


Adaptation

Spatial decision support for management of Dutch fen meadows

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KvR 027/12

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KvR report number KvR 027/12
ISBN ISBN/EAN 978-90-8815-025-8

This project (ME06; Spatial decision support for management of Dutch fen meadows) was carried out in the framework of the Dutch National Research Programme Climate *changes* Spatial Planning. This research programme is co-financed by the Ministry of Infrastructure and the Environment.

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Summary in Dutch

Nu de grenzen van technische oplossingen in zicht komen is het duidelijk dat adaptatie en ruimtelijke ordening steeds meer aan elkaar gekoppeld zijn. Ruimtelijke planning speelt dan ook een centrale rol in de ontwikkeling van ruimtelijke adaptatiestrategieën.
In dit project maken we gebruik van een interactieve kaarttafel voor het ondersteunen van participatieve ruimtelijke planning in Nederlandse veenweidegebieden. Voor ons proefgebied Bodegraven/Zegveld zijn drie workshops achter de rug met deelnemers van de provincie, waterschap en natuurorganisaties. Onze aanpak kent drie type workshops gebaseerd op verschillende soorten gebruik van kaarten in de beleidsvoorbereiding:

- Analyse de kaart als onderzoeksmodel
- Ontwerp de kaart als ontwerptaal
- Onderhandeling de kaart als beslisagenda

Kaarten staan centraal in de workshops. Interactie met de kaartinformatie wordt gefaciliteerd met de “Touch table”. Dit is een groot interactief computerscherm waarop de deelnemers plannen kunnen ontwerpen of aanpassen. Zij kunnen hierbij gebruik maken van een grote set achtergrondkaarten en krijgen feedback op de kwaliteit van de getekende plannen. De tafel kan ook worden gebruikt om informatie te combineren om bijvoorbeeld geschiktheidkaarten, waardekaarten en, conflictkaarten te genereren. Multicriteria methoden worden hierbij gebruikt om afwegingen tussen doelen duidelijk te maken en onderhandeling tussen stakeholders te ondersteunen.

Summary

After reaching the limits of technical instruments adaptation and spatial planning have become increasingly interrelated. As a result land use change plays a central role in the development of adaptation strategies. Within this project an interactive mapping device (the ‘Touch table’) is used to support participative land use planning workshops. The approach involves three types of workshops. The nature of each workshop is defined according to one of the three frames in the framework for map use in policy making:

- Analysis map a research model
- Design map as a design language
- Negotiation map as a decision agenda

Digital maps presented on the Touch table are the means of communication between participants. The ‘Touch table’ makes it possible to draw maps using for example an historical map, an aerial picture or a soil type map as background. The participants use their hands to change the land use maps. After each change the table provides feedback on the quality of the plan for the various stakeholders. The table can also be used to combine information to generate suitability maps, value maps and conflict maps. To support negotiation multicriteria methods are used to show trade-offs between stakeholder objectives.

Extended summary

After reaching the limits of technical instruments adaptation and spatial planning have become increasingly interrelated. As a result land use change plays a central role in the development of adaptation strategies. However, it is also clear that is that national and provincial agencies face many difficulties in adjusting their policies in such a way that future land use changes get serious consideration. On the one hand, this may be related to the fact that the consistency of different (long term) policy goals have not yet received due attention. On the other hand, strong public resistance at local level against any perspective of near future landscape changes has created an atmosphere of deadlock. Policy makers seemingly face the dilemma between doing the right thing and doing it the right way, i.e. through consulting the public. A participatory approach which will involve a multitude of stakeholders may be successful in that the stakeholders will be able to identify and reflect upon several comprehensive strategies and assess, with the help of scientists, their specific impacts for policy areas such as climate change, water retention, nature conservation, agriculture and other considerations with respect to spatial planning.

This report describes the use of spatial tools to support a land use allocation problem in a peat-meadow polder in the Netherlands. As part of the planning process a series of planning workshops with stakeholders were conducted. The tools were integrated into the design of the workshop and implemented in an interactive mapping device (the 'Touch table'). The approach involves three types of workshops. The nature of each workshop is defined according to one of the three frames in the framework for map use in policy making, according to Carton and Thissen (2009):

1. Design map as a design language
2. Analysis map a research model
3. Negotiation map as a decision agenda

Design and analysis workshop are found in the beginning and middle of a planning process and the negotiation workshop towards the end. Each workshop is designed to address specific objectives and therefore each workshop requires tools that deal with the tasks needed to meet these objectives. The main objective of the design workshop is to prompt and process local knowledge. The tools for this workshop are designed to support communication of information to stakeholders. The main objective of the analysis workshop is to combine different types of expert knowledge and to generate feedback between experts from different disciplines. The tools used in this workshop support evaluation of spatial attributes linked to, for example, different types of land use. The main objective of the negotiation workshop is to reach consensus on a plan that is acceptable for all stakeholders. Tools in this workshop show trade-offs between objectives of different stakeholders and support identification of, for example, changes in land use that are favourable for two or more stakeholders.

Spatial multicriteria analysis was used to structure and manage knowledge in a way that it can be used effectively by the negotiators. The approach used is simple and straightforward and proved to be easy to understand by the participants. Definition of the criteria and setting of weights was done in a special expert workshop. This step is crucial for the credibility of the approach and requires input from experts from different fields.

Negotiators found the Touch table easy to use and sitting around the table allowed for learning by doing. Even users that do not really understand the underlying multicriteria analysis get a feel for the implications of the method during the negotiation. The negotiation tool is based on interaction with the participants. In using the tool participants combine the provided information

with local knowledge. It was interesting to see that the negotiators focused only on the aggregated information presented on the 'Touch table' and ignored all other information. Negotiators in both teams showed a cooperative attitude. They had the intention of doing a good job. Successful use of the tool depends very much on such a cooperative attitude. As such it is very much a product of the Dutch way of decision-making. In situations of sharp conflict or a more power-based style of decision it is questionable if the tool is as useful.

1. Introduction

After reaching the limits of technical instruments adaptation and spatial planning have become increasingly interrelated. As a result land use change plays a central role in the development of adaptation strategies. However, it is also clear that is that national and provincial agencies face many difficulties in adjusting their policies in such a way that future land use changes get serious consideration. On the one hand, this may be related to the fact that the consistency of different (long term) policy goals have not yet received due attention. On the other hand, strong public resistance at local level against any perspective of near future landscape changes has created an atmosphere of deadlock. Policy makers seemingly face the dilemma between doing the right thing and doing it the right way, i.e. through consulting the public. A participatory approach which will involve a multitude of stakeholders may be successful in that the stakeholders will be able to identify and reflect upon several comprehensive strategies and assess, with the help of scientists, their specific impacts for policy areas such as climate change, water retention, nature conservation, agriculture and other considerations with respect to spatial planning.

Collaborative workshops are common in land use planning. Stakeholders coming together to discuss plans using maps is not something from recent years. In the beginning workshops were supported using large hard copies of the maps in combination with sheets of tracing paper maps representing attributes of the proposed plan or plan area (Carton and Thissen 2009). In the following years with the arrival of Geographical Information Systems (GIS) the transparent tracing map sheets were replaced by digital maps and map layers presented within the GIS on a computer screen (Scholten et al 2009). Involvement of stakeholders has increased over the years. In the early years the emphasis was on communication, in later years this shifted to participation were active involvement of stakeholders was required (Sieber 2006). At present the focus is on collaboration: stakeholders actively working together to produce the plan that best suits the needs of all stakeholders. Support systems evolved along with this development (Eastman et al 1998; Feick and Hall 2002; Dragicevic and Balram 2006). Undoubtedly, GIS was widely used but in the early stages mainly to provide information rather than to interact with stakeholders. A next step was the development of participatory GIS (PGIS) or participatory planning support systems (Sieber 2006; Jankowski 2008; Carver et al 2009). The focus of PGIS is on improving public access to data and maps and to provide possibilities for participatory learning and analysis by stakeholders. Finally, the shift to collaboration created the need for Group Spatial Decision Support Systems (GDSS), or Collaborative Planning Support systems. These systems support identification of trade-offs, conflict and compromise between stakeholder groups (Boroushaki and Malczewski 2010). However, Geertman and Stillwell (2009) state that the number of successful applications of geo-technology by planning practitioners to support their activities are far from commonplace. Uran and Janssen (2003) identify the mismatch between the decision problem of the end-users and the answers produced by the system as the main factor for this lack of success: the technology-driven systems produce the correct answer to the wrong question at the wrong moment. Along the same lines Geertman and Stillwell (2009) state that:"there exists a fundamental dichotomy between those PSS that are demanded for use in practice by potential users and those PSS supplied by systems developers according to their perception to what is required".

This report describes the use of spatial tools to support a land use allocation problem in a peat-meadow polder in the Netherlands. As part of the planning process a series of planning workshops with stakeholders were conducted. The tools were integrated into the design of the workshop and implemented in an interactive mapping device (the 'Touch table'). The approach involves three types of workshops. The nature of each workshop is defined according to one of the three frames in the framework for map use in policy making, according to Carton and Thissen (2009):

4. Design — map as a design language
5. Analysis — map a research model
6. Negotiation — map as a decision agenda

Design and analysis workshop are found in the beginning and middle of a planning process and the negotiation workshop towards the end. Each workshop is designed to address specific objectives and therefore each workshop requires tools that deal with the tasks needed to meet these objectives. The main objective of the design workshop is to prompt and process local knowledge. The tools for this workshop are designed to support communication of information to stakeholders. The main objective of the analysis workshop is to combine different types of expert knowledge and to generate feedback between experts from different disciplines. The tools used in this workshop support evaluation of spatial attributes linked to, for example, different types of land use. The main objective of the negotiation workshop is to reach consensus on a plan that is acceptable for all stakeholders. Tools in this workshop show trade-offs between objectives of different stakeholders and support identification of, for example, changes in land use that are favourable for two or more stakeholders.

The project proposal identified two objectives for the project:

1. To integrate and communicate knowledge generated in other Climate changes Spatial Planning (KvR) and Living with water (LmW) fen meadow projects.
2. To develop and implement a decision support methodology that can support interactive development of land use plans for fen meadows;

This report starts with a description of the Bodegraven Polder (Section 2). Integration and communication of knowledge is addressed in the analysis workshops. This is illustrated in Section 3 using assessment of ecological qualities linked to water management as an example. Within the project a negotiation support tool is developed to support interactive development of land use plans. This tool is integrated in the negotiation workshop as described in Section 4. Effectiveness of the tools is presented in Section 5 and conclusions are presented in Section 6.

This report only addresses the analysis and negotiation workshops. Full reports of all workshops can be found in Cornelisse et al (2007a); (2007b); (2008) and Janssen et al (2008).

2. The Bodengraven polder

The approach was tested as part of the planning process of the Bodegraven polder, a peat meadow area in the Netherlands where water tables are controlled. The polder is located in the centre of the 'Groene Hart' (Green Heart), the largest national landscape of the Netherlands (Figure 2.1). With an area of 4672 ha, this typical polder area is part of a water-rich region with agriculture, nature and recreation as primary activities. It consists predominantly of peat meadows, originating from peat lands drained in the 13th -15th century and currently used for commercial dairy farming, but also important for their high natural and landscape values. There are several problems to be addressed in Bodegraven: ground subsidence, preservation of the peat meadow landscape, inefficient water management, poor water quality, and the changing economic position of dairy farming [Jansen et al, 2007; Woestenburg, 2009]. Multiple stakeholders such as the local water board, the city of Bodegraven, the province of South Holland, farmers' and nature conservation organizations as well as individual farmers, residents and recreational visitors are involved.

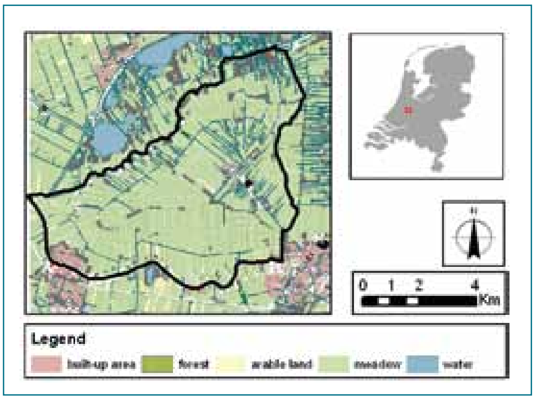

Figure 2.1.
The Bodegraven Polder, the Netherlands.

Land drainage causes soil subsidence, which increases the need for further drainage, etc. At some point this cycle has to stop. Lowering of water tables becomes too expensive or even impossible as ground levels continue to fall even further below seas level at an unprecedented rate. Consequently, the provincial authorities have started a planning process to change both water management and land use in the area. Water management is the driving force within this process and land use has to adapt to changing water conditions [Strategiegroep Gouwe Wiericke, 2007]. As part of the reallocation of land use in the polder, the provincial authorities devised long-term policies that aim to create 860 ha of nature and 1600 ha of land for extensive agriculture. This means that agricultural land must be purchased for conversion to nature and subsidies must be made available to support the transition to extensive agriculture.

After consultation with the stakeholders, four objectives were identified: (1) profitability of intensive agriculture, (2) minimization of land subsidence, (3) maximization of the visual quality of the landscape, and (4) maximization of the natural value of the area. Each objective includes several criteria, such as 'meadow birds', 'species-rich grasslands' and 'marsh birds' for natural values. The score for each criterion is determined by both land use and water level. Three types of land use are identified: intensive agriculture, extensive agriculture, and nature. Water level is divided into 10 levels in cm below ground level: (0, 0-10, 10-20, ..., 90-100). Each combination of land use and water level is valued for all criteria by experts according to their field of expertise. This information was used to generate value maps for all criteria and objectives (See Section 3).

The three types of land use investigated in this study are very characteristic for peat meadows in the western part of The Netherlands. These large grassland areas, typically located in polders, encompass long, relatively narrow strips of grassland, separated by drainage ditches, on peat soils; they are typically used for dairy production. For this *intensive agriculture* land use, drainage keeps water levels relatively deep and fertilizer use is high. *Extensive agriculture* is defined as a land use for commercial dairy production but supported by government subsidies to enhance natural values, in particular breeding opportunities for 'meadow birds'. This may involve higher water tables, lower fertilizer use and/or measures to protect breeding 'meadow birds'. Nature is a land use where meadow parcels are no longer in agricultural production but are used to maximize biodiversity values. Grazing by non-commercial livestock, mowing, and high water levels are examples of measures needed to achieve this [Vermeer and Joosten, 1992].

3. Using expert knowledge to assess ecological qualities

Assessment of nature values using expert knowledge is part of the analysis workshop. Results of assessment are stored in a value table and presented in value maps. This section addresses the structure of the value table, the classification of parcels used, selection of evaluation criteria, definition of the value scale used for scoring and finally the use of expert knowledge to assign scores. Land use and groundwater level are the two elements that drive the valuation. It is assumed that, within each land use/water level combination, the parcels are homogeneous with respect to their value. Three types of land use are possible: intensive agriculture, extensive agriculture and nature. Each land use is linked to 10 groundwater classes. The land use/water level combinations are scored for three nature values: 'meadow birds', 'species-rich grasslands' and 'marsh birds'. This means that the expert needs to assess 90 separate scores (Table 3.1).

The three criteria for evaluating natural value: 'meadow birds', 'species-rich grasslands' and 'marsh birds' refer to the most important types of valuable nature in Dutch peat meadows (Vermeer and Joosten, 1992). 'Meadow birds' comprise bird species from open, farmed terrain; for the peat meadow areas in The Netherlands, the most important meadow bird species are the black-tailed godwit (*Limosa limosa*), ruff (*Philomachus pugnax*), lapwing (*Vanellus vanellus*), redshank (*Tringa tetanus*), sky lark (*Alauda arvensis*) and meadow pipit (*Alauda arvensis*). The Netherlands has an international responsibility for 'meadow birds', particularly the black-tailed godwit, because the peat meadows harbour the largest populations in the world. Most nature targets for reserves and extensive farming in these areas are related to maximizing conditions for 'meadow birds'. Species-rich grasslands, once used for hay-making, have been common in the region until 1950's because they formed part of traditional agriculture. These plant communities have now become rare comprise several red list species, and are considered of high importance for nature conservation [Grootjans et al, 1996]. Marshlands are mostly valued for their potential to provide habitat for 'marsh birds'. Rewetting improves the opportunities for these species in terms of nesting and feeding grounds, but at the same time creates a risk of nutrient, in particular phosphate, mobilization. Leaching of phosphates and nitrates into surface waters can be diminished by stimulating the growth of helophytes such as reeds or cattails.
Expert knowledge based on published information is used to fill the value table. For all criteria, experts are asked to assign a score to each land use/water level combination on a 0-10 scale (Table 3.1). Scores of 10 and 0 refer to the best and worst possible values for peat meadow areas in the whole

peat meadow region of the western Netherlands [Grootjans et al, 1996, Kleijn and Van Zuijlen, 2004, Schrautzer et al, 1996; 2006]. For the Bodegraven polder, only the criterion 'marsh birds' reaches the maximum value of 10, as can be seen from Table 3.1.

Table 3.1.
Value table for 'meadow birds', species-rich grasslands and 'marsh birds'.

			Nature		
Land use	Water level		'meadow birds'	'species-rich grasslands'	'marsh birds'
Nature		> 0	3	0	10
	0	-10	3	3	10
	-10	-20	5	7	5
	-20	-30	7	9	3
	-30	-40	9	9	2
	-40	-50	8	7	0
	-50	-60	5	6	0
	-70	-80	3	4	0
	-80	-90	0	1	0
	-90	-100	0	0	0
Extensive Agriculture		> 0	2	0	7
	0	-10	2	2	7
	-10	-20	4	4	3
	-20	-30	6	5	0
	-30	-40	8	5	0
	-40	-50	7	5	0
	-50	-60	4	4	0
	-60	-70	3	0	0
	-70	-80	2	0	0
	-80	-90	0	0	0
	-90	-100	0	0	0
Intensive Agriculture		> 0	1	0	5
	0	-10	2	1	3
	-10	-20	2	1	1
	-20	-30	4	1	0
	-30	-40	6	2	0
	-40	-50	5	1	0
	-50	-60	3	0	0
	-60	-70	2	0	0
	-70	-80	2	0	0
	-80	-90	0	0	0
	-90	-100	0	0	0

'Meadow birds' and 'species-rich grasslands' never score higher than 9 because Bodegraven polder does not have any parcels where conditions are fully optimal. This is due to the land use history in the area. Table 3.1 shows that 'marsh birds' have the highest scores in the very wet areas where water tables are not lower than 10 cm below the ground. These conditions only exist when the land use is nature. As soon as the land is drained further, the scores quickly drop; scores of 0 are present only in the extensive and intensive agricultural land uses. Some combinations of water/level and land use cannot exist in practice.

It is assumed that the scoring is continuous within the whole range. This means that the difference in value between 5 and 6 is equal to the difference in value between 9 and 10. By assigning scores, the experts have implicitly defined three value functions (one for each type of land use) for each of the three criteria linking water levels to value measured on a 0-10 scale. An example of such a value function for 'species-rich grasslands' in *nature* land use is given in Figure 3.1. Note that this value function is continuous but not linear and ranges from 0-10 [Janssen, 2001].

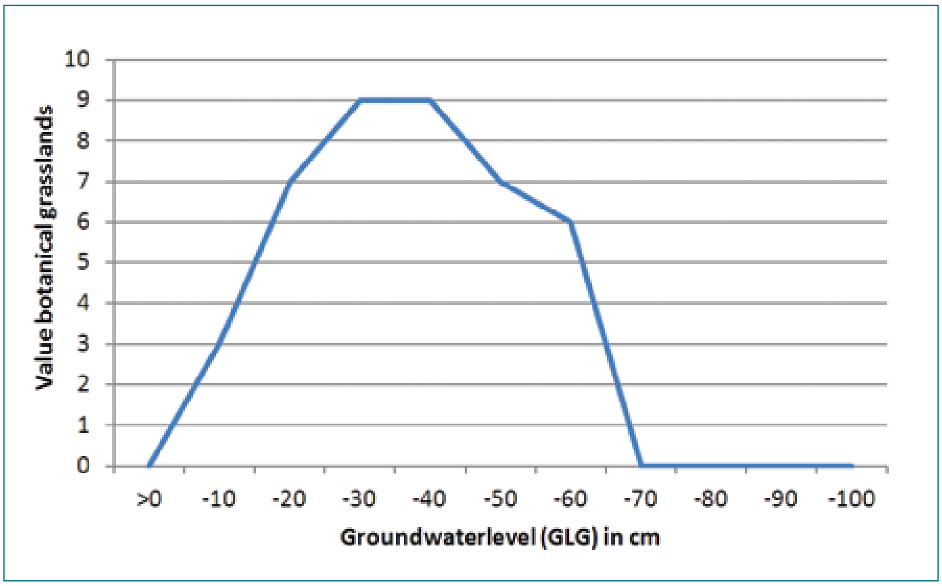

Figure 3.1.
Value function linking ground water level to the value of 'species-rich grasslands' for land use nature.

The value table can be used to evaluate the current situation but also to evaluate future plans. As previously explained, two maps are needed for an effective evaluation: a map of the predicted groundwater levels and a land use map. At present water management is inefficient with a large number of water management units each with their own water level. To make water management more efficient this number has to be reduced. In one of the stakeholder workshops it was decided that three water management units was best and borders of these units were drawn (Figure 3.2). Using these new borders, ground water levels (GLG) were predicted for the year 2050 (Figure 3.2). Changing water levels creates the need to change land use. Areas where the groundwater level rises may no longer be suitable for agriculture and areas where the level declines may no longer be suitable for nature. A reference plan was developed to meet these new conditions [Stroeken, F. 2008, personal communication]. This plan is shown in Figure 3.3 and involves development of new nature areas in combination with conservation of the traditional peat meadow landscape.

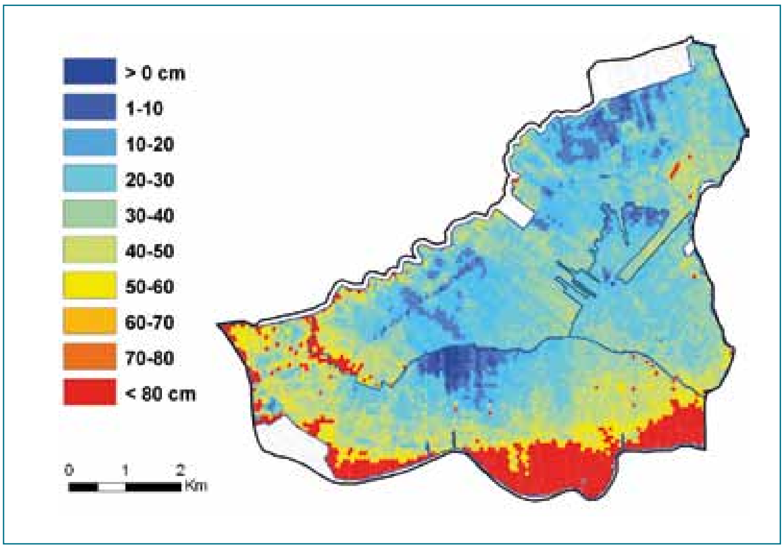

Figure 3.2.
Predicted average lowest groundwater levels (GLG) for the year 2050 based on three water level management units and surface water level -30cm below the surface (Jansen et al 2007).

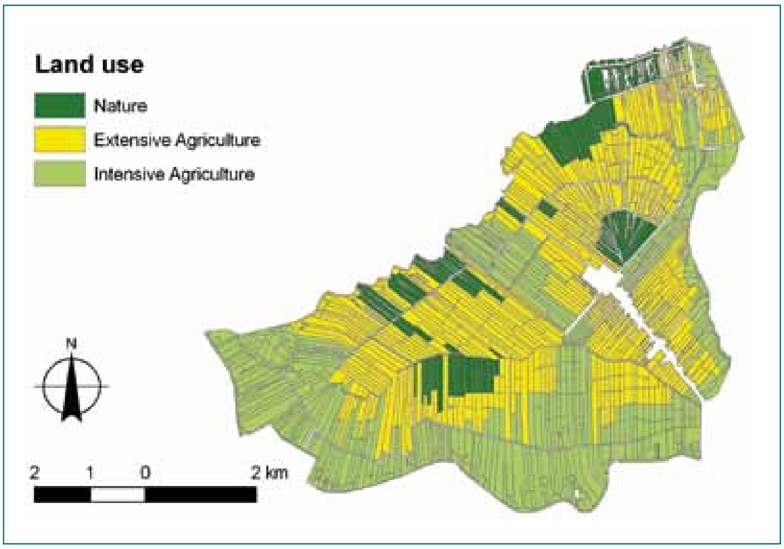

Figure 3.3.
Reference land use plan (2050).

Both land use and water level are now known for each parcel in the region. Together with the completed value table (Table 3.1) it is now possible to generate a value maps for criterion: 'meadow birds' (Figure 3.4. Good conditions for 'meadow birds' occur in *extensive agriculture* or *nature* parcels with a water table 30-50 cm below the ground; this occurs in the parcels in the centre-north of the polder (Figure 3.4). The areas in the southern part of the polder are in intensive use and have water tables too low for 'meadow birds', whereas some nature parcels in the northeast are too wet (compare figures 3, 4 and 5).). Similar value maps can be made for 'species-rich grasslands' and 'marsh birds'.

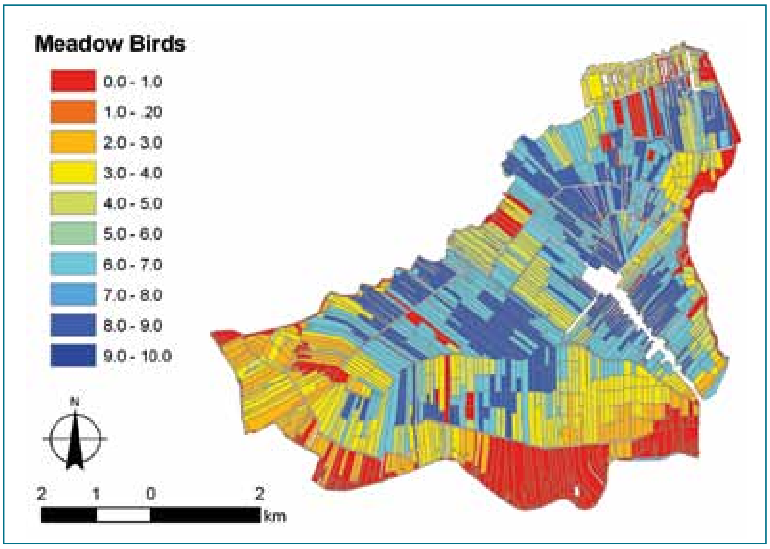

Figure 3.4.
Value maps for 'meadow birds' (2050).

To calculate the total nature value it is necessary to combine the score information on the three criteria into one integrated score. The simplest way to do this is to calculate an arithmetic mean of the scores. However, this implies that the three criteria are equally important with respect to ecological quality. This would give a biased evaluation because 'meadow birds' are seen by nature conservation organizations, environmentalists and the general public as the most characteristic feature of peat meadow nature. Some of the species (e.g. the godwit) are rare in Europe but relatively abundant in the western Netherlands (Kleijn and Van Zuijlen, 2004). Therefore, the three criteria are weighted in such a way that 'meadow birds' received twice the weight (50%) of species-rich grasslands (25%) and 'marsh birds' (25%).

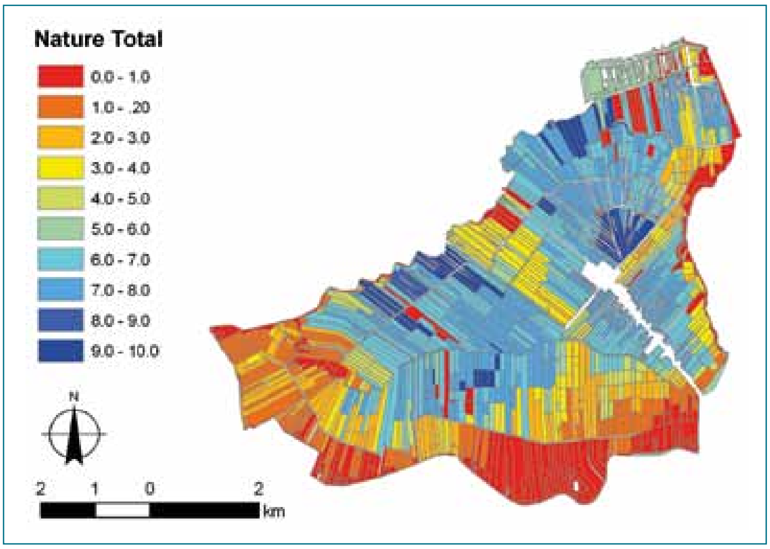

Figure 3.5.
Value map total nature (2050).

Figure 3.5 shows the total value for 'Nature'. It is clear that the highest nature values in the north-west half of the polder. From comparison of this map with the land use map (Figure 3.2) and the ground water map (Figure 3.3), it can be concluded that the highest nature values are found in parcels with land use *nature* and water levels between 30 and 50 cm. Intermediate values are found with parcels with land use *extensive agriculture* and water levels in the same range. Very low nature values are found in the southern part of the polder and on the polder margins. On the 'Touch table' comparison of maps is supported using the 'swipe' function available in ArcGIS©.

4. Negotiation support

A negotiation workshop was held as part of the planning process of the Polder Bodegraven. Participants of the workshop were experts involved in research about peat-meadows in the region. The workshop included two parallel interactive sessions with two groups of participants working on two separate Touch tables. The purpose of the workshop was to assess the extent to which the tool can improve the qualities of a reference plan (See Figure 4.1). Both sessions were held simultaneously, for the same length of time and under the same conditions. In each session a group of three participants used the negotiation tools collectively to generate, within 90 minutes, a consensus land use plan which meets long-term provincial goals. Each participant was asked to play a stakeholder role from the three possible roles (Farmers organizations, Agricultural nature organizations, Nature organizations) and increase the quality of a specific objective (Agriculture, Landscape, Nature, respectively). Both groups were asked to increase their individual objective and the total quality of the reference plan as they tried to achieve long-term provincial policy goals in hectares for each land use.

Long term provincial policies aim to create 860 ha of nature and 1600 ha of extensive agriculture in the Bodegraven polder. The Province of South Holland has already bought a substantial part of these 860 ha and plans to buy the remainder in the coming years. As a result of the change in water management not all of the acquired land is in the right location. This means that agricultural land must be bought for conversion into nature and some land already bought can be sold back to agriculture [Strategiegroep Gouwe Wiericke, 2007]. The assignment for the participants was:

- Allocate 860ha nature
- Allocate 1600ha extensive and 1600ha intensive agriculture
- Maximize the values of the four objectives and the total value

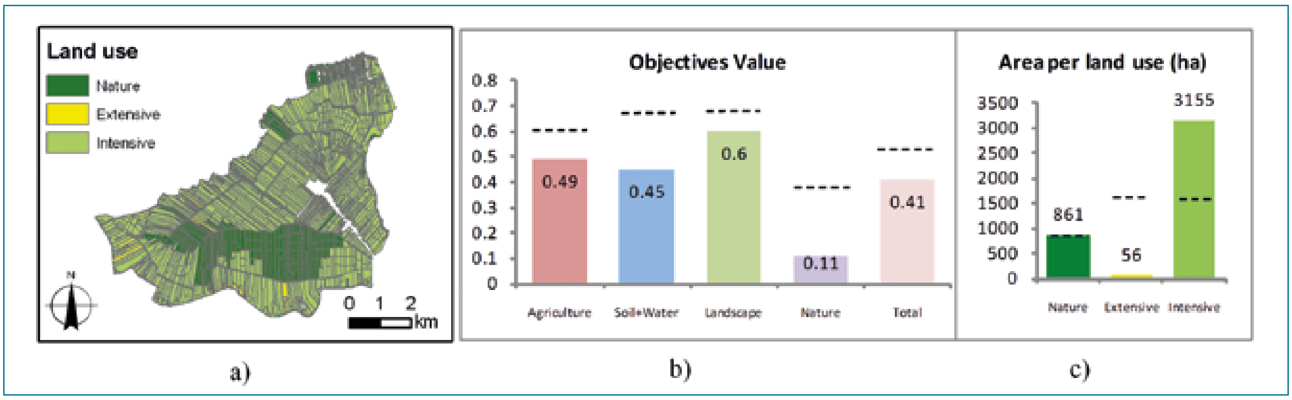

Figure 4.1.
Start situation for the negotiation session: (a) start land use map; (b) objective values of the start land use map (c) area size per land use type. Dashed lines indicate the maximum values of the objectives (b) and the policy goals set for the three land use types (c).

Participants enter these policy goals in ha and the tool produces a negotiation map. On the basis of the area sizes specified for the three types of land use the negotiation map (Figure 4.2) shows the best (blue) and worst (red) parcels for each of the three land uses: Nature (N), Extensive Agriculture (E), and Intensive Agriculture (I). For example, a sequence of characters 'N E I', coloured respectively blue, blue and red, indicates that a parcel falls within the best area for Nature and Extensive agriculture and within the worst for Intensive agriculture. If these parcels are currently in use for intensive agriculture they make good candidates for exchange. Parcels that are not within the specified limits are left blank. The MCA results for the entire study area are displayed in Figure 4.3. The dashed lines on each bar indicate each objective's theoretical maximum value. If the participants change the land use of parcels as a result of the negotiations, the plan will be automatically reassessed in real time.

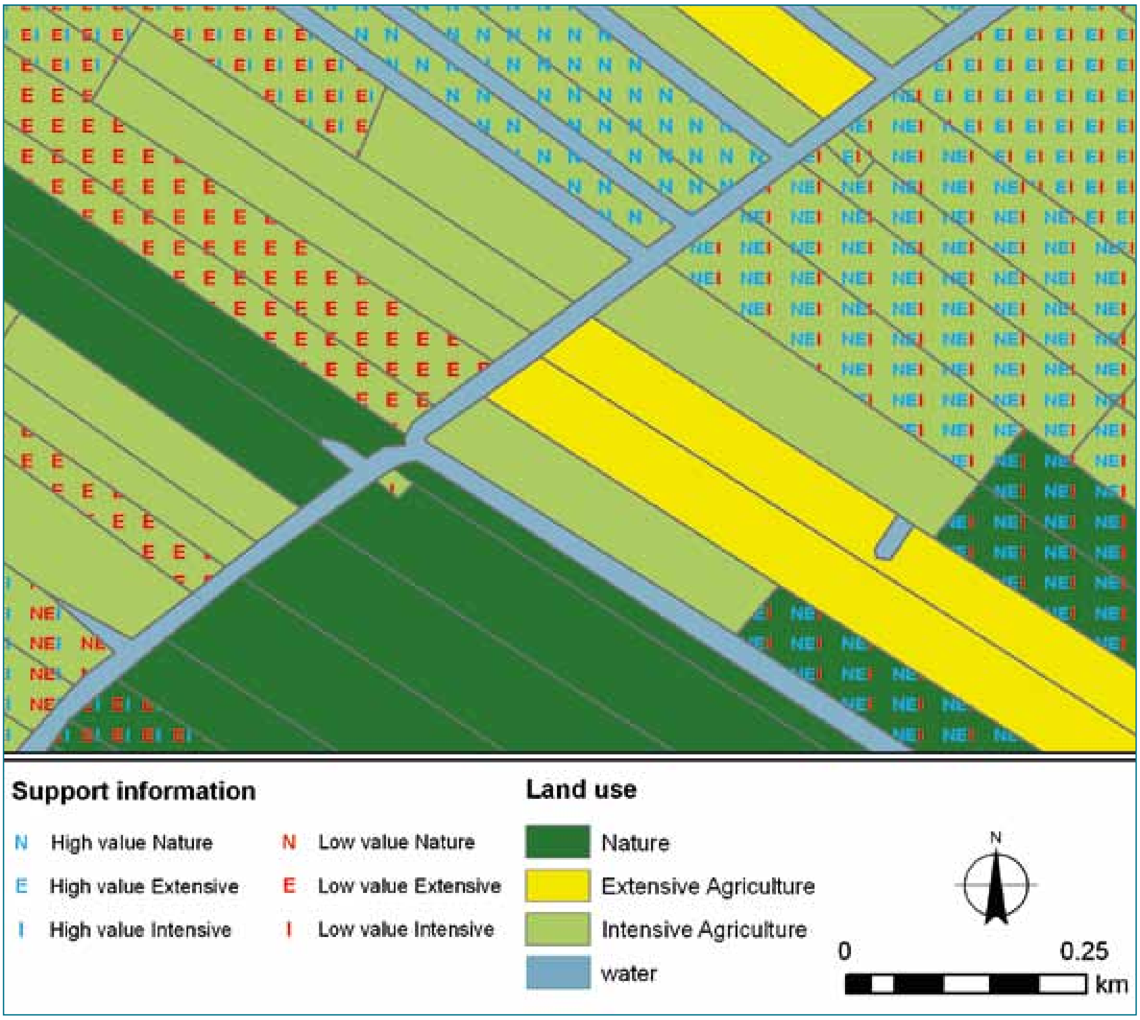

Figure 4.2.
Negotiation Support on part of the land use map of Bodegraven. Map shows Nature (dark green), Intensive agriculture (light green) and Extensive agriculture (light green). Blue and red letters indicate high (blue) and low (red) values (blue) for nature (N), Extensive agriculture (E) and Intensive Agriculture (I) of an individual parcel.

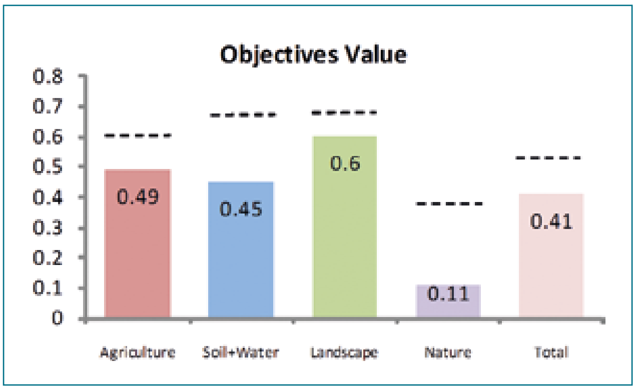

Figure 4.3.
Aggregated values for agriculture, soil and water, landscape, nature and total value.

Participants touch the table with their fingers to change the land use of one or more parcels. Figure 4.4 shows the workshop hardware setup, which includes a laptop, the Touch table and a separate screen. The software comprises MCA tools for dynamic plan evaluation, tools to support trade-off identification and drawing tools to change land uses on the map. The tools were developed with CommunityViz Scenario 360 (http://www.communityviz.com/).

Figure 4.4.
Workshop hardware setup.

Figure 4.5a zooms in on Figure 4.1a. In this part parcels are used for intensive agriculture and nature. The participant with an interest in nature uses the interface to retrieve only the best and worst 861 ha nature in the polder. A similar procedure is followed by a participant with an interest in intensive agriculture. With the input of both participants, feedback is displayed on parcels. Figure 4.5b shows blue N's and red I's overlaid on some parcels on the left currently used for intensive agriculture, indicating that these parcels are valuable for nature (blue N's) and not so for intensive agriculture (red I's). Likewise, some parcels on the right currently used for nature are valuable for intensive agriculture (as indicated by blue I's) and less valuable for nature (as indicated by red N's). These parcels are potentially suitable for an exchange that is favourable for both nature and agriculture. Both participants thus agree on the exchange and proceed to reallocate land use with the drawing tools on the Touch table. Figure 4.5c shows that nature has been reallocated to parcels with a high value for nature and low for agriculture; intensive agriculture is reallocated similarly. This exchange will likely increase the value for both nature and agriculture as well as the overall value.

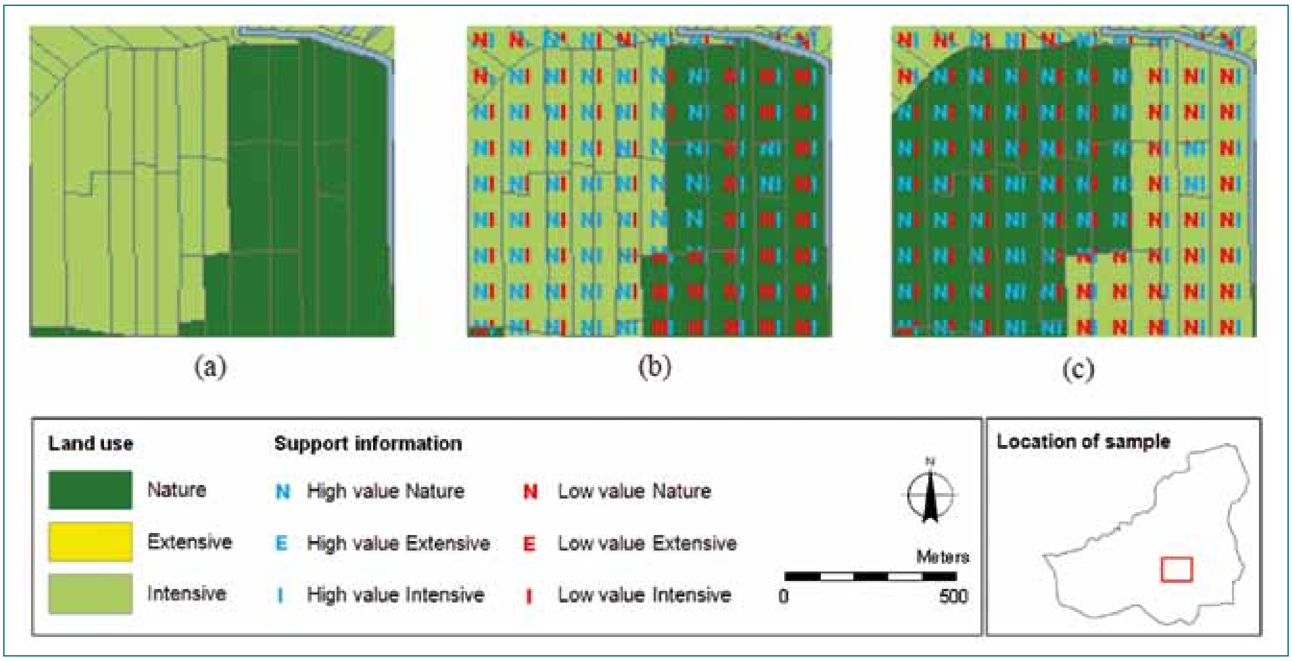

Figure 4.5.
A land use exchange between intensive agriculture and nature: (a) a portion of the polder showing land uses intensive agriculture and nature allocated to parcels. (b) With the participant's input, support information is displayed on top of the parcels to facilitate the identification of potential exchanges. (c) Parcels with a high value for nature have been changed to land use nature.

Results of negotiations

Once the two sessions were completed, each group presented their consensus plan, which was followed by a discussion about their underlying ideas and the negotiation support provided. Figure 4.6 shows the two maps generated by the participants in each session and the qualities of both plans. The spatial distribution of land use on both plans differs quite significantly. By comparing the qualities of the two plans generated by both groups with those of the reference plan, it is clear that both groups succeeded in improving the land use situation for each evaluation objective and the total aggregated score (See Figure 4.7). Both groups found it difficult to reach the target of 1600 ha of extensive agriculture. Both groups improved the reference plan by similar percentages: the first group from 0.41 to 0.48 and the second from 0.41 to 0.47.

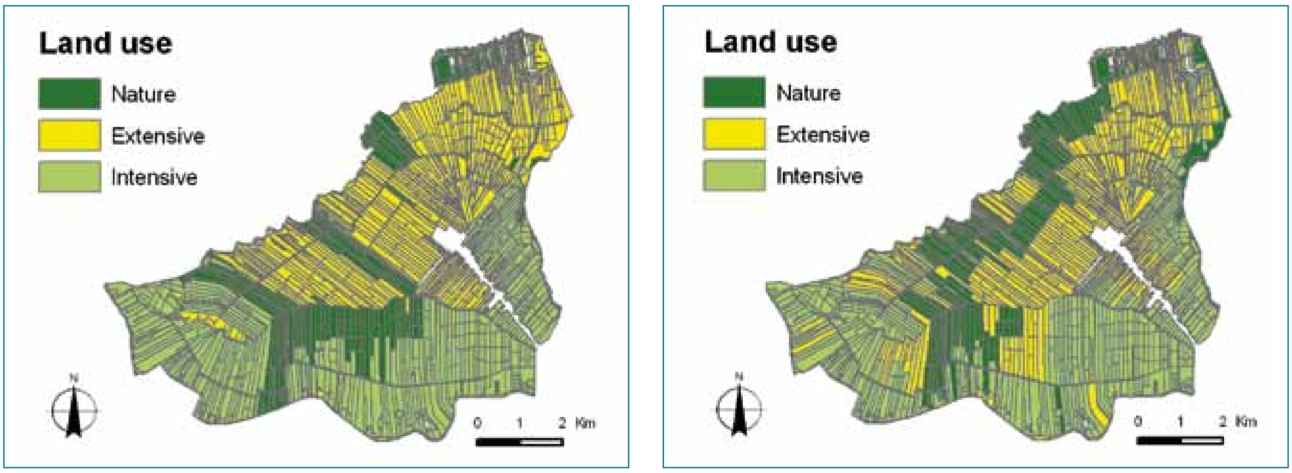

Figure 4.6.
Land use plans developed simultaneously by two stakeholder groups during a negotiation workshop.

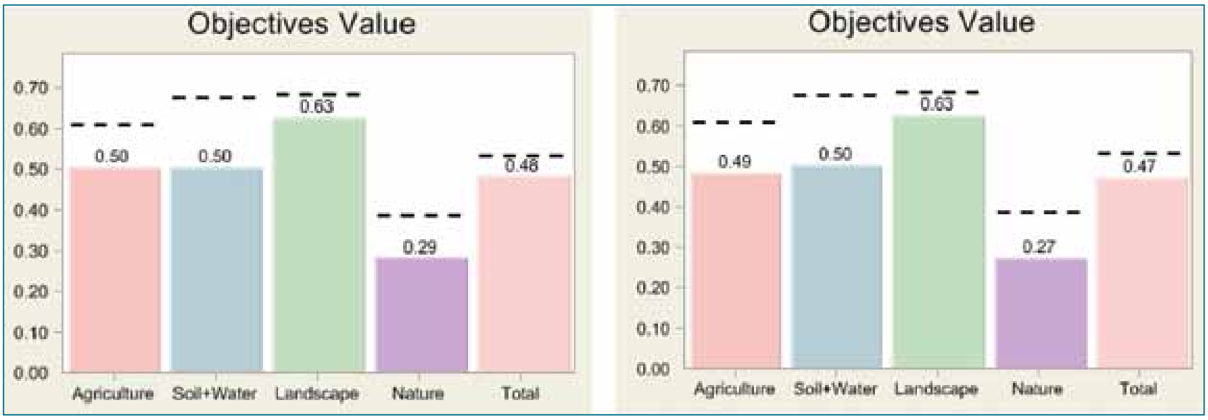

Figure 4.7.
Objective and total values of the two land use plans.

It is important to frame the assignment in such a way that it is perceived as fair by the negotiators and with room for give-and-take for all participants. Since the current situation is suboptimal, there is room for improvement for all negotiators. This proved to be important for the commitment of the negotiators to the process. Both teams produced a plan that increased the separate objective values and the overall value of the plan. Both teams did equally well in improving these values. However, the maps they produced showed large differences. In part this was the result of differences in local knowledge between the groups.

5. Effectiveness

This section provides results of an empirical analysis of the effectiveness of three participatory tools developed to support a land use allocation problem in a peat-meadow polder in the Netherlands. The tools use map-based MCA to make explicit the trade-offs between stakeholder objectives and to provide feedback on the land use changes negotiated by participants [Arciniegas et al., in press]. An interactive device, the 'Touch table', is used as the interface between spatial information and participants. The participants are informed about the relevant trade-offs on the map and use this information to change the land use map on the Touch table. A series of controlled experiments was conducted to test how well the tools fit the capabilities and demands of intended users, and how successfully they support spatial decision-making. The experiments focused on three aspects of effectiveness:

1. Usefulness: does the tool enable users to successfully perform the intended tasks?
2. Clarity: to what extent is the information presented in the tool understood by users?
3. Impact: how much do the tool and its outcomes influence the decisions made by users?

Support tools

Three types of support tools (Figure 5.1) were tested in ten sessions, with a total of 30 participants. Each session comprised three separate experimental modes, each involving a different tool. The first tool consists of three printed objective-specific choropleth maps showing ranges of MCA scores per parcel. The second and third tools provide information digitally per polygons (representing parcels) on the Touch table in two ways. The second tool presents scores on three objectives quantitatively per parcel and shows trade-offs by selecting polygons that would profit from a land use swap based on their actual MCA value. The third tool highlights trade-offs per parcel qualitatively as color-coded characters, which indicate the suitability of polygons for each potential land use type A, B, or C, based on their summed area and ranked MCA score.

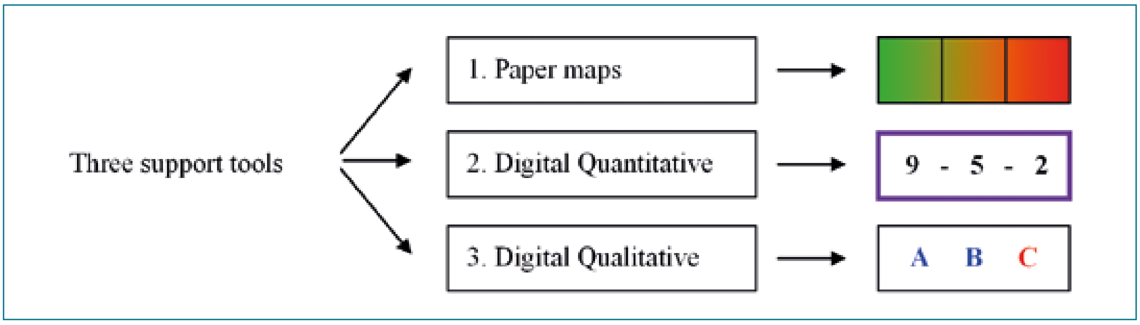

Figure 5.1.
Tool 1 shows trade-offs offered on three objective-specific paper maps; Tool 2 shows quantitative trade-offs offered per parcel. Tool 3 shows qualitative trade-offs offered per parcel.

Each mode involved both an individual and a group assignment. The individual assignment was carried out separately by each participant, who was asked to use each tool to modify a land use situation within a subset of the study area. The group assignment was carried out by each group of three participants. Each group was asked to use each tool collectively to generate a consensus land use plan that meets specific goals. Within a group, each participant was asked to play a stakeholder role and increase the quality of a specific objective. At the same time, each group was asked to increase the total quality of the plan.

Data on the performance of the participants were collected through four different methods: Questionnaires, Observation and analysis of the quality of the results.
Of the tools tested, the participants found the qualitative tool to be the most useful, followed by printed maps. These judgments match observations of performance: the use of the qualitative tool prompted the best performance for most individual tasks and also resulted in the best plans for both individuals and groups. The tool with the highest information level, i.e., the quantitative tool, proved to be too difficult for the participants to use, and was also considered by them to be the least useful. Using the quantitative tool resulted in the worst plans, despite the fact that the participants' understanding of this tool proved to be high. During the group assignment the qualitative tool was used the most extensively to support decisions. The use of printed maps took the most time and prompted the longest discussions. Footage shows that when conflicts emerged during the negotiations, paper-based technology proved to be the most used tool to address such conflicts. The extent of discussion and cooperation triggered by the use of the three tools had a positive impact on the quality of group results.

6. Conclusions

The project proposal identified two objectives for the project:

1. To integrate and communicate knowledge generated in other Climate changes Spatial Planning (KvR) and Living with water (LmW) fen meadow projects.
2. To develop and implement a decision support methodology that can support interactive development of land use plans for fen meadows;

Integration and communication of knowledge is addressed in the analysis workshops. This is illustrated in Section 3 using assessment of ecological qualities linked to water management as an example.

Within the project a negotiation support tool is developed to support interactive development of land use plans. This tool is integrated in the negotiation workshop as described in Section 4.

Spatial multicriteria analysis was used to structure and manage knowledge in a way that it can be used effectively by the negotiators. The approach used is simple and straightforward and proved to be easy to understand by the participants. Definition of the criteria and setting of weights was done in a special expert workshop. This step is crucial for the credibility of the approach and requires input from experts from different fields.

Negotiators found the Touch table easy to use and sitting around the table allowed for learning by doing. Even users that do not really understand the underlying multicriteria analysis get a feel for the implications of the method during the negotiation. The negotiation tool is based on interaction with the participants. It is clear that a plan that maximizes the overall value could be produced using an optimization tool. This is the approach to take if the value model used is a perfect representation of the problem. In practice creating a perfect model will not be easy. Some objectives are not so easy to translate into a formal model or remain implicit in the mind of the negotiators. In addition interaction prompts the use of local knowledge from the negotiators. In using the tool participants combine the provided information with local knowledge and objectives not included, such as adjacencies and corridors. It was interesting to see that the negotiators focused only on the aggregated information presented on the 'Touch table' and ignored all other information. Negotiators in both teams showed a cooperative attitude. They had the intention of doing a good job. Successful use of the tool depends very much on such a cooperative attitude. As such it is very much a product of the Dutch way of decision-making. In situations of sharp conflict or a more power-based style of decision it is questionable if the tool is as useful.

Further research

Learning by doing is an important element in the use of the tool. Participants use the tool because it brings a favorable result. It is not clear to what extent the participants understand the different types of information presented. Further research will analyze more systematically how effective the various tools are in supporting the tasks presented. This will involve setting up experiments to analyze strategies applied by different teams and comparing their plans with the results of formal optimization. More work needs to be done to include objectives linked to spatial pattern such as adjacencies, borders, corridors that are not easy to include in a vector-based tool. Last but not least, the approach should be tested with as many stakeholders as possible to get a good feel for its potential and limitations. Particularly, it will be interesting to test the approach with real stakeholders with direct stakes and limited scope for negotiation.

References

Arciniegas, G. A. And Janssen, R.. (in press) "Spatial decision support for collaborative land use planning workshops." Landscape and Urban Planning (2015).

Arciniegas, G. A., Janssen, R., & Omtzigt, N. 2011, "Map-based multicriteria analysis to support interactive land use allocation", International Journal of Geographical Information Science, p. 1-17.

Arciniegas, G. A., Janssen, R., & Rietveld, P. in press, Effectiveness of collaborative decision support tools: results of an experiment. Environmental Modeling and Software.

Boroushaki, S. and Malczewski, J., 2010. Measuring consensus for collaborative decision-making: A GIS-based approach. Computers, Environment and Urban Systems, 34, 322-332.

Carton, L.J. & W A H Thissen 2009. "Emerging conflict in collaborative mapping: Towards a deeper understanding?" Journal of Environmental Management 90(6) 1991-2001.

Carver, S., Watson, A., Waters, T., Matt, R., Gunderson, K., & Davis, B. 2009, "Developing Computer-Based Participatory Approaches to Mapping Landscape Values for Landscape and Resource Management," pp. 431-448.

Cornelisse, A.C., Janssen, R., Arciniegas G.A.&Omtzigt A.Q.A., 2007a. Workshop verslag "Waarheen met het Veen", Provinciehuis Zuid-Holland, 26 oktober 2007, Instituut voor Milieuvraagstukken, Amsterdam.

Cornelisse, A.C., Janssen, R., Arciniegas G.A.&Omtzigt A.Q.A., 2007b. Verslag van de projectgroep workshop "Waarheen met het Veen", Vrije Universiteit 11 december 2007, Instituut voor Milieuvraagstukken, Amsterdam.

Cornelisse, A.C., Janssen, R., Arciniegas G.A.&Omtzigt A.Q.A., 2008. Workshopverslag Publieke stakeholders "Waarheen met het Veen", Vrije Universiteit 19 februari 2008, Instituut voor Milieuvraagstukken, Amsterdam.

Dragicevic, S., and Balram, S., 2006. Collaborative geographic information systems and science: a transdisciplinary evolution. In: Balram, S. and Dragicevic, S. (Eds.), Collaborative Geographic Information Systems. Idea Group Publishers, Hershey, PA, 341–350.

Eastman, J. R., H. Jian & J. Toledano 1998. "Multi-criteria and multi-objective decision making for land allocation using GIS". In Multicriteria Analysis for Land-Use Management. E. Beinat & P. Nijkamp (Eds) (Kluwer Academic Publishers, Dordrecht) pp 227-250.

Feick, R. D. & G.B. Hall 2002. "Balancing consensus and conflict with a GIS-based multi-participant, multi-criteria decision support tool" GeoJournal 53 391-406.

Geertman, S. & J. Stillwell (Eds) 2009. Planning Support Systems: New Methods and Best Practice (Springer, New York).

Grootjans, A.P., L.F.M. Fresco, C.C. de Leeuw & P.C. Schipper 1996. "Degenerations of species-rich Calthion palustris hay meadows; Some considerations on the community concept" Journal of Vegetation Science 7 185-194.

Jankowski, P., 2009. "Towards participatory geographic information systems for community-based environmental decision making" Journal of Environmental Management 90 1966-1971.

Jansen, P C., E.P. Querner & C. Kwakernaak 2007. Effecten van waterpeilstrategieën in veen-weidegebieden. Alterra-rapport 1516, Wageningen.

Janssen, R. 2001. "On the use of multi-criteria analysis in environmental impact assessment in The Netherlands" Journal of Multi-Criteria Decision Analysis 10 101-109.

Janssen, R. and G. A. Arciniegas. "Gebruik van een interactieve kaarttafel bij participatieve planprocessen." Landschap 27.3 (2010): 183-88.

Janssen,R.,Cornelisse,A.C,.ArciniegasG.A.andOmtzigtA.Q.A.,2008.Verslagonderhandelingsworkshop "Waarheen met het Veen", Vrije Universiteit 9 december 2008, Instituut voor Milieuvraagstukken, Amsterdam.

Janssen, R., M. van Herwijnen, T.J. Stewart & J.C.J.H. Aerts 2008. "Multiobjective decision support for land-use planning". Environment and Planning B: Planning and Design 35 740-756.

Kleijn, D. & G.J.C. van Zuijlen 2004. "The conservation effects of meadow bird agreements on farmland in Zeeland, The Netherlands, in the period 1989-1995". Biological Conservation 117 443-451.
Scholten, H. J., Velde R.van de, & Manen, N. v. 2009, Geospatial technology and the role of location in science Springer, Dordrecht.

Schrautzer, J., A. Rinker, K. Jensen, F. Müller, P. Schwartze & K. Dierssen 2007. "Succession and Restoration of Drained Fens: Perspectives from Northwestern Europe". In Linking Restoration and Ecological Succession. L. R. Walker, J. Walker & R. J. Hobbs Eds. (Springer, New York).

Sieber, R. 2006, "Public Participation Geographic Information Systems: A Literature Review and Framework", Annals of the Association of American Geographers, vol. 96, no. 3, pp. 491-507.

Strategiegroep Gouwe Wiericke 2007. Strategische Agenda Gouwe Wiericke (Royal Haskoning, Rotterdam)

Uran, O. & R. Janssen (2003). "Why are spatial decision support systems not used?: Some experiences from the Netherlands". Computers, environment and urban systems, 27(5) 511-526.

Vermeer J. G .& J.H.J. Joosten, 1992. "Conservation and management of bog and fen reserves in the Netherlands". In Fens and bogs in the Netherlands: vegetation, history, nutrient dynamics and conservation. J T A Verhoeven Ed. (Kluwer Academic Publishers, Dordrecht) pp 433-478.

Woestenburg M. 2009. Waarheen met het Veen: kennis voor keuzes in het Veenweidegebied (Uitgeverij Landwerk, Wageningen).

Climate changes Spatial Planning

Climate change is one of the major environmental issues of this century. The Netherlands are expected to face climate change impacts on all land- and water related sectors. Therefore water management and spatial planning have to take climate change into account. The research programme 'Climate changes Spatial Planning', that ran from 2004 to 2011, aimed to create applied knowledge to support society to take the right decisions and measures to reduce the adverse impacts of climate change. It focused on enhancing joint learning between scientists and practitioners in the fields of spatial planning, nature, agriculture, and water- and flood risk management. Under the programme five themes were developed: climate scenarios; mitigation; adaptation; integration and communication. Of all scientific research projects synthesis reports were produced. This report is part of the Mitigation series.

Adaptation

Dutch climate research uses a 'climate proofing' approach for adaptation. Climate proofing does not mean reducing climate based risks to zero; that would be an unrealistic goal for any country. The idea is to use a combination of infrastructural, institutional, social and financial adaptation strategies to reduce risk and optimalise opportunities for large scale innovations. Climate changes Spatial Planning realised projects in a multidisciplinary network that jointly assessed impacts and developed adaptation strategies and measures. The following themes were central to the programme: water safety, extreme precipitation, nature and biodiversity, agriculture, urban areas, transport (inland and road transport) and the North Sea ecosystem. In special projects, the so called hotspots, location-specific measures were developed that focused on combining 'blue', 'green' and 'red' functions.

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