.
   1.1 Filename
   1.2 Extension
   1.3 Object type
   1.4 File size
   1.5 Size unit
   1.6 Input date
   1.7 Input person
   1.8 File type

2. Input of information about the content of the data:
   2.1 Main information category
   2.2 Information category
   2.3 Features and input codes
   2.4 Area name
   2.5 Coordinates, unit of measurement and map projection

3. Input of information about the source of the data:
   3.1 Origin type, author, title, publication date, scale, digitizing software, digitizing date, error

4. Input of information about the storage of the data:
   4.1 Storage type, directory, node type

Input of file information
The basic object data of the case study were described in Chapter Five, the intermediary object data were depicted by the maps in Chapter Seven and the resulting object data were described in Chapter Eight. A distinction can be made between raster and vector oriented data.
The names and extensions of the files were stored in the *RISOR* system. The item 'Object type' (1.3) was characterized for the vector information, as 'geometric and thematic information', and for the raster information was characterized as 'raster'.

The raster files contain the spatial models which were processed with the GIS, or which were the result of GIS processing. The item 'File type' (1.8) gives information about the type of object data. The *RISOR* system discerns:
1. basic data

2. intermediate data
3. resulting data

This distinction is based on the position of the knowledge in the planning process. The object knowledge can be described in a hierarchic flow chart, as illustrated in Appendix III.

remarks:

The system does not provide an opportunity to register the grid cell size of raster information. Information about the grid cell size is relevant to assess the informativeness of the maps, and it influences the applicability of methods.

Information about the content of the object knowledge

In the case study, the main classification of the object knowledge was based on the *MFO* model. In accordance with this model, the object information was segregated into knowledge about the physical organization and knowledge about the social organization. This classification formed the item 'Main information category' (2.1). On a more detailed level the main categories of information gave the content of the object information which formed the item 'Information category' (2.2), e.g. soil, geomorphology, infrastructure, administrative boundaries.

The items 'Features' and 'Input codes' enumerate the attributes of the files, e.g. heathland, grassland, built-up area, of the information category 'land use', or the specific soil types of the information category 'soil'.

The items 'Area name' and 'Coordinates' (2.4 and 2.5) describe the area whose spatial organization is being described.

remarks:

a. It is only possible to attach one 'main information category' to a data file. However, intermediate and resulting object data might give information on more than one main information category.

b. The 'information categories' are detailed by adding the features belonging to each information category. In the *RISOR* system, the user is obliged to import in one go all the features which belong to a specified information category. It is impossible to add new features later.

c. The 'input codes' represent the code the attribute has on the basic map. This code is likely to change during the processing. The code might also differ on the basic maps containing the same attributes, used in different processes; for example, identical soil units might have differing codes in various projects. It is impossible to give one fixed input code valid for all the maps in an information category. The relevance of recording the input code is therefore questionable.

Regarding the 'features' it should be noted that features are not related uniquely to one information category . They may occur in various information categories: e.g. 'infrastructure' comprises roads, but 'topography' comprises roads too.

The sources of the information
The object information used in the case study, was derived from various sources which were described in Chapter Five. These sources were managed in the *RISOR* system. In the case study, the item 'Origin types' were digitized maps or satellite images. Furthermore, the author, scale, and publication date of the sources of the information were recorded. If the digital information was derived by digitizing maps, the software with which the maps were digitized and the digitizing date were recorded.
remarks:
a. In the case study, the object knowledge was not only derived from maps. For the anthropocentric intention, statistics were also used. The items of the *RISOR* forms, however, notably refer to cartographical features.
b. The prototype gave problems when new values had to be imported in a subform, which had to be selected in a previous form. New features are not immediately processed in the database, which made it impossible to select new values immediately after they were added.

Storage of the data
As the *RISOR* system is a referring system, the references to where the data can be found are essential features. In the case study the files were stored on floppy disks in a compressed format.

9.3 Storing references to the process knowledge in *RISOR* (PROCESIN)

The process knowledge is described by the contents of the process, its position in the plan-generating phase, and the object knowledge which is processed during the processes. In fact, the process knowledge describes the 'action moments', in which the object knowledge is processed based on normative knowledge, with the help of methods (see section 2.4).

Sequence of storing the process knowledge:

1. Information about the file:
   1.1 File name
   1.2 Extension
   1.3 Description of the process
   1.4 Input date
   1.5 Input person

2. Information about the process:
   2.1 Process type

3. Input of information about the storage of the files:

3.1 Storage type, directory, node type

4. Input about the source of the process:
   4.1 Origin type, author, publication date

5. Relation of the process to other processes:
   5.1 Previous or next file: file name, description

6. Information about the object information processed:
   6.1 information category

Information about the file and its contents
The *RISOR* forms start by asking for the input of the 'File name' and its 'Extension' (1.1 and 1.2). In the case study, the files were 'Macro Command Files' with extension .MCF[1]. In Appendix IV an example of the contents of such a command file is given. The 'Description of the process' (1.3) requests a brief description of the function of the process. Furthermore, the 'Input person' and the 'Input date' are registered.

Information about the process
The *RISOR* system structured the process according to the plan-generating phase as it was structured by van Lammeren (section 3.4). The stages of description, construction and evaluation are subdivided into:

1. definition - inventory
2. definition - analysis
3. definition - interpretation
4. construction - inventory
5. construction - design
6. evaluation - inventory
7. evaluation - analysis
8. evaluation - interpretation

remarks:
a. The structure as described above was fixed in the prototype, which does not make the system very flexible if planners wish to structure the process in another way.
b. The flow charts in appendix II give an illustration of the subdivision of the stages described above. Appendix III describes the hierarchy in the process knowledge, also indicating the subdivision of the plan-generating stages. All substages 1, 2, 3, 4 and 5 could be identified in the plan-generating stage of the case study. However, not each substage is present at each of the three main stages, and sometimes substages are succeeded by previous substages and one process file might comprise several substages. This observation underlines the

unpredictable character of the plan-generating process. The *RISOR* system lacks flexibility: it cannot assign various substages to one process file.
c. Process files which describe procedures related to the final presentation of the resulting spatial models, e.g. the production of legends, colour and lay-out, should be subsumed at substage 8: evaluation-interpretation. In this substage the planning results are interpreted to abstract the information relevant to the policy process, and to decide how the models have to be submitted for the decision-making process.

Storage of the data
The information referring to the location of the process files is organized similarly to the information of the object knowledge, as described in section 9.1.

The source of the processes
The processes may be derived from external sources, in which case the origin type, author, and publication date can be recorded. In the case study, however, the processes were developed by the planner, and not derived from external sources. This information is selected from an overview which has been created, with the PROCORG procedure.

Relation of the process to other processes
As already mentioned, only segments of the planning process could be formalized in MCF files. To make it possible to combine various segments of processes to create a planning process, each process file should contain limited functions. The *RISOR* forms request the user to indicate the process files which precede or follow the recorded process.
remarks:
a. The forms offer the opportunity to select previous and subsequent process files of a file which has been recorded. In practice, however, it is only possible to select 'previous' files, because the 'next' files have not yet been imported, and are not always known when a file is being recorded. The module PROCESVIEW offers the opportunity to input the code of 'next' files and therefore to fill this hiatus after completing the PROCESIN procedures.
b. The system allows only one 'next' or 'previous' file to be selected. The flow charts in Appendix III illustrate that in the case study it happened that one process file was followed by three process files, each of which processes an aspect (i.e. one file having three 'next' files), or that the results of ten process files were processed with only one file (i.e. one file having ten 'previous' files).

The object knowledge processed by the process
The intermediate object data, and the resulting object data can also be classified as object information, similar to the basic object data. The last form of the procedure of recording object information asks the user to characterize the object

information which is processed and provided as output by the process file which is recorded.

9.4 Storing references to the normative knowledge in *RISOR* (NORMIN)

The normative knowledge is described by the type of the intention, its origin, its relation to other normative knowledge, and the processes which develop the spatial models related to the intentions. The normative knowledge is stored in the system in the following sequence:

1. Information about the file in which the normative knowledge is described:
   1.1 File name
   1.2 Extension
   1.3 Description of the normative knowledge
   1.4 Input date
   1.5 Input person

2. Information about the type of normative knowledge
   2.1 Intention type

3. Information about the source of the normative knowledge:
   3.1 Origin features, function, author, title and publication date

4. Relation of the normative knowledge file to other normative knowledge
   4.1 'Previous' and 'next' file

Information about the file
Usually, the normative knowledge will be described in text files. In the case study, the intentions, concrete intentions and planning statements, as described in Chapters Six and Seven, are stored in a 'CARDBOX' database system. Thus, the normative knowledge is systematically accessible. The items 'File name' and 'Extension' (1.1 and 1.2) give information about the files in which the normative knowledge is stored. The file names are indicated with the description of the normative knowledge in Chapter Six (intentions and concrete intentions) and Seven (planning goals and criteria). The item 'Description of the knowledge' (1.3) states briefly the contents of the intention, perspective or planning goal.

Information about the type of normative knowledge
The prototype of the *RISOR* system allows the user to choose between the descriptions:
1. integration
2. aspect
3. subaspect

These descriptions are based on the way van Lammeren classifies the normative knowledge in the planning process[2)].

remarks:

a. The classification of the normative knowledge types is entirely based on the subject of the normative knowledge: facet, aspect or subaspect. Within the case study, the classification of the normative knowledge was also related to the abstractness and phase in the process: intentions as the basis, on an abstract level, concrete intentions regarding the area, and operational planning goals and criteria in the plan-generating phase. These systematics are not supported by the *RISOR* prototype. Nevertheless, it was possible to apply the systematics of the system in the case study, to characterize the normative knowledge. In the case study, normative knowledge on the 'aspect' was employed for the intentions, the concrete intentions and for the plan-generating phase.

Information about the source of the normative knowledge

In a planning process, the normative knowledge will be derived and composed from various sources which vary from policy papers and plans to scientific or philosophical studies. In the *RISOR* system, this can be indicated by describing the function of the source. Furthermore, the title, author and publication date can be indicated with the help of the NORMORG module; this should be done before using the NORMIN module.

remarks:

a. To identify the contents of the normative premise, the 'title' of the origin should have the form of a brief characterization of the premise.

b. Origin features stored in the system were not transferred to the database immediately, and thus were not available during the same session. Therefore, it was impossible to store sources that were not already attached to previous premises.

Relation of the normative knowledge file to other normative knowledge

The normative knowledge was organized in hierarchical flow charts, as shown in Appendix III. In the case study, the intentions are based on the two basic anthropocentric and ecocentric intentions, from which the concrete intentions were derived. Subsequently, the planning goals and criteria were formulated, based on this normative knowledge. Similarly, most of the files which contain normative knowledge possess a 'previous' and a 'next' file.

remarks:

a. Similarly to the remarks a. and b. in section 9.3.5, it was only possible to select previous files. 'Next' files could be imported using the NORMVIEW module. Furthermore, the system allowed only one 'next' or 'previous' file to be selected, whereas in a planning process, one normative file can be followed or preceded by more files.

b. 'Previous' files which had been selected were not transferred to the database and were not attached to the normative files.

9.5 General remarks on the prototype of the *RISOR* system

The following general remarks about the system as a whole are based on the experiences of inputting object, process and normative knowledge in the system.

a. The reconstruction and administration of the planning process demanded substantial attention after the process was completed and the results had to be stored in the database of the *RISOR* system. On the other hand, options for employing the knowledge subsystem of *RISOR* on-line during the planning process which is carried out with the project subsystem (the GIS), storing each action in the system, will meet with difficulties. A planning process, notably a reconnaissance planning process, is a learning process during which the knowledge types are experimented with, rejected or changed. Using *RISOR* on-line during the process requires the system to be very flexible: it has to be possible to change, remove and correct knowledge stored in the databases. The prototype which was tested has not yet achieved this flexibility.

b. It is difficult and not always possible to correct and edit data already stored in the system.

c. In the prototype not all 'help' screens were defined.

d. The functioning of keys for editing or changing screens is not always consistent, and keys for interrupting the process did not always enable the user to exit the system.

e. Screens to obtain an overview of the data in the database at any moment, would be a useful addition to the system. Actually, the 'view' procedures are separate from the input modules and only give information related to a specific object which first has to be selected. It would also be advisable to add the option of generating listings during the process.

f. The user-friendliness of screens, the lay-out and information displayed can be improved. For example, some screens give codes, whereas the accompanying description would give more information. The user-friendliness of the screens should be geared to the type of users expected to work with the system.

g. The NORMIN module requires corrections to functions which do not function as they should.

Notes

1. If the case study had been performed with the Arc-Info package, the extension of the method files would be '.AML'.
2. Van Lammeren 1994) describes the 'integrational level' as normative knowledge which gives information about how the spatial facet should be organized, the 'aspect level' as a description of how certain aspects or sectors, e.g. agriculture, should be organized, and the 'sub-aspect' as a description of how parts of the aspect, e.g. intensive husbandry, should be organized.

Part III

In this, the final part of the thesis, I will reflect on the experiences gained during the case study with the GIS, the *RISOR* system and the reconnaissance planning approach. Furthermore, conclusions will be drawn from these experiences, which answer the questions which were raised in Part One.

The structure of this part is the opposite of that in Part One. It starts at the instrumental level, discussing the experiences with the Geographical Information Systems used in the study. As modelling was mentioned as a prerequisite for the use of GIS in planning, the question of whether it was possible to model the object and the process also touches upon the applicability of information systems in planning. Subsequently, the prototype of the *RISOR* system will be assessed in terms of its abilities to store the knowledge developed during the planning process. The systematics of the planning process on which van Lammeren based the system will be part of this discussion. The experiences with the GIS and the *RISOR* system are the experiences of a user. I hope that the experiences will prove helpful to software designers, to improve and perfect information systems that support planning and operationalize the reconnaissance planning approach.

Finally, this thesis cannot be concluded without discussing the applicability of the reconnaissance planning approach itself. Therefore, in Chapter Twelve, I will discuss how the planning methodology is operationalized, and the prospects of applying this interesting methodology in practice.

Like most research, this research raised new questions to be explored and new problems to be solved, which will be stated in the final chapter.

10 GEOGRAPHICAL INFORMATION SYSTEMS IN THE PLANNING PROCESS

'How can Geographical Information Systems support an operationalization of the reconnaissance planning approach?', was the third question stating the objective of this research. The answer to this question could touch upon various aspects of the use of GIS.
The first aspect concerns the abilities and constraints of hardware and software. This aspect will not be elaborated upon, as the experiences with the hardware and software were obtained under specific conditions during a certain period at the Centre for Geographic Information Processing. Research in which GIS is involved normally takes place in a highly dynamic environment, which changes rapidly and is unique[1].
The second aspect concerns the functionalities of the GIS which supports the planning process. In this research, the experiences are based on the software package *GeoPackage*. Therefore, the discussion of the functionalities of the GIS primarily applies to this package.
The third aspect is the way activities and procedures are formulated to be understandable to the GIS. It was concluded that formalized theoretical models are the basis for the successful application of information systems in planning processes. The final section of this chapter contains some general conclusions based on the case study on the prospects for employing GIS in a planning process.

10.1 Functionalities of the Geographical Information System software within the planning process

The case study was largely based on a raster-oriented module of a GIS package which was available at the Centre for Geographical Information processing[2]. The use of a raster-oriented module offered advantages over the use of a vector-oriented software. The GeoMap module of the GeoPackage was derived from the MAP programme, which was based on a concept by Tomlin (1990). In his book Tomlin gives a brief introduction to raster and vector software. He discerns two major differences between raster- and vector-oriented GIS software:
- a raster-oriented GIS stores its information in grid squares, defined by rows and columns, whereas a vector-oriented GIS stores the coordinates of each location at which a boundary line changes direction, or boundary lines intersect;
- with vectors greater precision can be achieved than with grid squares.

The first characteristic has considerable effects on the size of the data files. This results in a relatively high speed when processing data. This speed is of importance if a user wants to work with the GIS software interactively, e.g. to evaluate

each step that has been carried out, which is regarded as essential for designing and carrying out methods in planning.
The greater precision of vector maps should be taken into consideration. However, the precision of raster maps can be enhanced by reducing the grid cell size[3]. In the case study, a grid size of 100 x 100 metres was considered to be satisfactory. With this grid size, all elements of at least 200 x 200 metres are mapped; this is acceptable, given the regional level of the planning exercise, which used maps of 1:50,000. Three other differences between raster and vector packages mentioned by Tomlin concern data preparation, presentation and interpretation[4]. All these aspects can play a role in the choice between raster and vector packages.
During the planning process the GIS performed various tasks, as described in section 7.2 and Appendix II. The GIS procedures can be categorized in four groups:

1. data input
2. data management
3. data processing
4. data output.

Input procedures
Information can be fed into an Information System in various ways. In the underlying research, basic knowledge was input by digitizing and importing external data. Furthermore, new objects or attributes were added by on-screen editing of maps. Scanning techniques to import data were not employed within this project. The information derived from other institutes were digitized or derived from satellite images. Based on the experiences of the case study it is possible to give some recommendations for digitizing.
Digitizing data (activity 15 section 7.2) is a laborious activity and is often underestimated[5]. In the case study, digitizing, acquiring and correcting data took up roughly, one third of the project. Thorough preparation before starting a digitization project can save time later. To prevent the digitization of superfluous information, the question of which information is really essential to the project should be answered first.
It is advisable to start with a pilot project. In the case study, the digitizing project of the topographical map comprised a pilot project, systematization and preparation of the information on the maps, digitizing and correction. During the pilot project a small area was digitized. In the light of this project, the guidelines for the digitization of the topographical map were fixed. Clear guidelines about which objects have to be digitized, nomenclature, size of the objects to be digitized and direction of digitizing of the polygons have to be given, especially when the digitization is carried out by various persons. It is advisable to keep a log during the project.
The technique of digitizing a map is also an important aspect, which is closely related to the functioning of the software package[6]. Based on the pilot study, the

most appropriate technique can be chosen. In the case study, two approaches were followed: the topographical map was digitized as a whole, and the geomorphological map was unfolded into three layers.
The digitizing should be carried out conscientiously, as correcting an object afterwards is far more time-consuming than the digitizing of the object itself. Nevertheless, a correction stage after the digitization is unavoidable.
Although a digitization project is normally carried out for a specific project it is advisable to build up a set of data which can be used in several projects, thus saving time and money for the development of data in subsequent projects. On the other hand, each project may have specific demands for information, legends and scale. If a map with basic information is digitized, e.g. a soil map or a topographical map, the most adequate way seems to be to digitize the required objects as shown on the map, without any interpretation. The attribute information assigned to the objects should contain the description given by the basic map. This way enables the information to be used in various projects. Attributes of relevance to the specific project can be assigned during the digitization or at later stages.

Data management
Once digital data are available, the data have to be corrected, updated, changed or transformed to be used in other GIS packages. The correcting of digitized data has already been discussed in the preceding section. In the case study, the conversion of data was carried out at activity 15: structuring, digitizing and pre-processing data (section 7.2). The experiences in the case study illustrate the problems one can face concerning limitations of the hardware and software and with the conversion of data.
The conversion of the various data from one format to another took a considerable time. Conversions were necessary because of the limitations of the software and hardware which were outlined above, and because the data from external sources were supplied in formats which differed from the GeoPackage format.
Problems and delays during a project can be minimized if, before a project is started, it is checked whether:
- the GIS software used allows various formats to be converted and can handle the size of the datafiles which have to be processed,
- the space available on the hardware system is sufficient to handle the datafiles.

Of course, the time spent in transforming data can be significantly reduced when working with one GIS package containing all functions that are required, in hardware surroundings which provide enough space and speed to handle large data files. However, this will not always be possible.

Data processing
The case study allows conclusions to be drawn about the interactivity of the process, the formalization of methods and the use of other software.

The activities of data processing are illustrated by Figure 7.4 and the flow charts in Appendix II. These diagrams illustrate that the employment of GIS in planning is an interactive process, in which there is continuous communication between GIS-software and planner. Segments of the planning process which could be designed beforehand and be performed automatically were scarce, and many ideas about possible criteria and planning goals arose during the planning process. Decisions about the progress and direction of the planning process were made when working with the GIS, based on the evaluation of results of the GIS commands.

Furthermore, Figure 7.4 and the flow charts in Appendix II illustrate that GIS could only be employed if methods could be described in a formal way. Based on this observation the options for employing GIS in planning, using formal models, will be discussed in section 10.2.

Limits to the abilities of GIS packages sometimes make it necessary to combine GIS software with other software, e.g. spreadsheets[7)].

The interactivity of the process places demands on the GIS package. Tomlin, who was quoted earlier, mentioned the speed as an advantage of raster software. This speed enables the user to perform calculations on-line and to examine each map resulting from a GIS command on the screen. This enables the user to decide whether to repeat the action with other criteria, to select other GIS commands to realize the desired result, or to continue with the process.

The processing of thematic data is best performed on data stored in a database attached to the GIS. This offers better options for performing calculations within the GIS and for manipulating thematic data.

Output

The presentation is an important aspect determining the attention a plan receives. As one of the purposes of the reconnaissance planning approach is to initiate a discussion about the desired spatial development, the visualization of its results should receive ample attention.

The results of the processing stage in the case study were spatial models which visualized possible directions for development of the study area. In the GIS the spatial model, which is a type of theoretical model, was transformed into a formal model, composed of coordinates and attributes. During the output stage these formal models were converted back into spatial models which take the form of maps describing the spatial organization in the area.

Two categories of output were produced during the planning process: rough maps, and maps which can be presented to a wider audience. Both types of output could be presented on screen or on paper. The presentation of the latter type of output took a considerable time[8)].

It can be concluded that the two types of maps which were produced had different functions. The first category can be characterized as 'intermediate maps to be evaluated and interpreted by the planner on the screen' (see activity 22, plan construction, section 7.2), the second category can be characterized as maps which have to be comprehensible to a wide audience. The development of the second type of map requires specialists who combine GIS and cartographic knowledge, and the work involved should not be underestimated.

10.2 The necessity of modelling in a GIS-supported planning approach

An important aspect of using GIS in planning is the way activities and procedures are formulated to be understandable to the GIS.
In Chapter Two, *'The Use of Models when Exploring Possible Development of Spatial Organization'*, the importance of modelling when employing GIS in a planning process was discussed. Theoretical models can provide the necessary theoretical framework to approach reality and apply (GIS) methods and techniques to deal with problems regarding reality. Formalized theoretical models are the basis of the successful application of information systems in planning processes.
In the case study, the *MFO* model formed the theoretical framework for the description and analysis of the object. It also defined the natural and social context within which the methods and techniques are applied. The use of a specific method or technique can be influenced by specific natural, political, cultural or economic circumstances in an area. Thus, the context in which a method is applied may determine its success or failure. Furthermore, a systematic study of the natural and social settings of an area in the analysis can be used in the evaluation phase, to identify the boundaries of desirability, possibility and probability, as described by de Jong (see section 2.3, note 8).
In the case study three groups of theoretical models were employed:
- a model describing the object of planning, the spatial organization: the *MFO* model,
- models describing relations and processes within the spatial organization,
- models of segments of the planning process carried out.

The theoretical models consist of maps, diagrams or texts. Formalizations of these models, e.g. the MCF files in the case study, may be applicable generally. When using these models, however, the specific context in which the models were developed should be studied first, to assess the applicability of the models.
When using Information Systems, the procedures and the knowledge of experts regarding the planning object are described by the formal models which are part of the Information System.

Modelling the planning object
The planning object of the case study was described by a theoretical model, the *MFO* model, which was outlined in section 2.2. This model was employed successfully to describe the intentions, to formulate descriptions, interpretations

and concrete intentions of the area, and finally it was employed in the plan-generating stage.
Firstly, the model proved to be a good base for the systematization of the normative knowledge, the intentions (activity 6, section 7.2) which described the attitude to the economic and political subsystems. The base of the intentions was derived from the cultural subsystem: the premise of man's relation to nature.
Secondly, the *MFO* model played an important role in the description of the object, as the systematization of the object was derived from the model. The model can provide a reference to assess the completeness of any description, this can be illustrated by an assessment of the case study.
In the case study, emphasis was put on the description of the physical organization, as the planning exercise involved claims made by the social organization on the physical organization. The subsystems of the social organization played various roles in the case study. Regarding the economic subsystem, only the agricultural aspect was chosen to represent the claim of the economic subsystem on the physical organization. The cultural subsystem of the region was described briefly. At the beginning of the case study detailed research into the views and premises of important actors within the planning field in Noord-Brabant was carried out; however, these views and premises were not described further in the research. Fundamental premises about the relation between man and nature were derived from sources which were described for other regions or at a global level. The political subsystem in the study area was studied from monographs (e.g. van der Laken, 1990).
Finally, in the plan-generating phase the MFO model made the object of planning manageable and open to discussion. It provided insight into the variables and processes which had to be taken into account, as it systematized the object and its subsystems. Based on this insight the relevant relations were identified and formalized, to develop the spatial models in the GIS. Which relations were modelled will be discussed in the following section.
The *MFO* model provided a framework for the classification of the basic data, which were organized according to the systematics of the model. The basic data employed in the GIS can be regarded as formalizations of the descriptions of the subsystems. Maps, which were characterized in section 2.1 as 'theoretical models of a concrete system (the real world)' described the socio-physical organization of the area. When these maps were digitized, they were formalized in coordinates and attributes. The coordinates formed the geographical components of the object. The attributes identified the function or contents of the object, which was based on the classification of the *MFO* model. The *MFO* model proved to be a good classification for the organization of the normative and object knowledge in the *RISOR* system, as will be illustrated in the succeeding chapter.

Modelling relations and processes
Relations and variables were identified based on the systematization of the *MFO* model. As the case study focused on agriculture, the relations mainly concerned

the relations between agriculture and the abiotic and biotic subsystems of the physical organization.

The description of these relations can be regarded as theoretical models. The knowledge of disciplinary experts was required for the construction of these theoretical models. Economic knowledge was used primarily for modelling the relations within the anthropocentric planning process, whereas ecological knowledge was mainly employed for the ecocentric planning process. For employing the theoretical models in the GIS, they were formalized into formal models.

In the anthropocentric intention an economic approach dominated the planning process. Causal relations between farm size, intensity, production and economic strength were formalized. The formalized relation between the social organization and the physical organization concerned the relations between soil suitability and claims from agriculture. The decision to withdraw agricultural land from production for the development of nature was based on a theoretical model of the Agricultural Economic Institute (de Graaf and Tamminga, 1990), which predicted the spatial consequences of a market-oriented policy on dairy products (see section 6.3).

In the ecocentric intention the conflicting relation between agriculture and valuable nature areas was regarded as the principal problem. These relations were enumerated in section 5.3: acidification, eutrophication, 'drying up' and disturbance. The relation between the source of these hazards and the nature areas was simplified, by assuming that the impact of all hazards is counteracted by creating a zone of 500 metres around natural areas[9)], in which ecological agricultural methods have to be practised. Is was assumed that by practising ecological methods, agriculture would sustain nature and landscape, and would support the development of gradients at the fringes of woods, wooded banks and the management of natural meadows and grasslands in stream valleys. The formalized relations between the vegetation of ecotopes and the underlying abiotic subsystem were based on expert knowledge derived from literature (Bink et al., 1979).

In the evaluation phase of both planning processes the costs of the changes in land use were formalized in GIS procedures based on the relation between the acreage converted from one land use into another (Groen et al., 1989).

It can be concluded that during the case study formal models were used in three ways:

- as simplified generalizations, e.g. modelling the impact of agricultural activities on nature, and modelling the economic strength, based on three indicators;
- to operationalize relations mentioned in literature, with the help of specified criteria, e.g. to identify areas for the development of specified ecotopes;
- to attach values to specified spatial interferences.

In section 2.1, I quoted Friedman, who warns that models describe only a part of the reality. This can be illustrated by the models described above. Experts may argue that the economic strength or the impact of agricultural activities on nature should be assessed with different methods, using different variables. Furthermore, it may be very well possible that a successful development of nature areas, is influenced not only by aspects of the physical organization, but also by the social organization.

Modelling segments of the planning process

The flow chart in Figure 7.4 is an example of a theoretical model of the planning process, which was explained in section 7.2. In the flow chart moments at which GIS was used are shown. At these moments formal models were used.

The following activities were formalized and performed with the help of the GIS software:

1. structuring, digitizing and preprocessing of the basic information of the physical organization in the study area, in the form of vector and raster data;
2. provide support to the analysis for the anthropocentric intention focusing on the spatial dispersal of statistical data and agricultural suitability of the abiotic subsystem;
   provide support to the analysis for the ecocentric intention focusing on the ecological suitability of the abiotic subsystem and selection of specified ecotopes;
3. in the plan construction phase of the anthropocentric intention, the combining of maps from the analysis stage according to decision rules which were drawn up;
   in the plan construction phase of the ecocentric intention, the processing of the suitability maps to assign areas to specified ecotopes or agricultural land use, creating buffer zones and supporting on-line drawing of new areas;
4. in the evaluation phase, performing calculations which concern such spatial aspects as acreage and comparison of planned and actual land use.

The plan-generating phase within a planning process supported by GIS does not differ fundamentally from plan generating in a traditional planning process. Both follow a cyclic process of analysis, construction and evaluation. For the case study it can be concluded that theoretical models were used alternately with moments which could not be modelled or planned at all. This is illustrated by the plan-generating phase of the case study as described in section 7.2, activities 17-31. Theoretical models, i.e. ideas about the relations within *MFO* model, formed the base of the planning goals and criteria. Furthermore, formal models were employed for the analysis and processing with GIS. No models could be used at the strategic moments when it was decided which models had to be used or how the process had to be organized. Also, when more complicated political considerations played a role, e.g when locations for enlargement of heather areas were chosen, the intuition and judgement of the planner was the deciding factor.

10.3 GIS in planning

The preceding section discussed the functions that the GIS software performed in the planning process of the case study. To perform these functions, the management and processing of object knowledge, process knowledge and normative knowledge has to be described in formal models. However, planning cannot be narrowed down to the groups of input, data management, processing and presentation. Therefore, in this section I will discuss the employment of GIS in planning more generally. Some conclusions, mostly based on the case study, will be drawn about the prospects for using GIS in a planning process.
GIS cannot be used if formal models cannot be constructed properly for lack of sufficient knowledge about a subsystem or process. Theoretical models cannot be employed to describe unpredictable economic, political or cultural processes within the social organization. To cope with these aspects the planner requires social skills, flexibility and creativity[10)].
As the application of GIS was only possible for methods described in a formal way, an entire planning process cannot be automated. Therefore, we may describe a planning process supported by GIS as a process consisting of moments in which theoretical models and formal models are used to model the object of planning, alternating with moments in which no models can be used. Nevertheless, it can be concluded that GIS as a tool can contribute positively to the aspects of 'planology' as defined in section 3.3, and to a spatial planning process in general.

1. Employing GIS in a planning process enables the user to integrate and manipulate large amounts of assorted information. Because of this, the descriptions and models of the characteristics and problems of the spatial organization, can be highly detailed, thus corresponding more to the real world, than the more general spatial models in 'manual' planning processes.

In the case study the object data were very detailed: soil maps, land cover maps and geomorphological maps. This detailed information was combined and processed, retaining its detail, which resulted in more detailed spatial models than the spatial models resulting from traditional methods. In traditional methods, e.g. the methods of McHarg mentioned in section 3.3, the information is put on overlays which are generalizations and interpretations of the basic object information. Manually, only limited overlays can be made.

2. Knowledge derived from experts, can be described in formal models. The collection of these models can be developed and extended within successive planning exercises, thus building up a reservoir of knowledge which describes the planning object and explains its characteristics and problems[11)].

During the plan construction, object knowledge is manipulated on the basis of normative knowledge, using specific methods and techniques. These methods and

techniques may be developed interactively in the GIS software, or may be existing registrations of previously developed GIS methods. The methods are developed in consultation with experts and may be employed in other planning exercises. Of course, doing this the context and characteristics of the planning process and its object should be taken into account.
The integration of normative knowledge and object data can be based on rational decisions invoking specified GIS functionalities[12)], but it can also be the result of a creative idea or of inexplicable policy considerations. The GIS can support both exercises: in the case study at activity 24 (plan construction) the areas in which peat was to be developed were identified by GIS procedures, and the interactive choice of where heathland should be enlarged was only supported.

3. Working with a GIS enables the planner to evaluate the consequences of alternatives quickly, dealing with 'what if...' questions, using various goals, criteria or assumptions. This enhances the flexibility of the planning process and supports the search for possible solutions to the problems that have been identified.

Theoretically, it is also possible to evaluate alternatives using manual methods. However, time and labour are constraints to these methods. The interactive use of GIS makes it possible to evaluate the results of each GIS procedure (see section 10.1). If the results of a method were not satisfactory or alternatives had to be evaluated, criteria could be changed simply, and the GIS procedure could be repeated.

4. Presentation techniques shift from drawing techniques in the traditional planning, towards programming and on-screen editing in GIS supported planning. The results of the processing of data can be presented on maps without interpretations or generalizations. Therefore, the results form a full reflection of the planning process carried out, which enhances the evaluation of both process and resulting plans.

The maps which were shown in Chapter Eight are the results of the planning process which was carried out. All designated land uses are somehow related to criteria that were used and choices that were made during the planning process. To make changes on the resulting maps, criteria have to be changed or added.
If manual methods had been used, it would have been difficult to relate designations on the final maps to explicit choices and criteria employed within the planning process.

5. Because the planning process followed was recorded it is possible to evaluate and discuss the methodological aspects of that process.

Because all the GIS procedures which were carried out were recorded, and the planning goals, criteria and choices were also stated explicitly, the planning process followed can be reconstructed. As a result of this, the planning process will become more systematic and explicit, provided that the processes, object data and goals which were used have been recorded. If not, the GIS will maintain its 'black box' character, into which information is imported and from which results are exported.

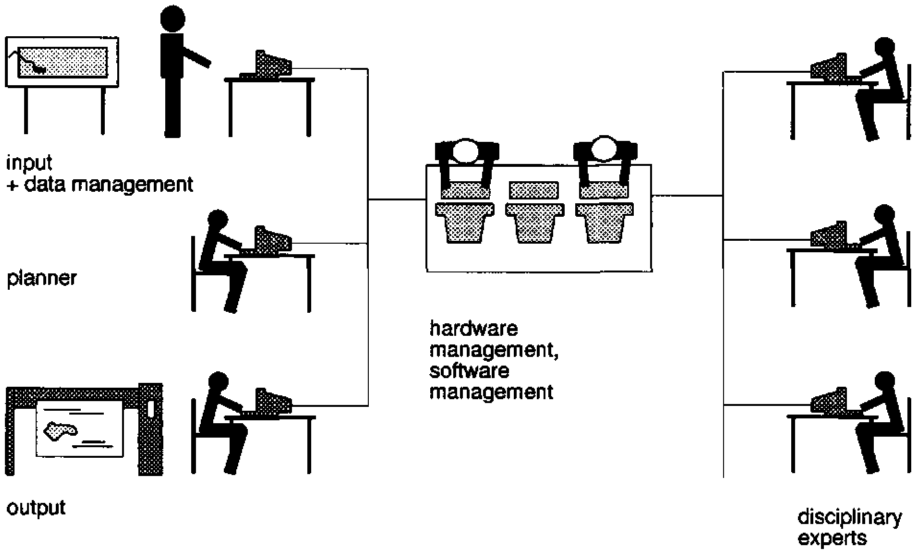
6. In Chapter Three, Carter was quoted as defining GIS as an institutional entity, reflecting an organizational structure. This structure includes various types of expertise which should be present so that GIS can be used in a planning process. The planner, for example requires insight and experience with the functions of the software package, as he should be able to concentrate on methodological questions related to the planning process and be able to select the appropriate functions of the software. Other aspects concern input, output, hardware and software management. Constraints on software, hardware and data might influence or even determine strategic decisions during the planning process.

An optimal organizational environment for employing Information Systems and supporting planning processes enables the planner to concentrate on the planning process itself. Otherwise, as in the case study, much attention will be spent on problems connected with the management of hardware, software and data. In the case study it was concluded that data input and output, i.e. presentation, require specialized knowledge. During the case study various experts were consulted.
Based on these experiences, an ideal organizational setting of an Information System supporting planning processes can be delineated. Such an organizational setting comprises various tasks and skills which should be present in the team operating the GIS, as illustrated in Figure 10.1.
These tasks include:

- input and management of data of various projects,
- performance of the planning process with the GIS,
- output and cartographic presentation of results,
- hardware management,
- programming of software applications.

The knowledge used in the GIS starts with the input of data, is then processed by the planner, and ends with the output of information. During the planning process the planner uses and integrates the knowledge of several experts. Ideally, these experts have an on-line connection with the planner, performing the process, in order to supply additional knowledge and to evaluate interim results.
A systematic approach is essential to prevent one losing one's way while acquiring a vast amount of data, techniques or GIS functionalities which are irrelevant to the planning process.

Figure 10.1 The ideal organizational structure to perform a reconnaissance planning process supported by an Information System.



A systematic, problem-oriented approach and a continuous critical examination should avert the risk of the GIS organization becoming a goal in itself, thus producing a planning process determined by the technology itself, which creates its own organization of scientists and finances, focusing solely on developing the technique and identifying problems to be solved with that technique. Problems that are identified should originate from the physical (biotic or abiotic) or social organization, rather than from a desire to use or develop a technique.

10.4 Summary

In this chapter I discussed the question of how GIS could support an operationalization of the reconnoitring planning approach, based on the experiences of the case study. The raster software used in the case study offered good opportunities for the modelling of the object and the modelling of segments of the planning process itself. In particular the speed, ability to evaluate the results of each step and the facilities for registering the process with the help of command files, contributed to these opportunities.

At the start of a GIS-supported planning process, a suitable methodology and analysis model should be chosen to serve as a basis for the planning process. On this basis the problems, data and appropriate GIS functionalities can be chosen. All GIS functions, which were categorized into four groups, possess their own

specific problems and requirements. All hardware and software has its own constraints which may make it necessary to use other software.
It was concluded that GIS can be employed only for those activities which can be described in formal models. As a planning process was described as a process consisting of moments in which theoretical models and formal models are used alternating with moments in which this was impossible, we may conclude that an entire planning process cannot be automated.
Before starting a GIS-supported planning process it should be carefully considered if and where the use of GIS will support the process. The advantages of the use of GIS compared to 'traditional' planning processes, are mainly related to its speed and ability to cope with large quantities of complex information. Also the ability to register the knowledge of experts and the support of presentation offer advantages. The development of knowledge systems will not only contribute to more attention being paid to the knowledge employed in the planning process, but will also enable the experience and expertise of specialists and other planners developed in earlier projects to be used.
Because GIS obliges the user to work systematically and explicitly, the planning process becomes transparent, in contrast to the 'black box' it often is at present.
It may be presumed that GIS will enable the discussion of the spatial models resulting from a planning exercise and facilitate the scope for discussion of the process itself, notably for the reconnaissance planning approach. An appropriate organizational environment in which the GIS operates is a prerequisite for the optimal use of these advantages.

Notes

1. Although the circumstances are not discussed, their influence on the project should not be underestimated. Circumstances such as available budgets and manpower, available hardware and software facilities and bureaucracy within the organization can be decisive factors for the progress of the project. The case study with the GEO-package was carried out on a Tulip 386 SX. Due to the constraints of the GIS package on the PC, some activities had to be carried out in the Arc-Info GIS package, which ran on a micro VAX.
2. The experiences of this research were made with the raster module of the GIS package (GeoPackage 3.0). A vector-oriented package (ArcInfo 5), was used for transformation and presentation of data. The latest release of ArcInfo (ArcInfo 6.1) also comprises a raster module: Arc-GRID.
   The conversion of data from and to Arc-Info comprised the following transformations:
   1. *Transformation of Landcover maps with a 25x25 grid to 100x100 grid:*
      LGN 25x25 -> .SVF format 25x25 -> coverage, manipulations in Arc-Info -> .SVF, command (POLYGRID) -> .VAE format.
   2. *Transformation of .VAE formats:*
      .VAE format -> .SVF format -> coverage, manipulation in Arc-Info -> .SVF format -> .VAE format.

   .SVF is the Arc-Info grid format,
   .VAE is the GEO-package grid format.
   Transformations to an .SVF format were made using software: LGN2SVF and SVF2VAE (developed by R. van Zoest, CGI). Unsolvable problems occured at the transformation of vector

data which were digitized in the GEO-package and were converted into ARC-Info coverages. These problems are connected with the systematics of data storage in both packages.

3. The extent to which the grid size may be reduced is determined by the scale of the maps on which the grid-maps have been based. This is discussed in GIS literature, but not elaborated on within this study. Van der Meer and Van der Knaap (1991) give a formula to calculate the reliability of objects on a digitized map: $N_{xy}=(N_{dig}*S)/f$ in which, $N_{xy}=$ the accuracy of the terrain XY (metres), $N_{dig}=$ accuracy of the digitizer, f= relation number map/terrain, S= map scale. For the geomorphological map. $N_{dig}=0.2$ mm (Calcomp 9100 digitizer), S = 50,000, f = 1000 (mm on digitzer, m in the terrain) thus, $N_{xy}=$ 10 metres, the location of points or lines on the digital map have an accuracy of 10 metres in the field.
4. In this study the data available were both raster data (the land cover information) and vector data (the digitized maps). Presentation was by raster maps. The difference regarding interpretation is characterized by Tomlin as follows:
   Raster: position-oriented, recording characteristics that are associated with locations.
   Vector: theme-oriented, recording locations that are associated with characteristics.
   Tomlin conludes that for this reason 'raster structures are generally better suited to the interpretation of "where", while vector structures are better suited to the interpretation of "what"'.
5. In a Geographical Information System, an object is normally represented by two aspects: a description of the characteristics of the object (thematic) and information about the location of the object (geometrical). It is also possible to add a third category, giving information about aspects of time.
6. In the GeoPackage which was used for digitizing in the case study, objects are digitized. The attributes and other information are attached to the object. If two objects posess a common border, this border line is stored twice, separately for each object. Other packages, e.g. Arc-Info follow different approaches,for example by digitizing the lines, points and polygons and creating the 'topology' of the objects at a later stage.
7. In the raster software employed in the case study, thematic data were not stored in a database connected with the grid maps, but as attributes which could not be processed. The package had, for example, the option to use only integers as grid cell values. Therefore, a spreadsheet, had to be used for calculations such as multiplying and calculating percentages. These manipulations were carried out on thematic data, not on geographical data. After the calculations in the spreadsheet, the results were attached to the objects in the GIS
8. The resulting maps were transfered from the GeoPackage to the Arc-Info software. The simple black-and-white maps were edited with the Arc-Plot module and presented as vector maps. The complex maps were processed in the Arc-Grid module of Arc-Info 6.0. The colour maps were separated into the three main colours, for the printing process. All maps were printed as 'PostScript' files.
9. This model was inspired by the former 'guideline on intensive husbandry' of the Ministry of Agriculture, which prohibited the expansion of intensive husbandry farms within a zone of 500 metres around valuable nature areas.
10. Foqué (1975, p. 30) cites Alger and Hays who define creativity as 'the ability to choose the right line of action out of a number of alternatives, too great to evaluate beforehand, which are not only original but also effective. This adds the condition of effectiveness to the condition of originality'.
11. A prerequisite for this is the ability of the package to record the GIS commands that were performed and to operate on macro command files, in which several GIS commands are structured describing the model.
12. Described by van Lammeren as 'action' moment, see section 2.4.

11 THE RISOR CONCEPT AND SYSTEM

One of the objectives of this research stated in section 1.1, was to assess whether 'the structure of the prototype of the RISOR system is sufficient to store the knowledge acquired during a planning process'. The *RISOR* information system is based upon a perception of the reconnaissance planning approach, which is described by van Lammeren in his thesis. He unfolds the planning process into action phases and action moments, as was described in section 2.4. Furthermore, he categorized the knowledge used during the planning process into four groups: process, normative, object and method knowledge. In this chapter, I will comment upon this viewpoint, based on the experiences of the case study.
In section 3.5 (Figure 3.1) six possible ways of using the *RISOR* system were discerned. Of these, four were partially employed and actually tested in the case study:

1. using the GIS functions for processing data and recording the process,
2. description of normative knowledge,
3. description of process knowledge,
4. description of object knowledge.

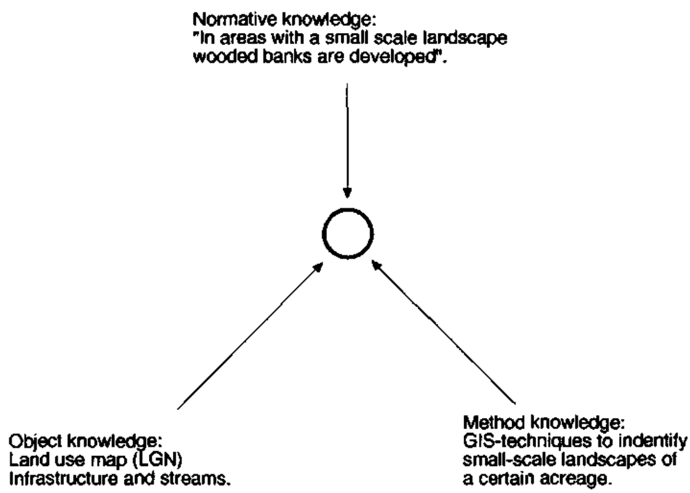
In the first application the project subsystem of the *RISOR* system is used. In section 3.5 I already pointed out that this subsystem has not yet been integrated with the knowledge subsystem, but still functions separately. How the GIS functions were used in the case study was described in Chapter Seven and Appendix II, which paid attention to the methods used. The conclusions drawn from these experiences were discussed in Chapter Ten. This chapter will focus on conclusions that can be drawn from the experiences with the input of the information in the *RISOR* system. These experiences, which were described in Chapter Nine, were obtained using the prototype of the system. The difficulties that arose during the case study may have their roots in the design of the *RISOR*, or in the implementation of this concept in a software system.

11.1 Process knowledge

A discussion about the applicability of *RISOR* in a reconnaissance planning process can be based on comparing the planning process described by van Lammeren, which forms the base of the *RISOR* system, with the planning processes carried out in the case study. In section 10.2 it was argued that GIS can be employed only for methods which can be described in a formal way. Using these methods, the object data are processed to develop spatial models, based on the normative knowledge. The GIS techniques that constitute a method are described in command files of the GIS package, an example of which is shown in Appendix IV. In addition, the command files contain a description of the norma-

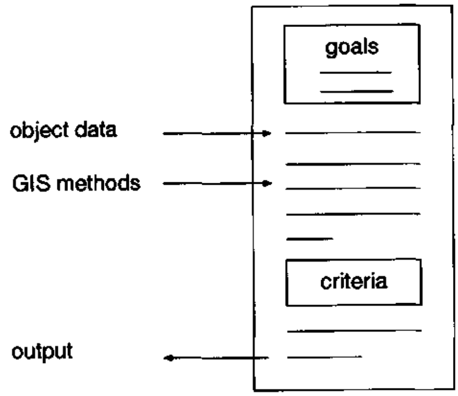
tive knowledge which formed the base of the planning action, and the object knowledge which was processed during the action. Thus, the command files are to be regarded as a description of the action moments, according to the RISOR concept. Figure 11.1 illustrates the establishing of an action moment in the case study. The action moment is formalized in a command file of the GIS software, as shown in figure 11.2. The process knowledge in the command files links the action moments to a planning process.
The formalized methods in the command files constitute the formalized knowledge of experts. The systematic description of the process in the command file, integrating methods, premises and object data, is to be regarded as formalized knowledge of the planner

Figure 11.1 Example of an 'acting moment' in the case study in which the knowledge types are integrated.



The formalized process knowledge stored in the *RISOR* system, can be characterized as 'meta' information, because it describes the knowledge of the planning experts and the knowledge of the disciplinary experts. To be stored in the *RISOR* system, the process knowledge has to be formalized, on the interpretation of the reconnaissance planning approach described in section 2.4.
In Figure 11.3, the systematization of the planning process as described by the *RISOR* concept is compared with the process carried out in the case study, which

Figure 11.2 Structure of a 'Macro Command File' which registers an 'action moment' in which normative, object and method knowledge is integrated. See Appendix IV.



was described in Chapter Seven. The heading of the scheme describes the reconnaissance planning process of the case study. This model will be discussed at greater length in the following chapter. The phases discerned by van Lammeren are marked in the scheme of Figure 11.3. The column on the right gives the structure of the process knowledge in the *RISOR* system as was described in section 9.3.

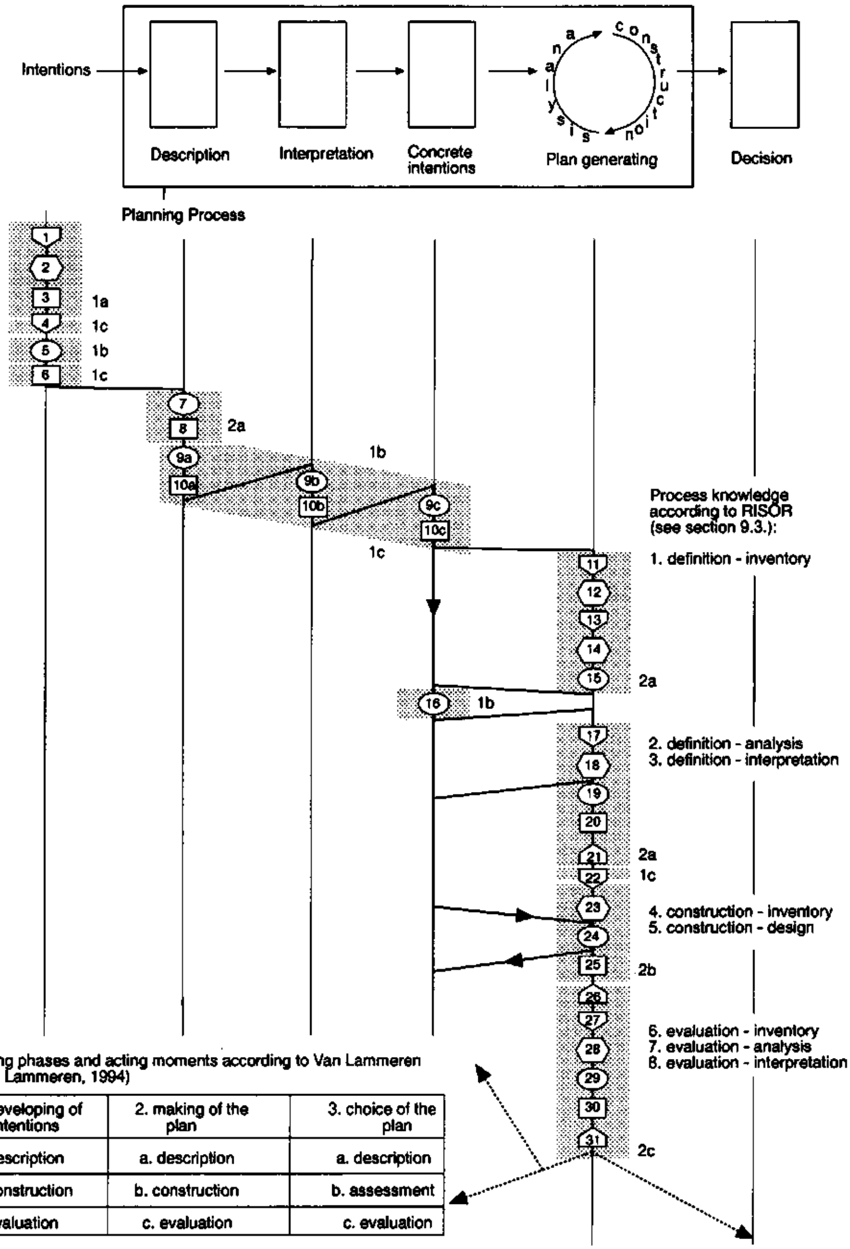
Based on the comparison of the concept, which forms the basis of *RISOR*, and the case study, it can be concluded that all phases identified by van Lammeren could be distinguished in the case study. However, the scheme illustrates that the planning phases were not performed sequentially. In particular, the development and use of normative knowledge were interwoven with other phases of the planning process, during description, interpretation, concrete intentions, and the plan construction.

The major conclusion regarding the input of the system in section 9.3 concerns the flexibility of the PROCESIN module. The option of attaching various related files to a file in which the process is described, or to attach various substages to one file would fit in with the complexity of a planning process. The structure of the system, described in section 9.3, turned out to be in accordance with the structure of the process knowledge used in the case study, as illustrated by the column on the right in Figure 11.3.

11.2 Normative knowledge

Van Lammeren classifies the normative knowledge into three levels of integration of the contents of the statements (see sections 2.4 and 9.4): integration, aspect and subaspect. In the case study, however, the normative knowledge was organized according to its abstractness and phase in the planning process. This resulted

Figure 11.3 Comparison of the planning process carried out in the case study and the process as systematized in the *RISOR* concept



1. developing of intentions	2. making of the plan	3. choice of the plan
a. description	a. description	a. description
b. construction	b. construction	b. assessment
c. evaluation	c. evaluation	c. evaluation

in three levels.

1. Intentions: intentions described how the subsystems of the social organization had to be organized, and how the social organization and the aspects nature, agriculture and recreation had to be related. These normative descriptions formed the basis of the reconnoitring process. They had a high level of abstraction, integration and had a global significance.
2. Concrete intentions of the aspects: the concrete intentions outlined the future of the aspects within the intention that was chosen. The concrete intentions were formulated on a regional scale and sketched prospects for aspects of the spatial organization: nature, agriculture and recreation.
3. Planning goals: in the plan-construction phase, the normative knowledge took the form of goals which described the contents and location of the planning objects. The object were both aspects (agriculture, nature) and subaspects (specified ecotopes). The criteria which were part of the planning goals are also to be regarded as normative knowledge.

It is possible to characterize the normative knowledge in the case study in accordance with van Lammeren, on the extent of integration of the contents. However, the classes of integration, aspect and subaspect were not related to specific phases in the planning process or to a specific spatial scale. The intentions at a global level concerned 'integration' and 'aspect' level, concrete intentions at a regional level concerned 'aspects' and 'subaspects', and, finally, the planning goals at a regional level concerned 'aspects' and 'subaspects'. The act of developing and using normative knowledge can be identified in each exercise of reconnaissance planning; however, this knowledge can be developed at various stages of the planning process, as the case study illustrated (Figure 11.3, phase 1). The *RISOR* concept assumes that for each level of normative knowledge (integration, aspect or sub-aspect), spatial models are developed. By contrast, the case study had a different approach. The development of spatial models of the intentions was based on planning goals. No spatial models were derived directly from the intentions or concrete intentions. The planning goals described the normative starting points for spatial models regarding aspects (nature, agriculture), and subaspects (agricultural branch and various ecotopes). However, the intentions and concrete intentions did influence the integration of these spatial models in the final stage. The integration of the resulting spatial models of the anthropocentric and ecocentric intentions, as shown in Chapter Eight, was based on the concrete intentions which described the relation between the aspects of nature and agriculture. The integration of the anthropocentric intention started from the agricultural aspect, whereas the integration of the ecocentric intention started from the ecological aspect.

Based on the comparison of the case study with the *RISOR* concept it can be concluded that the classification of the normative knowledge according to the *RISOR* concept was satisfactory. Nevertheless, it is important to increase the flexibility of the system by adding the ability to employ other classifications of the normative knowledge. The normative knowledge which forms the basis of a planning process will not always be structured as described by the three types of *RISOR* concept.

11.3 Object knowledge

The object data used in the case study were digitized maps, processed satellite images and statistical data. The knowledge-oriented structure of the *RISOR* system discerns basic data, intermediate data and plan data. The basic data describe the real world, intermediary data describe results of stages in the planning process, and plan data describe resulting spatial models. All three data types can be input in planning processes.

The basic data used in the case study were described in Chapter Five, the intermediate data are shown on various maps in Chapter Seven, and the plan data which represent the resulting spatial models are described and displayed in Chapter Eight.

The *RISOR* system offered good opportunities to store the descriptions and references of the object knowledge. The remarks regarding the storage in the system concern the flexibility in the classification of the object data.

11.4 Method knowledge

The method knowledge comprises the procedures to process object knowledge, to develop spatial models. In the preceding chapter, section 10.2, the method knowledge in computer-supported planning processes was characterized as formalized procedures to process object data. These procedures are based on theoretical models of processes between and within subsystems of the *MFO* model which are derived from experts.

In the *RISOR* system, references to the method knowledge is only indirectly stored. The method knowledge is described in the command files of the GIS package which describe the process knowledge. In the *RISOR* system itself, information about the methods only can be stored in the form which registers the sources of the processes. In the case study, methods were developed during the planning process, in the context of the problems which were met. The development was based on experience, literature and advice of experts. Methods can be formalized using any command language of a GIS package.

As the formalized methods constitute the knowledge of the experts, it is advisable to extend the module which registers the meta information about the process with a form in which source, contents and applicability of the methods are described. This provides the user with information about the knowledge of experts which is available.

11.5 Prospects of RISOR

Employing RISOR to support reconnaissance planning

The *RISOR* system is designed to support the reconnaissance planning process in various ways. Figure 3.1, section 3.5, illustrated the functions for which the *RISOR* system is designed.

In this research the system was used only for recording knowledge and using the GIS functions. Once the knowledge has been stored in the system, it may be used to develop alternatives in other areas, based on the existing normative and process knowledge and new object knowledge. Another application is to develop alternatives in the same area, based on modified or new normative and/or process knowledge. The knowledge stored in the system may be derived from experts, thus making this knowledge available to non-experts and enabling planners to use this knowledge in a planning process. The ability to record the planning process may also enable decision-makers to reconstruct and discuss the planning process and the normative knowledge which it was based on. All these abilities of the system still have to be refined and explored further, as will be described in section 13.1.

Recording the knowledge used during the planning process enables a collection of knowledge to be built up which is at the planner's disposal. The reconnaissance planning approach, as described in section 2.3, is not a blueprint for an approach. During the process insight is gained into the consequences of intentions, new methods are developed and more knowledge is acquired about the natural and social organization and the relation within its systems and sub-systems. The planning process is regarded as a 'learning process'.

The case study illustrated how the *RISOR* system can play a role in supporting this learning process by offering means of storing the knowledge which is created during the process, or offering knowledge developed in preceding planning exercises.

The *RISOR* system can save information about the formalized object and process knowledge. In section 10.2 it was concluded that a planning process only partly employs formal models. Activities which cannot be formalized often involve strategic choices in the planning process. Descriptions of these non-formalized moments are not stored in the *RISOR* system. To store references to information which was used during these moments, such as letters and minutes, the databases have to be adapted. The *RISOR* system can thus be regarded as a 'filing cabinet' for knowledge, which can be retrieved by the planner.

Flexibility is a prerequisite for any expert system which aims to support a planning process. The first general remark on the *RISOR* system in section 9.5 concluded that the prototype did not yet have the ability to support planning on-line. This would be enhanced if the system provided the option of approaching each database at random, at any moment within the process. Such a flexible system would have to provide the option to add, change or view data in the

databases. The databases of the prototype tested in this research could only be accessed by forms which had to be filled in a fixed sequence.
The application of knowledge in other planning exercises and the reconstruction of a planning exercise which was carried out were two applications for which the *RISOR* was designed, but which were not tested in this research. When employing knowledge which was developed in earlier planning exercises, the context in which this knowledge was developed should be taken into account. Knowledge is developed within the context of a natural and social organization.
Most methods have been developed to solve a specific planning problem. Therefore, variables which are specific to the planning context in which the method was developed can influence the applicability of the methods in other planning exercises. Object knowledge is directly related to a specific planning object. Therefore, this can only be applied in other planning exercises if the planning object of the second exercise is identical to the first exercise, or if identical objects occur in a different area.
The *RISOR* system is tailored to support the reconnoitring planning approach. In addition, the separate modules of the system could be used for other functions. For example, the object database could be used for administrative purposes, storing references to available data within an organization.

The User Interface
Section 3.5 outlined a 'user interface' which supervises the employment of the functions. The prototype of the *RISOR* system enables the user to communicate with the knowledge subsystem, in which the descriptions and references of the knowledge are stored. The user interface has to coordinate the knowledge subsystem and the project subsystem, which comprise the GIS software. A user interface with such a coordinating task should be able to extract the information from the knowledge subsystem, recover the files in which the actual data are stored, and process the data with the GIS software in the project subsystem. The design of the user interface is determined by the type of user, which can be a GIS expert, a planner, a decision maker or any citizen.
As the *RISOR* is a 'referential knowledge system' it has the flexibility to refer to the results of different GIS packages and data formats. Any GIS package which contains the abilities to register the process is appropriate. Therefore, it seems undesirable to fully integrate the knowledge subsystem and the project subsystem. If one specific GIS software module is integrated in the *RISOR* system, the flexibility to employ various GIS packages will diminish. However, maintaining the ability of using various GIS packages will place high demands on the flexibility of the user interface.

11.6 Summary

Although the overall conclusion of Chapters Nine and Eleven is that the structure of the *RISOR* system met with the requirements to store the knowledge types acquired during the case study, some suggestions for improving the system were made. These suggestions concern the conceptual description of the *RISOR*, and the implementation of this concept in a software system.
The suggestions were based on the experiences as described in Chapter Nine.
The suggestions concerned four main topics:
a. flexibility in the classification of the knowledge,
b. flexibility of the system in accessing the database,
c. adding modules for storing information about the method knowledge,
d. improving the system's user-friendliness.

Suggestion a. concerned the *RISOR* concept, notably the way in which a process and its 'action moments' are described. Suggestions b, c and d concerned the implementation of the *RISOR* concept in a software system, and should be regarded as suggestions from a 'user' to a 'system developer', who has to improve the prototype of *RISOR*.

re. a. The flexibility in the classification of knowledge concerned the possibilities of choosing various 'main information categories' and the options of relating more than one preceding or succeeding file to the normative and process files.
re. b. In section 11.5.1 it was concluded that the flexibility of the system to support a planning process would be enhanced if the system offered the option of accessing the databases to add, change or view data at any desired moment.
re. c. Adding a database in which information about the source, contents and author of method knowledge is recorded would enable the user to assess the methods which were or could be used in a planning process.
re. d. In Chapter Nine some suggestions were given to improve the user-friendliness of the screens, 'help' facilities and the keys by which the forms are manipulated.

The concept behind the planning process which formed the base of the *RISOR* system was evaluated with the help of Figure 11.3 in which the phases of the case study were compared with the phases as discerned in the *RISOR* concept. It was concluded that all phases identified in the *RISOR* concept could be distinguished in the case study too. However, it became clear that, the phase of developing intentions of the *RISOR* concept occurred in various phases of the case study.
Finally some rough outlines were given for a user interface which could coordinate the communication between user, knowledge subsystem and project subsystem.

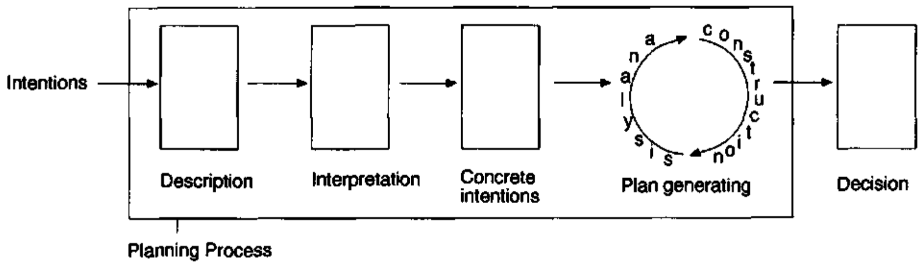
12 METHODOLOGICAL ASPECTS OF DEVELOPING POSSIBLE DIRECTIONS OF DEVELOPMENT

The objective of the research started with the basic question regarding the methodology: 'How can the reconnaissance planning approach be operationalized at a regional level?'. This question was answered by carrying out a case study at regional level. The case confirmed that GIS could be an important aid for the operationalization of the reconnaissance planning approach, although the use of GIS itself caused some difficulties which were partly due to the specific capabilities of hardware and software. In the first section of this chapter it will be established that the case study was a component of the reconnaissance planning approach.
In Chapters Ten and Eleven it was reviewed how information systems played a fruitful role in the case study. Based on this exploratory study, it can be concluded that the reconnaissance planning approach itself seems a promising methodolology which has substantial advantages, which will be discussed. An application of this methodology in practice would be an asset to planning practice. Although the feasibility of applying the reconnaissance planning approach in planning practice was not examined in this research, the experiences gained in the case study and the dialogue with the planning authorities of Noord-Brabant provide sufficient material to present a preliminary discussion on this.

12.1 The case study as an example of reconnaissance planning at a regional level

Since Kleefmann developed his model of a reconnaissance planning process by describing the planning process as an 'action' in 1985, (Figure 2.3), different elaborations of this approach have been made. In the preceding chapters it was illustrated how GIS could contribute to the operationalization of a reconnaissance planning process. Furthermore, it was argued that modelling is a prerequisite for the use of GIS. Finally, it was shown how the *RISOR* was capable of storing information about the knowledge used and developed during the planning process. What is left in order to draw the conclusion that the case study demonstrates that the reconnaissance planning approach can be operationalized at a regional level with the use of GIS and *RISOR*, is to ascertain to what extent the case study is an example of the reconnaissance planning approach.
Van Lammeren divides the cyclic reconnaissance planning process into three stages: the development of intentions, the making of plan alternatives and the choice of the plan, dividing each stage into three phases: description, construction and evaluation. This classification formed the base for the concept of *RISOR*. The process of the case study is depicted in Figure 12.1.

Figure 12.1 Model of the planning process of the case study



Intentions
The case study started with the construction of intentions, on which the planning process was based. The intentions are positioned outside the planning process, which reflects the responsibilities of the formulating of the intentions. In the philosophy of reconnaissance planning, the intentions are ideally the result of a political discussion without considerations of power or strategic elements. Participants in this discussion could be politicians, interest groups and organizations, scientists, etcetera. The principal responsibility of the planner in this discussion is to convert the intentions into knowledge which is of spatial relevance, in order that it may be used in the planning process. However, in the cases study, the intentions were developed by the planner himself.

Description
The planning process started with the description of the planning object (the spatial organization), and the outlining prospects and planning goals. In his model of planning as an 'action' (Figure 2.3) Kleefmann positions the 'description' in the stage of the 'definition of the situation'. Van Lammeren includes this activity in the definition stage of the plan-making (section 2.4). In the case study, the description of the object was carried out as an objective quantitative description of the characteristics of the object, which is not influenced by normative aspects. It delineated the economic situation of the agriculture and the state of nature in the area (see Chapter Five).

Interpretation
In the action process of Kleefmann, the 'definition of the situation' also comprises the interpretation of the object, and a description of prospects. In the case study,

the interpretation of the situation of the object is part of the normative knowledge which was described in Chapter Six.

Concrete intentions
The concrete intentions outline the prospects, and possible solutions to the problems stated at the interpretation. The intentions are influenced by the intentions, and regarded as normative knowledge (see Chapter Six).

Plan generating
In the plan-generating phase, two possible spatial models were developed. The act of plan construction is the central activity in reconnaissance planning. According to the model of the process by Kleefmann, in this phase the prospects and goals are projected onto the spatial organization, to illustrate the spatial consequences of the intentions. The plan generating is to be regarded as a cyclic process of analysis and construction. The methods used in the evaluation stage can be considered as similar to the methods used in the analysis stage.
The planning process ends with a discussion about the most desired spatial model. Based on this discussion the spatial models, the intentions and concrete intentions could be adjusted and the process could start again. However, this discussion was not part of the case study.

Decision making
The plan generating and decision making are regarded as two separate activities. Van Lammeren and Kleefmann describe the phase of decision making as a separate phase, following the plan generating. The case study concluded with the onset of an evaluation within the plan-generating phase. The decision-making stage was not considered, as this was not regarded as the final responsibility of the planner. As with the drawing up of intentions, decision makers and other social actors are involved in this phase.

Results
According to Kleefmann the tentative policy programme must comprise the following facets (see section 2.3):
- a cartographic image of the prospects,
- a description of the future spatial organization and its the management aspects,
- a financial analysis.

The results of the case study comprise a plan for the area based on the two premises (see the maps in Chapter Eight). The legends to the plans provide a starting point for management guidelines. A rough financial analysis of the plans also forms part of the results. In Chapter Eight the future spatial organization according to the two premises was also described.
It was pointed out that reconnaissance planning exercises should be the work of an interdisciplinary team of planners and specialists working together. This was

not the case in the underlying research, which underlines the caution with which the results should be evaluated.

12.2 Reconnaissance planning and planning practice

Although this research did not focus on the applicability of the reconnaissance planning approach to the practice of planning, it seems worthwhile to discuss this briefly. This discussion will be based on a comparison of the case study with planning practice in Noord-Brabant.

Assets of the reconnaissance planning approach to planning practice
Although the gap between the academic setting of the reconnaissance planning approach and planning practice may seem hard to bridge, aspects of this approach can benefit planning practice. A more explicit description of intentions, methods and object knowledge can be incorporated in planning exercises in practice. This will enhance the consistency and clarity of planning processes[1]. Reconnaissance planning exercises enhance insight into the consequences of policy decisions, which support the decision-making process in which the most appropriate and desired future developments are discussed. The monitoring of the policy intentions in the effectuation phase will also be facilitated by explicitly stated policy intentions and object knowledge[2].
Given the changing position of government in society, noted by the Dutch Scientific Policy Council (WRR, 1983), it is desirable to introduce elements of the reconnaissance planning approach. As stated in section 1.2, the Council regards government as a co-figure in the 'market of society', its task being to point out the consequences of choices that are made and to encourage the debate about the desirable future spatial organization.

Problems to be solved, to apply the reconnaissance planning approach in practice
An overview of the main differences between planning practice and the reconnaissance planning approach, indicate the problems that need to be solved before elements of the latter approach could be successfully introduced into planning practice. A planning process in practice is carried out within a social context. To date, the operationalization of the reconnaissance planning approach has been limited to academic planning exercises. Significant differences between a planning process in practice and the 'academic' reconnaissance planning approach have been found:

- in practice, the planner operates under pressure of time, within time limits connected to procedures, consultations and, political priorities which are often unpredictable;
- the planning process in practice is a very strategic process, involving many persons, and it may be decisively influenced by political considerations and power balances;

- in practice, public discussion and decision-making focus on the resulting plans, rather than the plan's normative base and options, or the methodological aspects of the planning process;
- the starting points of a planning process in practice are formed by problems determined by the 'political agenda'[3];
- in practice, the planning process is directed at the implementation of the plan, within the social limits of 'possibility', rather than on 'desirability' regarding the social or environmental problems.

The differences between the reconnaissance planning approach and planning practice are mainly caused by the planning context within which the planning exercise is carried out. An open debate, based on arguments rather than interests or other political strategic considerations, may be possible in an academic environment, but in practice it is still difficult.
A study of the normative knowledge contained in the plans of the provincial government of Noord-Brabant led to the conclusion that the objectives of the province are pragmatic, aiming for political feasibility, and that these objectives are derived from various, sometimes conflicting premises (van der Laken, 1990). This is understandable, given that the provincial policy is a result of a strategic process of negotiation. Often the intentions of the actors who influenced the plan are not stated explicitly, but can only be deduced by reading between the lines. Explicit choices increase the likelihood of political conflicts or rejection of the plan. It is within this field of tension that a planner has to operate in practice.
For the introduction of elements of the reconnaissance planning approach in practice to be successful, the planning practice has to incorporate the following aspects:
- the planning has to be based on verifiable knowledge of the object and processes within the object, and a description of the process providing insight into the methods employed in the planning;
- intentions, goals and criteria, and methods used during the process have to be stated explicitly, so they can be discussed;
- the plans must be the result of an open discussion which focuses on the underlying normative premises and the associated spatial models, based on arguments;
- normative premises, e.g. derived from programmes of political parties, have to constitute the starting point of the process; the 'problems' are derived from an interpretation of the object, based on explicitly stated intentions;
- the planning process has to be directed at encouraging the discussion about the desired future organization.

Augmenting the results of the reconnaissance planning approach with a description of social and natural processes that have to be initiated if the scenario is to be realized, would promote the relationship between reconnaissance planning and planning practice.

12.3 Summary

In this chapter, not only conclusions based on the case study were drawn, but the prospects for future applications of the methodology in practice were discussed.
From a comparison of the planning process carried out in the case study with the reconnaissance planning process as described by van Lammeren and Kleefmann, it can be concluded that the case study is not a comprehensive example of a reconnaissance planning approach: it was not the result of an interdisciplinary team, the intentions were not the result of a political discussion and there is no final discussion or decision about the resulting spatial models. Nevertheless, the case study can be regarded as an example of the first section of a reconnaissance planning process, although restricted by constraints on time and available labour. Therefore, it may be concluded that the reconnaissance planning approach could be operationalized at a regional level by using GIS, although the limits of this laboratory environment should be taken into account.
A genuine reconnaissance planning exercise does not comprise the drawing up of intentions or the decision making stage. These stages are not regarded as the principal responsibility of the planner. However, in the academic settings of the case study in this research, the planner had to develop the intentions himself. Nevertheless, the planner has an important task in the stages of formulating intentions and decision making, for the intentions have to be defined in such a way that they can form a basis for further planning. At the decision-making stage, the responsibility of the planner is to present the spatial models and reports of the planning process in such a way that the decision-making process is optimally supported.
In the second section of this chapter, the differences between the planning practice and the reconnaissance planning approach were discussed. The changing position of government in society seems to advocate planning exercises with an exploratory character. The gap between the planning practice and reconnaissance planning could be bridged by applying aspects of the reconnaissance planning approach in practical planning exercises. A description of the processes which have to lead from the presence to the future situation would enhance the reconnaissance planning approach. The application of explorative planning exercises, the answering of '*what if ...*' questions, will certainly strengthen the process of searching for the most appropriate and desired future spatial development.

Notes

1. In his book *'Kennis en Ruimtelijk Beleid'* Arts (1991) shows, that actually, in planning practice, knowledge is not used very consciously, nor very systematically and implicitly. Arts advocates a concept of knowledge management with the following rules:
   - explicitly described knowledge, but which is still flexible enough to be employed,
   - knowledge accessible to the organization and not only belonging to an individual,
   - determine the knowledge sources, the availability and influencing factors, in relation with the decision situation of the planner.
2. In the Province of Noord-Brabant, research is carried out into the development of an information system to support the monitoring of the implementation of spatial policy. In the system, policy statements and relevant object data to monitor these statements are described (Gombert, 1989).
3. The processes of identification and formulating of problems by the political system should be regarded as unrelated processes. Politicians may identify a problem which was identified by academics long before, academics may identify problems which are not regarded as a problem by politicians, or politicians may raise a problem which scientifically is not regarded as a problem at all (van Staalduine, 1991). This underlines the normative aspect of the identification of problems in an area.

13 TOPICS FOR FURTHER RESEARCH

This research was the first exploration into the application of GIS and *RISOR* at the reconnaissance planning approach. Therefore, I hope that its results and conclusions will serve as starting points for various further studies: on the continuing operationalization of reconnaissance planning, on the application of GIS in planning and on the refinement of the *RISOR* system. Subsequent research on the feasibility of operationalizing reconnaissance planning with the help of information systems could focus on various aspects discussed in this chapter.
The further research on GIS, decision support systems and expert systems, will focus on the improvement of the information technology. Within this research, the applications and development of *RISOR* can be prominent. Research on modelling and formalization will study how knowledge can be modelled in theoretical and formal models. Methodological aspects will focus on the reconnaissance planning approach, notably how knowledge is used and how the planning process has to be organized. The various aspects can be studied separately, but also may be combined in various projects.

13.1 Information Systems

In the early days of the development of information technology for the support of planning, the developing of software applications was an important theme of research. This research resulted in valuable knowledge, experiences and modules that could be employed in planning processes. Nowadays, it seems that geographical information technology has come of age. Producers and developers of software release GIS software packages that have been developed in close collaboration with the research world and practice. New demands on software functions are quickly incorporated into new releases. The specialization and experience of the developers often guarantee well tested and user-friendly operations. This development diminishes the need to focus scientific research on the development of GIS techniques. Therefore, academic research, should concentrate on innovative research, e.g. the development of methods which have not yet been implemented, and the development of decision support and expert technology. This research has to be carried out in close cooperation with commercial software developers, as it is their task to implement the techniques and to improve the user friendliness of the software. Furthermore, research into the use of information technology in planning should now focus on applications and methodological issues.
The development of GIS as an organizational structure (see the definition of Carter in section 3.2) requires much attention. The relation between experts and the GIS-supported planning process demands particular research attention. The

knowledge of methods from various disciplines is formalized in GIS procedures. Ways of developing and applying this knowledge should be studied in collaboration with experts from various disciplines.

In the *RISOR* system, the communication between the user and the system takes place via the user interface. Usually, that is not a functionality which is part of the GIS software package supplied by the developer. It has to be tailored to a specific field of application and geared to the users; this requires detailed research.

- A user interface can be modified to match the experience and knowledge of the user or to his specific interests. The development of user-friendly interfaces may facilitate the use of GIS by inexperienced users who are unacquainted with the GIS software commands. Before a user interface can be designed these users have to be described: should the users be planners, administrators, managers, politicians, scientists or laymen?
- A study of the organizational context in which the system has to function: how does information flow in the organization, what questions will be asked, what knowledge must be available?
- In the *RISOR* system, the user interface coordinates the communication with and between the process subsystem and the knowledge subsystem. It has to be flexible and should not force the user into a specific straitjacket. Nevertheless, the degree to which the user is directed by fixed procedures can be discussed, and is connected with the application of the system and the profile of the user.

Subsequent planning exercises with the reconnaissance planning approach using the *RISOR* system could involve two topics. The first is to test the ability of the information system to support planning exercises offering knowledge stored in the system. In the case study described in this thesis, the system was filled with knowledge generated for the study area Midden-Brabant. If the *RISOR* system is able to support planning exercises, it should be able to support a second case study in which the reconnaissance planning approach is operationalized. A study area for such a case study area should be comparable to the case study of Central Brabant, thus limiting the study areas to small-scale Dutch landscapes on a sandy soil (see Figure 4.1). In such an exercise the object knowledge has to be supplemented with basic data of the new study area. The normative knowledge and the method knowledge of the Brabant study could be applied within the second case study. Based on such a study, further recommendations to the design of the prototype of *RISOR* could be made.

A second topic, which will comprise several projects, can be studied after modifications and adjustments to the prototype have been made, and the system can be regarded as fully operational. The second topic concerns the operationalization of the reconnaissance planning approach with *RISOR* focusing on the object of planning. In these studies, a reconnaissance planning process would be carried out. The intentionalities would be derived from a political debate, and converted by planners into operational statements. The knowledge concerning the various aspects would have to be provided by experts from various disciplines who are also involved in the evaluation of preliminary results.

13.2 Modelling and formalization

Aspects of modelling the object of planning, of planning processes and the feasibility of formalizing these theoretical models, will be part of the research into application of RISOR and operationalization of the reconnaissance planning approach. These aspects were concluded to be the crucial questions when examining the possibilities of employing GIS in planning processes. Research into these questions will involve experts on the aspects of the systems and subsystems studied. The model of the socio-physical organization offers a framework for the structure of such research.

This research has to focus on the development of theoretical models of the spatial organization, its systems and subsystems and the processes and claims between these subsystems.

Within the natural organization:
- abiotic aspects
- biotic aspects.

Within the social organization:
- economic aspects
- political aspects
- cultural aspects.

The planner's task will be to operationalize these models in the context of a reconnaissance planning process, exploring the spatial consequences of various policy options.

The formalization of such a planning process supported by information systems is another topic deserving substantial attention for the further development of the *RISOR* system. The design of this process is to be regarded as an interactive process between a GIS and the planner, comprising formalized methods as well as moments at which GIS cannot be employed because of the complexity of the information or desired rational or irrational moments of decision-making or creativity.

13.3 Methodology

A study of the reconnaissance planning approach and how information systems can contribute to this approach may be structured by the different knowledge types discerned: object knowledge, method knowledge, normative knowledge and process knowledge. Research into the use and systematization of the object

knowledge comprises the study of systems and subsystems, structured according to the *MFO* model. Further research into the elaboration of this model in specific planning contexts, i.e. in various areas with a specific socio-physical organization, can prove the value of this model for analysis.
Research to develop and assess the method and object knowledge required for specific disciplines will focus on methods used for analysis and evaluation by the individual disciplines. Within the context of the research into the application of information systems, this research will focus on the feasibility of formalizing this knowledge in automated GIS procedures. This research should be carried out with continuous feedback to experts from the various disciplines.
The process knowledge could be augmented by analyzing future-oriented planning processes carried out in academic environments, as well as in practice. The link between reconnaissance planning and planning practice will improve if scenarios are part of the results. These scenarios which were defined by van Vught in Chapter Two, note 6, have to depict the social and physical processes which should lead the present organization in the direction of the desired future. To provide leads for the planner as to how spatial models and policy programmes can support the planning process optimally, the way decision-making processes are organized and carried out can be studied.
The development of normative knowledge shaped as consistent intentionalities and programmes requires substantial attention. The planner's task is to analyze the normative knowledge and to convert it into notions which are of spatial relevance. This places demands on how the normative knowledge is organized and formulated. Although at present it is problematical to derive normative knowledge from practice, it is possible to determine the spatial consequences of parts of policy statements, and to discuss their desirability or feasibility.
The case study described an operationalization of the reconnaissance planning approach using information systems. Based on insight into the planning process of the province of Noord-Brabant the prospects of applying reconnaissance planning in practice were discussed. However, this comparison cannot be regarded as a full comparative study between the reconnaissance planning approach and planning practice. Further research could involve studies comparing the reconnaissance planning approach and planning practice, both in a traditional, 'manual', way and supported by information systems. This research could provide leads for the introduction of reconnoitring elements in planning practice or for broadening the reconnaissance planning methodology with knowledge derived from planning practice.

SUMMARY

Goal

One of the themes of the research at the Department of Physical Planning and Rural Development in Wageningen Agricultural University is the planning within the field of tension between sustainability and flexibility. This research has resulted in a method called the 'reconnaissance planning approach', first described by Kleefmann, in which possible directions of development are formulated for an area. The aim of this approach is not only to find the best possible spatial organization for an area, but also to encourage the discussion about the normative choices that underlie a planning process. Information systems are regarded as valuable means to operationalize this methodology.

Another Wageningen researcher, van Lammeren, developed a prototype of a planning support system named *RISOR*. The structure of the *RISOR* system was based on an analysis of the planning methodology as described by Kleefmann. The research described in this thesis is a further elaboration of the work done by van Lammeren and Kleefmann.

Its main goal was:

'To operationalize the methodology of 'searching for possible directions of development' (i.e. the reconnaissance planning approach), at a regional level, using Geographical Information Systems. From the results of a case study, it should be possible to evaluate the concept of the planning support system *RISOR* and to assess that system's structure in terms of its capacity to store the knowledge used and generated during the case study in an accessible way'.

This goal was expressed in three questions:

- how can the reconnaissance planning approach be operationalized at a regional level?
- how can Geographical Information Systems support such an operationalization?
- is the structure of the prototype of *RISOR* sufficient to store the knowledge acquired during the planning process?

At the beginning of the research, a study area had to be chosen. The choice was determined by methodological considerations, availability of data and opportunities for cooperation with colleagues during the research. These considerations resulted in the catchment areas of the lowland brooks Beerze, Reusel and Voorste Stroom in the province of Noord Brabant being selected as the study area. For practical reasons, the research was limited to agriculture and nature, particularly their physical aspects. Additionally, some economic information was derived from economic statistics.

Methodology

In the case study, a reconnaissance planning process was carried out, within the constraints described above and the practical and methodological constraints connected with the laboratory situation in which the process was carried out. Because of the conceptual nature of the planning theory and *RISOR*, plus the limited experience regarding GIS applications in planning and the constraints of the available facilities, this research was exploratory in nature.

The aim of the research was to carry out a reconnaissance planning process with the help of GIS and to describe systematically the main knowledge types discerned by the *RISOR* information system: object, normative and process knowledge. The methods used during the planning process constitute the 'method knowledge'. Subsequently, these knowledge types had to be stored in the databases of *RISOR*.

The object knowledge was generated by collecting and digitizing. The planning process began with the formulation of normative notions for the plan construction and the drawing up of the accompanying plans. Final stages of the process were the visualization and the evaluation of the resulting plans. The planning process was done using GIS. Finally, the knowledge used in and resulting from the case study was stored in the *RISOR* system. To make this possible, the planning process carried out had to be described in terms of the *RISOR* concept.

Results

The spatial organization in the study area, i.e. the object of planning, was described according to the systematics of a theoretical model of the socio-physical organization. So that they could be inserted in the GIS, these theoretical models were formalized. Both types of models constitute the basic object knowledge used in the case study.

In this case study, three types of normative knowledge were discerned, based on their abstractness and on statements regarding the planning process. The most abstract normative knowledge was called 'intention'. Two intentions were formulated:

1. an anthropocentric intention, with privately owned means of production and a governing body that 'follows' the market, from a technocratic position,
2. an ecocentric intention, with privately owned means of production and a governing body that 'guides' the market in a sociocratic way.

In the process knowledge, the normative, object and method knowledge are integrated. A systematic description of the planning process constitutes the process knowledge. A description of the various (GIS) methods and techniques which had been employed formed part of the process knowledge. The planning process in the case study was unfolded into four phases: description, interpretation, concrete intentions and plan generation. It was preceded by the formulation of intentions and followed by the decision-making phase. These six phases were taken as a guideline for the systematic description of the planning process. The resulting maps of the plans show the possible spatial organizations for the two normative intentions. The final part of the case study involved storing the knowledge categories in the *RISOR* system.

Conclusions

In answer to the question of how GIS could support an operationalization of the reconnaissance planning approach, it is concluded from the experiences obtained during the case study that the raster software used in that study was an adequate tool to model the object and the segments of the planning process itself. Its speed, ability to handle large quantities of complex data and to evaluate the results of each step, and the facilities for registering the process with the help of command files proved essential. Furthermore, it is concluded that at the start of a GIS-supported planning process, a suitable methodology and analysis model have to be chosen to serve as a basis for that process; it should be carefully considered if and where the use of GIS will support the process.

Another conclusion is that GIS can only be used for activities that can be described in formal models, and therefore it is not to be expected that an entire planning process can be automated. The development of knowledge systems will probably not only lead to more attention being paid to the knowledge used in the planning process, but will also allow the experience and expertise of specialists and other planners that was developed in earlier projects to be exploited. The advantage of the reconnaissance planning approach is that by using it the planning process will lose its 'black box' character, and that GIS will enable the discussion of the spatial models resulting from a planning exercise to be brought forward and will enlarge the scope for discussing the process itself.

Although the overall conclusion is that the structure of the *RISOR* system satisfied the requirements for storing the types of knowledge acquired during the case study, the system could still be improved further by making its classification of the knowledge and access to the database more flexible, adding modules for storing information about the method knowledge, and increasing its user-friendliness.

Regarding the planning methodology, it is concluded that the case study was not a true replication of a reconnaissance planning approach, as it was not the result of interdisciplinary teamwork, the intentions were not the result of a political discussion and there was no final discussion and decision about the resulting spatial models. Nevertheless, the case study illustrated the first section of a reconnaissance planning process, restricted by constraints on time and available labour. It certainly demonstrated that reconnaissance planning could be operationalized at a regional level using GIS, within the constraints of the laboratory setting of the study.

As the changing position of government in society seems to advocate exploratory planning exercises, the applicability of the reconnaissance planning approach in practice was discussed. It is concluded that the application of reconnaissance planning exercises would strengthen the process of searching for the most appropriate and desired future spatial development.

SAMENVATTING

Doel
Eén van de thema's van onderzoek aan de Vakgroep Ruimtelijke Planvorming van de Landbouw Universiteit Wageningen, is de planning in het spanningsveld tussen dynamiek en duurzaamheid. Dit onderzoek resulteerde in een planningsbenadering genaamd 'richtingzoeken'. In deze planningsbenadering, beschreven door Kleefmann, worden mogelijke ontwikkelingsrichtingen voor een gebied geformuleerd. Het richtingzoeken beoogd niet alleen de best mogelijke ruimtelijke organisatie voor een gebied te vinden, maar vooral ook wil het de discussie over de normatieve keuzen die aan het planningsproces ten grondslag liggen stimuleren. Informatiesystemen worden verondersteld een belangrijke rol te kunnen spelen bij de operationalisering van het richtingzoeken.
Een medewerker van de vakgroep, Van lammeren, ontwikkelde een prototype van een planningsondersteunend systeem, onder de naam *RISOR*. De structuur van het *RISOR* is gebaseerd op een analyse van de planningsmethodologie van Kleefmann. Het onderzoek dat in dit proefschrift wordt beschreven is een vervolg op het werk van Van Lammeren en Kleefmann.
Het hoofddoel was: 'Het operationaliseren van het richtingzoeken op regionaal niveau, met behulp van Geografische Informatie Systemen. Met behulp van een case studie moest het concept achter het *RISOR* geëvalueerd worden, en de mogelijkheden van het systeem om de tijdens het planningsproces gebruikte en ontwikkelde kennis op te slaan onderzocht worden.
Dit doel werd vertaald in drie onderzoeksvragen:
- hoe kan het richtingzoeken geoperationaliseerd worden op het regionale niveau?
- hoe kunnen Geografische Informatie Systemen een dergelijke operationalisering ondersteunen?
- voldoet de structuur van het *RISOR* om de tijdens het planningsproces gebruikte en gegenereerde kennis op te slaan?

De keuze voor het studiegebied voor het onderzoek werd bepaald door methodologische overwegingen, beschikbaarheid van data en mogelijkheden voor samenwerking gedurende het onderzoek. Deze overwegingen leidden tot de keuze van het stroomgebied van de beken Beerze, Reusel en Voorste Stroom in Noord Brabant. Om praktische redenen werd het onderzoek ingeperkt tot de aspecten landbouw en natuur en in het bijzonder de fysieke aspecten daarvan. Daarnaast werd in beperkte mate economische informatie verwerkt.

Methodiek
In de case studie werd een deel van een proces van richtingzoeken doorlopen, binnen de hiervoor beschreven beperkingen en binnen de methodologische beperkingen die de 'laboratorium situatie' waarin het onderzoek zich afspeelde met zich meebracht. Omdat zowel de planningstheorie van het richtingzoeken én

het *RISOR* nog in een conceptueel stadium verkeren, omdat de ervaring met GIS toepassingen in planning beperkt was én vanwege beperkingen in de beschikbare faciliteiten heeft het onderzoek een verkennend karakter.
Het doel van het onderzoek werd bereikt door het richtingzoeken uit te voeren met behulp van een GIS en vervolgens de hoofd kenniscategoriën die gedurende het proces werden gebruikt te beschrijven volgens de systematiek van het *RISOR*: object kennis, normatieve kennis en proces kennis. De methoden die gedurende het planningsproces gebruikt werden vormen de methoden kennis. Tenslotte werden deze kennis typen opgeslagen in het *RISOR*.
De object kennis werd gegenereerd door het verzamelen van informatie en het digitaliseren van deze informatie. Het planningsproces startte met het formuleren van normatieve opvattingen voor de plan constructie en het construeren van de bijbehorende plannen. Tijdens het planningsproces werd gebruik gemaakt van GIS. Aansluitend werd de kennis opgeslagen in het RISOR systeem, waarvoor het planningsproces beschreven moest worden volgens de systematiek van het *RISOR*.

Resultaten
De ruimtelijke organisatie in het studiegebied, het object van planning, werd beschreven met behulp van een theoretisch model van de maatschappelijk-fysieke organisatie. Om deze informatie in een GIS te kunnen gebruiken moesten deze theoretische modellen worden geformaliseerd tot formele modellen. Beide typen modellen vormen de object kennis die tijdens de case studie werd gebruikt.
In de case studie werden drie typen normatieve kennis gebruikt, onderscheiden naar hun abstractieniveau en naar het onderwerp waarop zij betrekking hadden. De normatieve kennis op het hoogste abstractieniveau werd 'intentie' genoemd. Er werden twee intenties geformuleerd:
1. een anthropocentrische intentie, met privaat eigendom van de produktiemiddelen en een overheid die de markt volgt vanuit een technocratische houding,
2. een ecocentrische intentie, eveneens met een privaat eigendom van de produktiemiddelen, maar met een overheid die de markt stuurt vanuit een sociocratische houding.

De proces kennis wordt gevormd door een systematische beschrijving van het planningsproces. Deze kennis beschrijft de wijze waarop normatieve, object en methoden kennis worden geïntegreerd. Een beschrijving van de diverse GIS methoden en technieken die gebruikt werden tijdens het planningsproces zijn onderdeel van de proces kennis. Het planningsproces is uiteen gelegd in vier fasen: beschrijving, interpretatie, concrete intenties en plan constructie. Het planningsproces werd voorafgegaan door de formulering van intenties en gevolgd door de besluitvormings fase. Aan de hand van deze zes fasen werd het doorlopen proces beschreven. De resulterende kaarten geven een indruk van een mogelijke ruimtelijke organisatie behorend bij de twee opgestelde normatieve intenties. Het laatste deel van de case studie betrof het opslaan van de kennis categorieën in het *RISOR* systeem.

Conclusies

Als antwoord op de vraag hoe GIS een operationalisering van het richtingzoeken kan ondersteunen wordt aan de hand van de case studie geconcludeerd dat het raster pakket dat gebruikt werd een geschikt instrument vormde om het object en het onderdelen van het planningsproces te modelleren. Met name van belang hierbij waren de snelheid, de mogelijkheid om grote en complexe data bestanden te bewerken, de mogelijkheid om na elk commando de tussenresultaten te evalueren en de mogelijkheid om het doorlopen proces te registreren. Ook wordt geconcludeerd dat voordat aan een planningsproces met behulp van GIS wordt begonnen, een eenduidige planningsbenadering en een beschreven analyse model moet worden gekozen, als basis voor het proces. Van te voren moet zorgvuldig overwogen worden in welke fasen van het proces GIS op een zinvolle manier in te zetten is.

Een tweede conclusie is, dat GIS enkel te gebruiken is bij activiteiten die beschreven kunnen worden in formele modellen. Daarom is het niet te verwachten dat een planningsproces volledig geautomatiseerd kan worden. De verdere ontwikkeling van GIS in de richting van kennis systemen zal niet alleen leiden tot meer aandacht voor de kennis die tijdens het planningsproces gebruikt wordt, maar zal het ook mogelijk maken om kennis van andere planners en vak-specialisten, ontwikkeld in andere projecten, te gebruiken. Het gebruik van GIS bij de planningsmethodologie van het richtingzoeken zal planning ontdoen van haar 'black box' karakter en het zal de discussie over de ruimtelijke modellen die het resultaat zijn van het planningsproces beter bediscussieerbaar maken. Ook zal het de mogelijkheden vergroten om het proces zelf beter te bediscussiëren.

Alhoewel de eindconclusie luidt dat de structuur van het *RISOR* voldoet om de verschillende kennis typen gebruikt tijdens het planningsproces op te slaan, kan het systeem nog verder vervolmaakt worden. Met name moet de classificatie van de kennis en de toegankelijkheid van de databases van het systeem flexibeler gemaakt worden, kunnen modules toegevoegd worden om de informatie over de methodenkennis op te slaan en kan de gebruikers vriendelijkheid vergroot worden.

Ten aanzien van het richtingzoeken zelf wordt geconcludeerd dat de case studie niet een volledige exercitie van richtingzoeken was, omdat het niet het resultaat was van interdisciplinaire samenwerking, omdat de intenties niet het resultaat waren van een politieke discussie en omdat er geen besluitvormende discussie plaats vond over de resulterende ruimtelijke modellen. Niettemin is de case studie een illustratie vaan een eerste cyclus van een proces van richtingzoeken, beperkt door de randvoorwaarden gesteld door beschikbare financiën en menskracht. De case studie toont aan dat richtingzoeken met behulp van GIS geoperationaliseerd kan worden op een regionaal niveau, zij het binnen de randvoorwaarden van de laboratorium situatie van het onderzoek.

De veranderende maatschappelijke positie van de overheid pleit voor verkennende toekomstgerichte onderzoeken, waarbinnen een discussie over de zinvolheid van richtingzoeken zeker past. In dit onderzoek wordt geconcludeerd dat de toepassing van het richtingzoeken een waardevolle ondersteuning kan zijn voor het zoeken naar de meest geschikt en de meest gewenste ruimtelijke ontwikkeling.

GLOSSARY

action	The process of doing something.
Arc-Info	A GIS software package.
concrete intention	A description of how the socio-physical organization or aspects of it should be organized for a specific area and context.
decision support system	Any computer-based system from database management or information systems via simulation models to mathematical programming or optimization could conceivably support decisions (Fedra and Reitsma, 1991).
expert system	A computer system that uses a representation of human expertise in a speciality domain in order to perform functions similar to those normally performed by a human expert in that domain (Goodall, 1985).
forecasting planning	A planning technique which aims at predicting and visualizing future developments.
formal model	A formal model is a symbolic assertion in logical terms of an idealized relatively simple situation sharing the structural properties of the original factual system (Rosenblueth and Wiener, 1945).
GeoPackage	A GIS software package.
GIS software	A powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world (Burrough, 1986).
GIS system	An institutional entity, reflecting an organizational structure that integrates technology with a database, expertise and continuing financial support overtime (Carter, 1989).
houtwal	A bank, usually planted with oak and undergrowth, in former farming systems grown for periodic cutting and serving as a natural fence.

	translated as 'Spatial Information System for Operationalizing the Reconnaissance Planning Methodology'.
scenario	A scenario describes the present situation of a specified part of reality, of one or more possible or desired future situations at a point of time in the future and of the processes that lead or should lead from the present situation to the future situation (van Vught, 1978).
small scale landscape	A varied landscape with fields, clumps of trees, solitary trees, hedges and farms.
spatial facet	Used in Dutch to indicate the spatial aspect of various sectors (e.g. the spatial facet of agriculture).
spatial model	A construction, representing the socio-physical spatial organization of the real world or an imaginary socio-physical organization of this real world.
spatial organization	The spatial expression of the socio-physical organization.
techniques	- means, possibly instruments, to perform methods; - aids which are used, or skills which should be learned to perform methods (Sol, 1986)
theoretical model	A model of relevance to the empirical sciences, which represents a concrete system, e.g. real numbers as a scale division on a thermometer or the network structure representing social interaction in a group (Bertels and Nauta, 1969).

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APPENDIX I: EQUIVALENTS TO DUTCH SOILS, AS GIVEN IN THE FAO SOIL MAP OF THE WORLD AND THE EC SOIL MAP OF EUROPE

This overview is based on de Bakker (de Bakker, 1979), who refers to the 1:5 000 000 FAO-Unesco Soil Map of the World, Volume I, Legend; Unesco, Paris, 1974. This Legend was updated in 1988. If de Bakker's 1974 description of the soil units was not mentioned in the 1988 version of the FAO map, both that description and the 1988 FAO assumed equivalent (FAO, 1988) are given.
The descriptions in the Soil Map of Europe were based on the publication of the Commission of the European Communities, 'Soil Map of the European Communities, 1:1 000 000', Directorate-General for Coordination of Agricultural Research, 1985. The soil units used for the FAO/Unesco Soil Map of the World (FAO, 1974) were adopted for this map. However, some groups were added or further qualified.

Veldpodzol Hn
World (FAO, 1974/1988): Gleyic Podzol, coarse textured, level to undulating.
Eur. : Ditto

Laarpodzol cHn
World (FAO, 1974/1988): Not mentioned specifically, is included in the Gleyic Podzols.
Eur. : Ditto

Haarpodzol Hd
World (FAO, 1974): Humic Podzol, coarse textured, level to undulating
World (FAO, 1988): Ferric Podzols
Eur. : Humic Podzol

Kamppodzol cHd
World: Not mentioned by de Bakker. Can be classified as a Humic Podzol (FAO, 1974) or Ferric Podzol (FAO, 1988).
Eur. : Ditto

Moderpodzol Y
World: Not mentioned by de Bakker. Can be classified as a Cambic Podzol (FAO, 1988).
Eur. : Ferro-Humic Podzol (?)

Veengronden V
World (FAO, 1988): Fibric Histosols

Eur. : Eutric Histosols

Moerige gronden W
World (FAO, 1974/1988): No suitable category
Eur. : No suitable category; on the map included in the association of organic soils and podzolized soils (de Bakker).

Vlakvaaggrond Zn
World (FAO, 1988): Arenosol
Eur. : Luvic Arenosol

Duinvaaggrond Zd
World (FAO, 1974/1988): Albic Arenosol, coarse textured, gently undulating
Eur. : Dystric Regosol

Enkeerdgrond EZ
World (FAO, 1974/1988): No suitable category
Eur. : Plaggensol

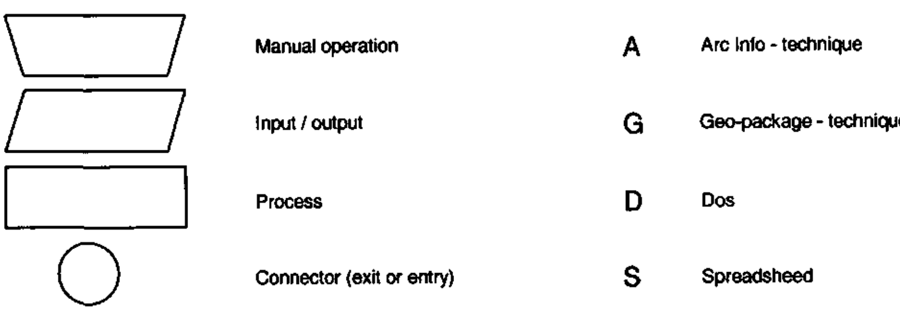
Beekeerdgrond pZg
World (FAO, 1974): Humic Gleysol, coarse textured, level.
World (FAO, 1988): Umbric or Mollic Gleysol
Eur. : Humic Gleysol

Associatie Beekdalgronden AB
Not mentioned by de Bakker.

APPENDIX II: Formal description of GIS procedures

It is possible to evaluate the extent to which GIS can be employed in a planning process, only if the GIS method in question can be described in a formal way. Chapter Seven describes the procedure used in this study. In this Appendix, the activities for which GIS was employed are described as flow charts, using the symbols described in figure 1. The symbols indicate the type of software used. This software comprised the GEO package[1)], ARC-Info[2)] and 'other' routines of MS-DOS, VAX/VMS, Pascal or Fortran.
The names of the GIS command file ('MCF-file') in which the GIS-supported process and the normative statements were registered (see 'Process knowledge', Appendix III) are printed in *italics*. The character indicates the type of GIS technique used (see figure 2[3)]).

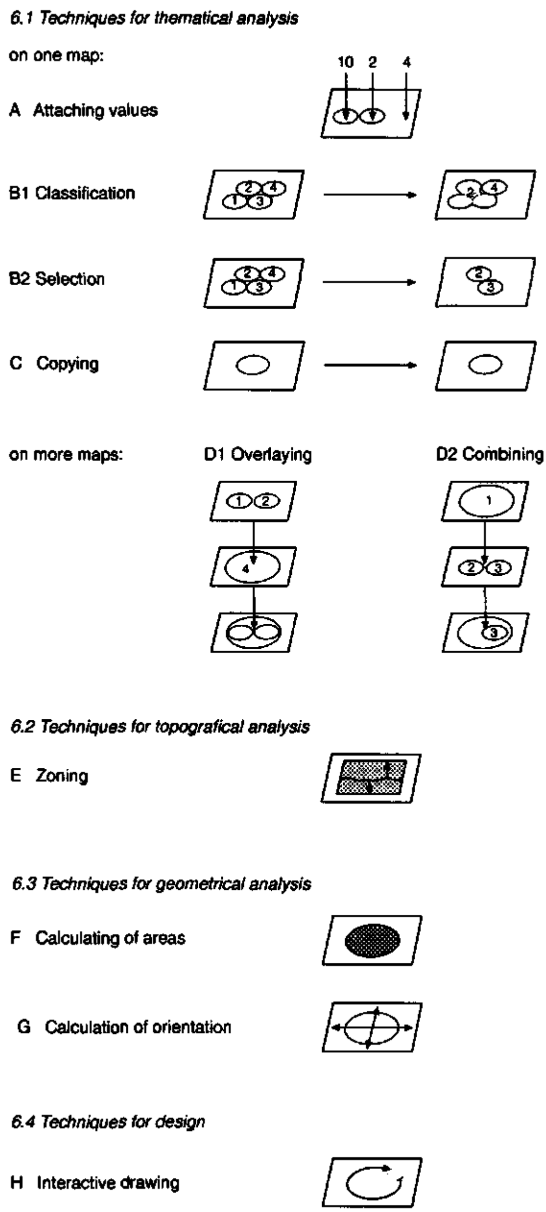
Figure 1. Symbols used in the flow charts



1.1 Activity 7: Analysis of the case study area

The analysis in the description stage was partly based on three student projects (Cleveringa and Keeman, 1990, Buysman, 1991 and de Leeuw, 1991), each of which started with an analysis of the study area, with the help of the GeoPackage.

Figure 13.2 GIS techniques used in the planning process



1.1.1 Cleveringa and Keeman: Formalizing the planning process of the nature development plan of Noord-Brabant Province

Cleveringa and Keeman contributed ecological information on flora and fauna in the area to the analysis. They used digital data supplied by the provincial authorities, to produce maps of the occurrence of flora and fauna. Furthermore, they combined these data with information about the land cover, which elucidated the relation between land use and flora and fauna. They used GIS techniques for thematic analysis.

1.1.2 Buysman: Employing GIS in the planning of the recreational sector

Buysman's research gave insight into the present recreational situation
of the area and its potentiality. Recreational objects (e.g. camping sites, leisure parks) were digitized and their relation with the present land use was studied. The landscape was analysed with respect to its visual attractiveness and ecological value. GIS techniques for thematic analysis were used.

1.1.3 De Leeuw: Structuring information on dairy farming and intensive husbandry for processing in an information system

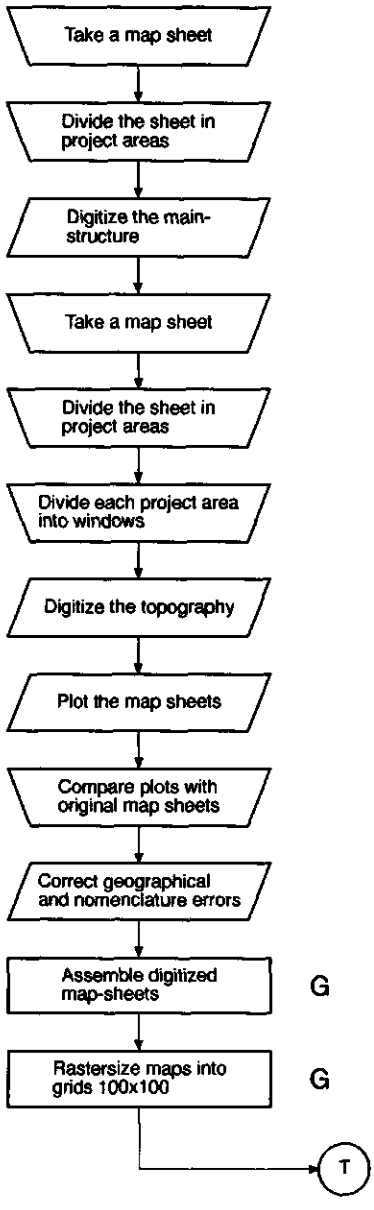
De Leeuw made a broad inventory of data on dairy farming and intensive husbandry in the area. He also gave an overview of the policy measures of national, provincial and local authorities relating to these types of farming. He used GIS techniques for thematic analysis.

1.2 Activity 8: Reporting of the analysis

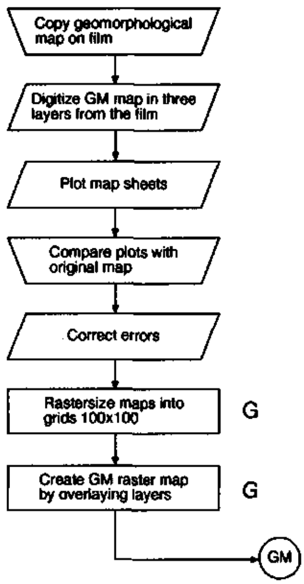
The Pizazz programme was used to present the results of the projects described in the preceding section was carried out with . This procedure is described in flow chart 5, activity 20.

1.3 Activity 15: Structuring, digitizing and pre-processing vector and raster data

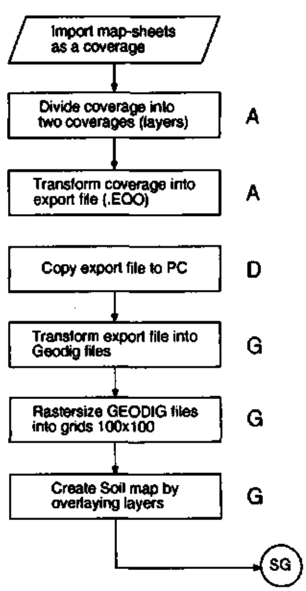
1.3.1 Digitizing the topographical map (T)



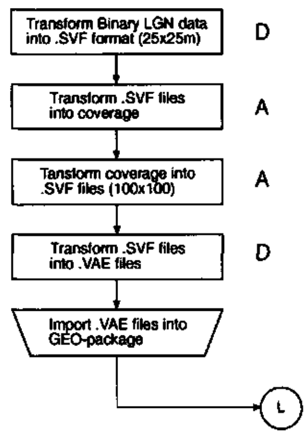
1.3.2 Digitizing the geomorphological map (GM)



1.3.3 Processing soil and groundwater data (SG)

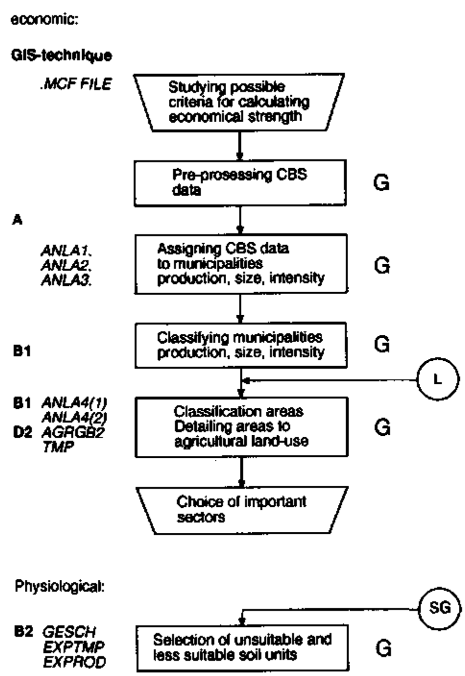


1.3.4 Processing of LGN data



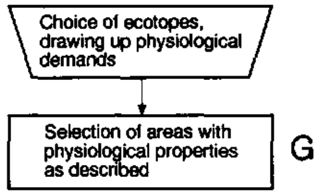
1.4 Activity 19: Analysis

1.4.1 Analysis of the Anthropocentric notion

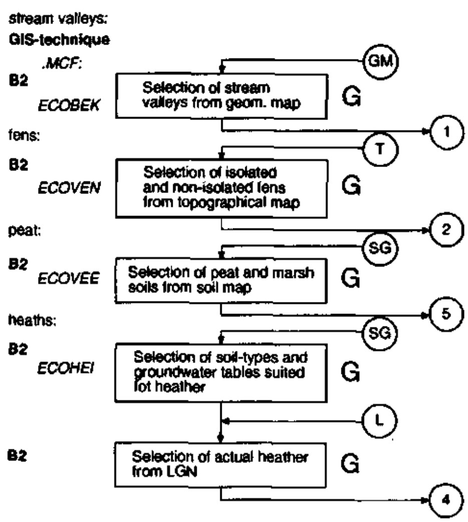


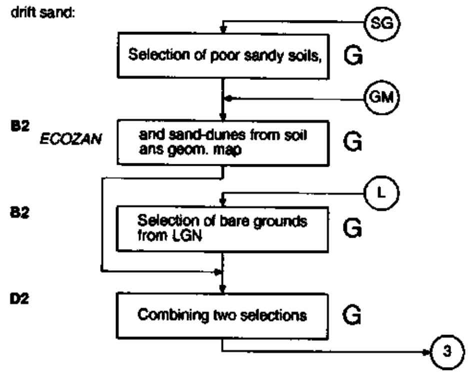
1.4.2 Analysis of the Ecocentric notion

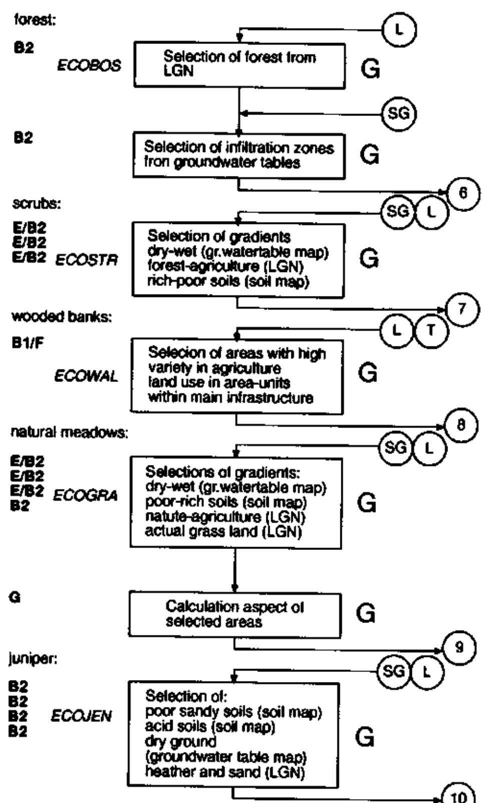
Based on the ecological knowledge collected in activity 15 a list of ten ecotopes is drawn up, described by its vegetation type and its physiology. The potentiality of each of these ecotopes in the area is studied.



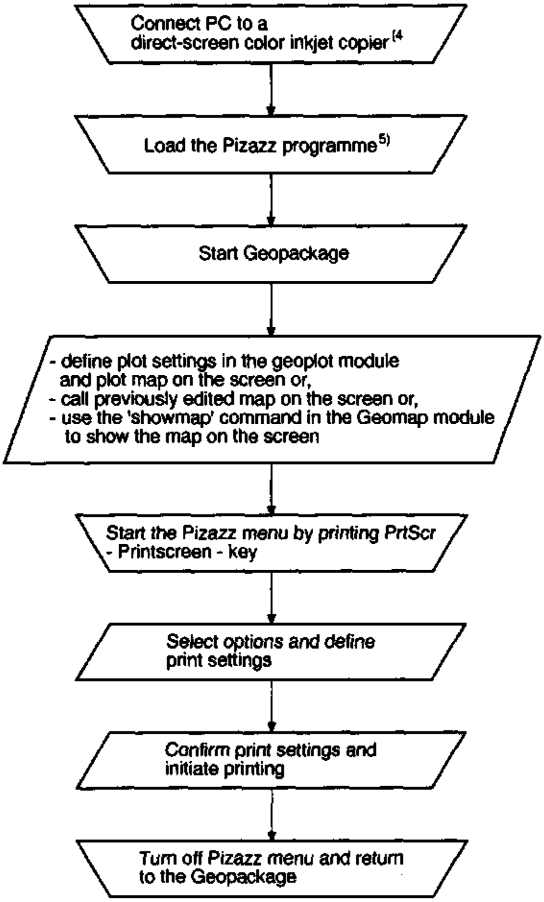
Note: this selection differs for each ecotope. The way it was carried out depended on the properties. Generally the base maps were studied for the vertical or horizontal relations between attributes. The following selections were made.




drift sand:
SG
Selection of poor sandy soils,
G
GM
B2
ECOZAN
and sand-dunes from soil ans geom. map
G
L
B2
Selection of bare grounds from LGN
G
D2
Combining two selections
G
3

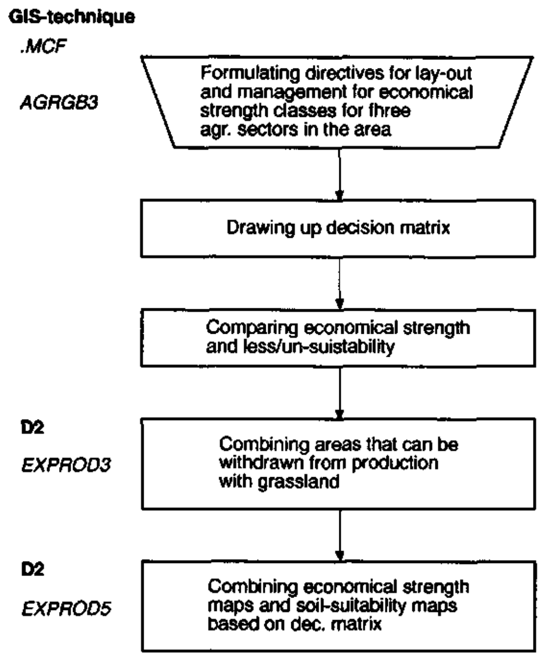

forest:
L
B2
ECOBOS
Selection of forest from LGN
G
SG
B2
Selection of infiltration zones fron groundwater tables
G
6
scrubs:
SG
L
E/B2
E/B2
E/B2
ECOSTR
Selection of gradients
dry-wet (gr.watertable map)
forest-agriculture (LGN)
rich-poor soils (soil map)
G
7
wooded banks:
L
T
B1/F
ECOWAL
Selecion of areas with high variety in agriculture land use in area-units within main infrastructure
G
8
natural meadows:
SG
L
E/B2
E/B2
E/B2
B2
ECOGRA
Selections of gradients:
dry-wet (gr.watertable map)
poor-rich soils (soil map)
natute-agriculture (LGN)
actual grass land (LGN)
G
G
Calculation aspect of selected areas
G
9
juniper:
SG
L
B2
B2
B2
B2
ECOJEN
Selection of:
poor sandy soils (soil map)
acid soils (soil map)
dry ground
(groundwater table map)
heather and sand (LGN)
G
10

1.5 Activity 20: Description of the results

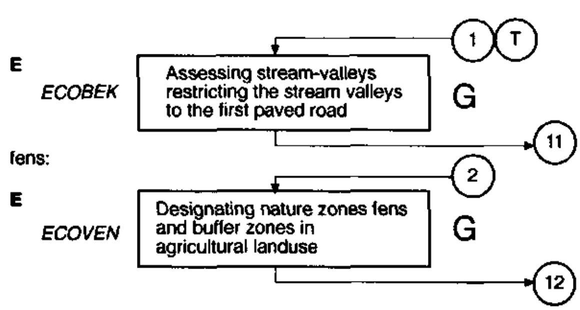


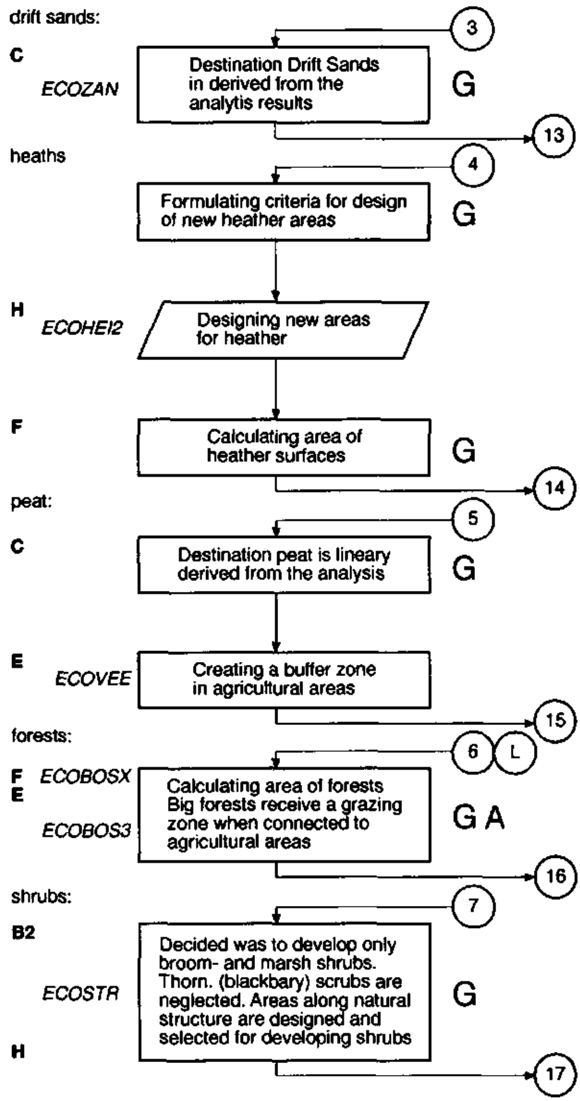
1.6 Activity 24: Processing data and construction

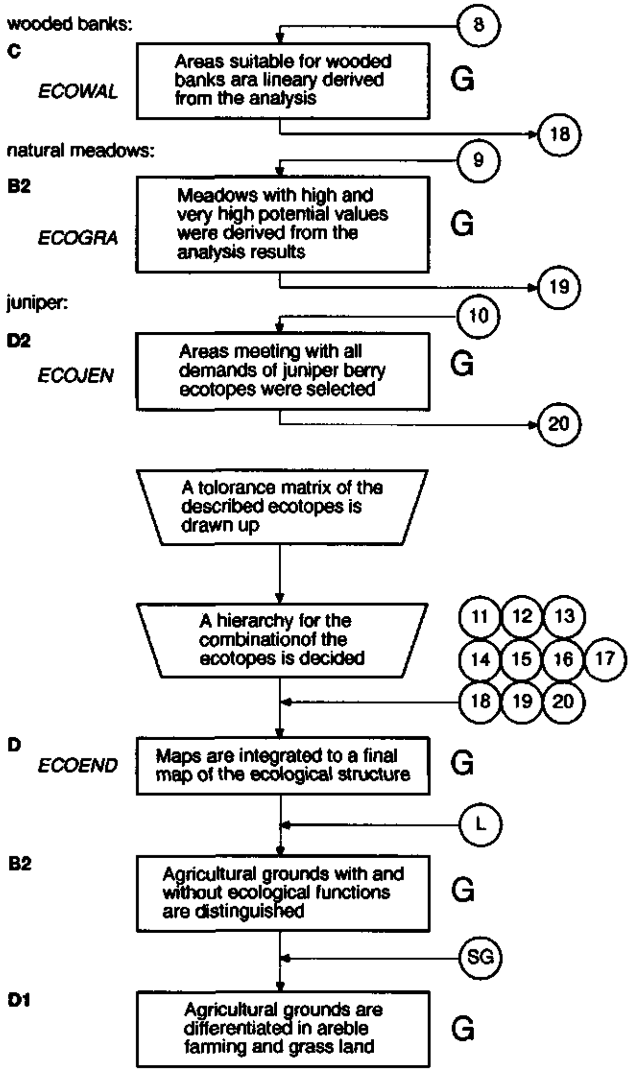
1.6.1 Plan construction according to the Anthropocentric notion



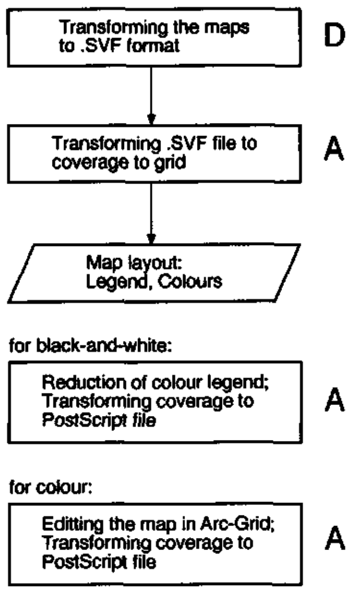
1.6.2 Plan construction according to the Ecocentric notion



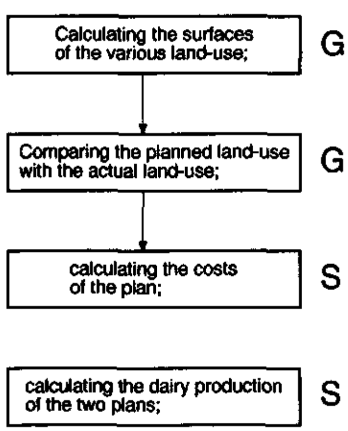

drift sands:
C
ECOZAN
Destination Drift Sands in derived from the analytis results
G
3
13
heaths
4
Formulating criteria for design of new heather areas
G
H
ECOHEI2
Designing new areas for heather
F
Calculating area of heather surfaces
G
14
peat:
5
C
Destination peat is lineary derived from the analysis
G
E
ECOVEE
Creating a buffer zone in agricultural areas
15
forests:
6
L
F ECOBOSX
E
ECOBOS3
Calculating area of forests Big forests receive a grazing zone when connected to agricultural areas
G A
16
shrubs:
7
B2
ECOSTR
Decided was to develop only broom- and marsh shrubs. Thorn. (blackbary) scrubs are neglected. Areas along natural structure are designed and selected for developing shrubs
G
H
17


wooded banks:
C
ECOWAL
Areas suitable for wooded banks ara lineary derived from the analysis
G
8
18
natural meadows:
B2
ECOGRA
Meadows with high and very high potential values were derived from the analysis results
G
9
19
juniper:
D2
ECOJEN
Areas meeting with all demands of juniper berry ecotopes were selected
G
10
20
A tolorance matrix of the described ecotopes is drawn up
A hierarchy for the combinationof the ecotopes is decided
11
12
13
14
15
16
17
18
19
20
D
ECOEND
Maps are integrated to a final map of the ecological structure
G
L
B2
Agricultural grounds with and without ecological functions are distinguished
G
SG
D1
Agricultural grounds are differentiated in areble farming and grass land
G

1.7 Activity 25: Presentation



1.8 Activity 29: Analysis



Notes

1.GeoPackage, Geocompiler, Geodig, Geomap and Geoplot are trademarks registered by GEOPS B.V., Wageningen, The Netherlands.
Most of the data were digitized with the Geodig module. Transforming vector data that had been digitized with Geodig to ArcInfo coverages gave substantial problems, to do with the way the information is stored. The ArcInfo package stores the geographical information as points, arcs or polygons, attaching thematic information to label points which are placed in the object made up by the points, arcs or polygons. Geodig however, stores each object, consisting of points, lines or polygons, attaching the thematic information to the point, line or polygon itself.

2. ArcInfo is a trade mark, registered by Environmental Systems Research Institute Inc., Redlands, California, USA.
For the presentation of the coverages, the ArcInfo version 5.0.2 operating under VAX-VMS on a VAX computer and version 6.0, operating under Unix on a workstation were used.

3.The systematization is based on van Lammeren (1994), who distinguishes four categories of GIS method:

- methods for thematic analysis;
- methods for geometrical analysis;
- methods for topological analysis;
- methods for design.

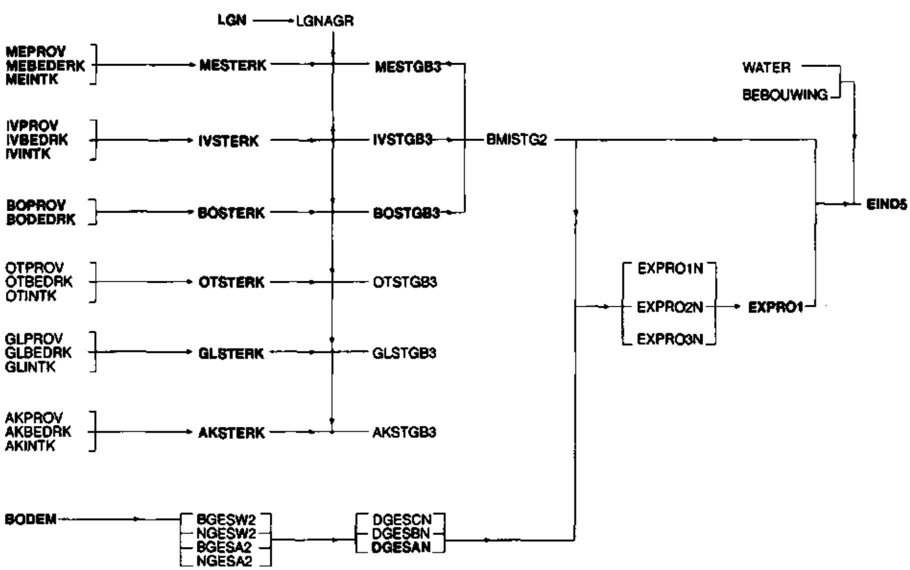
Appendix III Flowcharts of the Knowledge Categories

Chapter Nine described how the categories of knowledge were described in the *RISOR* system. The relations between the three knowledge categories was also stored in the system. This appendix describes the procedure carried out based on the object knowledge, method knowledge and normative knowledge.

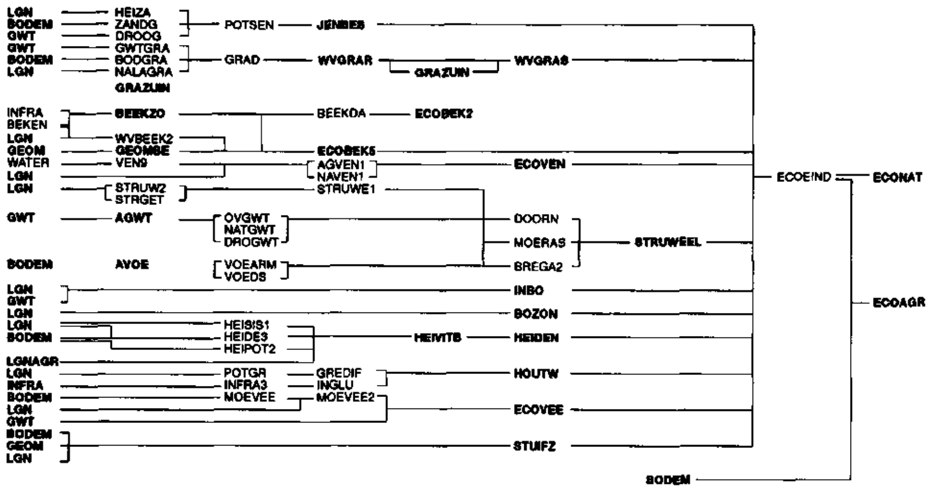
The object knowledge

The flow charts of the object knowledge describe the relations between the spatial models (i.e. maps) which were used or generated during the process. The maps with bold-printed names are shown in Chapters Five (Figures 5.3-5.6), Seven (Figures 7.5 - 7.42) and Eight (Figure 8.1-8.3) . The flow charts start with the object knowledge which forms the base of the methods. The output is categorized as 'resulting data' in the *RISOR* system (section 9.2). In between are the 'intermediate data'.

ANTHROPOCENTRIC

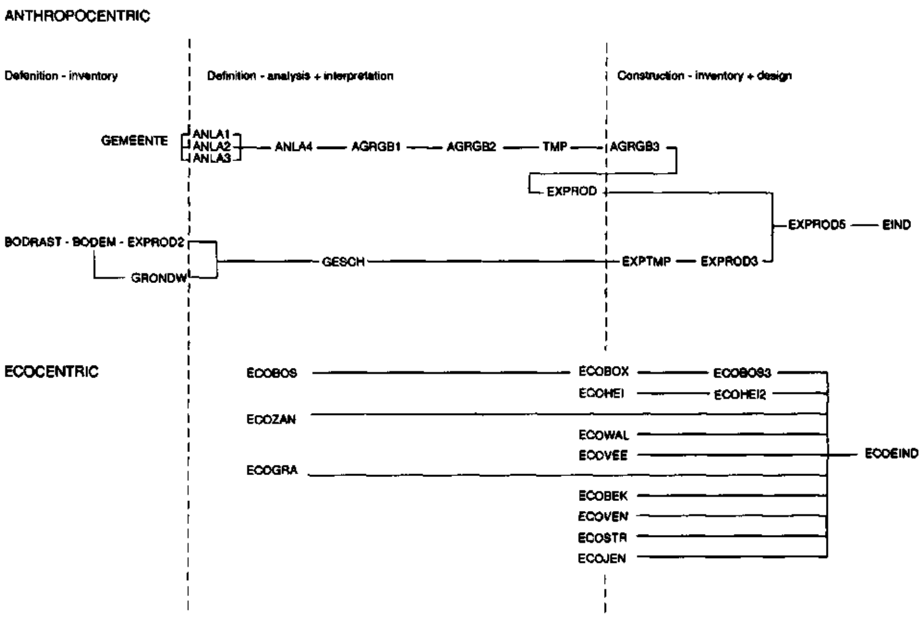


ECOCENTRIC


LGN
BODEM
GWT
GWT
BODEM
LGN
HEIZA
ZANDG
DROOG
GWTGRA
BODGRA
NALAGRA
GRAZUIN
POTSEN
JENBES
GRAD
WVGRAR
GRAZUIN
WVGRAS
INFRA
BEKEN
LGN
GEOM
WATER
LGN
LGN
BEEKZO
WVBEEK2
GEOMBE
VEN9
STRUW2
STRGET
BEEKDA
ECOBEK2
ECOBEK5
AGVEN1
NAVEN1
STRUWE1
ECOVEN
ECOEIND
ECONAT
GWT
AGWT
OVGWT
NATGWT
DROGWT
DOORN
MOERAS
STRUWEEL
BODEM
AVOE
VOEARM
VOEDS
BREGA2
LGN
GWT
LGN
LGN
BODEM
INBO
BOZON
HEISIS1
HEIDE3
HEIPOT2
HEIVITB
HEIDEN
ECOAGR
LGNAGR
LGN
INFRA
BODEM
LGN
GWT
POTGR
INFRA3
MOEVEE
GREDIF
INGLU
MOEVEE2
HOUTW
ECOVEE
BODEM
GEOM
LGN
STUIFZ
BODEM

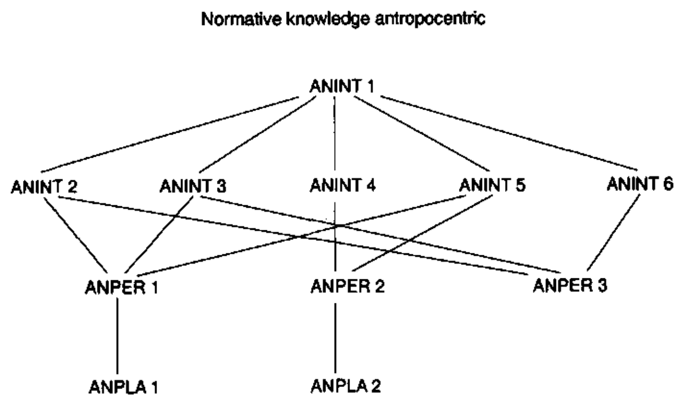
The method knowledge

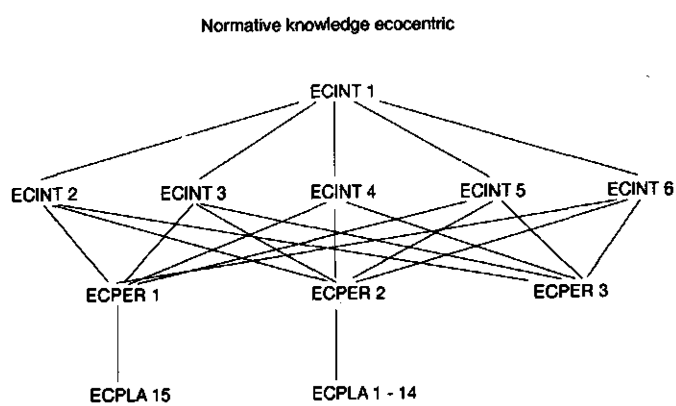
The method knowledge used in the planning process is described in command files of the GIS package. In Appendix II, the methods were described with flow charts, showing the GIS manipulations that constitute the methods. The flow charts are formalized in GIS command files, the names of which are indicated in italics. These names correspond to the descriptions in the flow charts below. The relations between the method files is described in the *RISOR* system (section 9.3).



The normative knowledge

Normative knowledge in a planning process can be described as hierarchic trees. The trees start with the basic intention. The following intentions, prospects and planning statements, goals and criteria are derived from one or more preceding notions. In the case study the normative knowledge (see Chapter Six) was classified according to its abstractness and place in the case study: intentions, concrete intentions and planning statements. The codes allocated to the normative premises (see Chapter Six), indicate the basic premise: Anthropocentric (AN) or Ecocentric (EC) and the type of the premise: intention (IN), concrete intention (PER) or planning statement (PLA). In the *RISOR* system the relation between the premises is described. The subject: integration, aspect or sub-aspect, is also described in the system (section 9.4).





Appendix IV: Example of a Macro Command File

```
: *******************************************************
: * HEADER:4
: * DATE:  1-10-1991
: * TIME: 10:58:19
: * AUTHOR: R.Eweg
: * MCF-FILENAME:  ECOHEI.MCF
: * DATABASE-NAME: ECOCEN2
: Intention: ecocentric
: Goal: Integration of nature, landscape with a good functioning of
:      natural ecosystems on heathlands.
: Procedure: With the help of basic maps actual and potential heath-
:       lands are selected and a protection zone is calculated.
: Basic data: LGN, BODEM, GWT
: *******************************************************
:                                                  4- 0- 0
: ------------------------------------------------------------
: *******************************************************
: * GROUP:1
: Goal: Heathlands have to be maintained
: Procedure: Heathland is selected from LGN.
:         with the help of BODEM the heather is classified into wet
:         or dry heather.
: *******************************************************
:                                                  4- 1- 0
: ------------------------------------------------------------
: ==============================
: The heathland is selected from the land cover LGN
: ==============================
:                                                  4- 1- 1
: ------------------------------------------------------------
RENUMBER
LGN
HEIDE
0
12
12
:                                                  4- 1- 2
: ------------------------------------------------------------
: ==============================
: From BODEM the soil units suitable for dry heather are selected:
: Haarpodzolen (Hd21), Holtpodzolen (Y23), Duinvaaggronden (Zd21)
: ==============================
:                                                  4- 1- 3
: ------------------------------------------------------------
RENUMBER
BODEM
POTHEI
0
5
```

```
16,18,36,38,73,83,85
:                                                   4- 1- 4
:-----------------------------------------------------------------
: ================================
: Soil units suitable for wet heather are selected:
: Veldpodzolen (Hn23, Hn30), Moerige Podzolen (kWp,zWp)
: ================================
:                                                   4- 1- 6
: -----------------------------------------------------------------
RENUMBER
BODEM
NATHEI
0
6
6,10,11,14,67,70,7,8,66,68,82
:                                                   4- 1- 7
: -----------------------------------------------------------------
COVER
POTHEI,NATHEI
HEIPOT
:                                                   4- 1- 9
: -----------------------------------------------------------------
: ================================
: The heathlands are separated into dry and wet heather
: ================================
:                                                   4- 1- 10
: -----------------------------------------------------------------
CROSS
HEIPOT,HEIDE
HEIDE2
7
5
12
8
6
12
:                                                   4- 1- 11
: -----------------------------------------------------------------
COVER
HEIDE2,HEIDE
HEIDE3
:                                                   4- 1- 12
: -----------------------------------------------------------------
COVER
HEIDE,HEIDE2
HEIDE3
:                                                   4- 1- 13
: -----------------------------------------------------------------
: ================================
: Feasibility of grazing with a flock of sheep: an acreage of at
: least 500 hectares of heathland
: ================================
:                                                   4- 1- 14
```

```
: ---------------------------------------------------------------------------
CLUMP
HEIDE
HEIDE4
s,d
10
:                                                                4- 1- 15
: ---------------------------------------------------------------------------
RENUMBER
HEIDE4
HEIDE5
0
1
:                                                                4- 1- 16
: ---------------------------------------------------------------------------
: ===============================
: The area (ha) of each cluster of heathland is calculated
: ===============================
:                                                                4- 1- 17
: ---------------------------------------------------------------------------
SIZE
HEIDE5
HEISIZ
:                                                                4- 1- 18
: ---------------------------------------------------------------------------
DESC
HEISIZ
o
heisiz
:                                                                4- 1- 19
: ---------------------------------------------------------------------------
DESC
HEISIZ
:                                                                4- 1- 20
: ---------------------------------------------------------------------------
RENUMBER
HEISIZ
HEISIZ1
0
-1
:                                                                4- 1- 21
: ---------------------------------------------------------------------------
: .............
```

CURRICULUM VITAE

Hinrick Peter Arnold Eweg was born on 17 June 1959 in Arnhem, The Netherlands. In 1977 he obtained his Athenaeum B diploma at the Carmel Lyceum in Oldenzaal. From 1977 until 1981 he studied civil engineering at the Technical College in Hengelo. His final project concerned a reconstruction of the channel between Almelo and Coevorden in the eastern part of the Netherlands.
From 1981 until 1987 he studied Land and Water Use Planning at the Agricultural University Wageningen, majoring in Physical Planning and Geomorphology.
In 1988 he started work as a research assistant at the Department of Physical Planning and Rural Development. The PhD research was carried out between 1988 and 1993. He is currently coordinating a research project carried out by the Centre for Geographical Information Processing, Wageningen University for the European Commission (Rehabilitation of degraded and degrading areas in Tigray, Ethiopia).