6 To See or not to See, that is the Question: Geo-information Visualisation Tools as a Means to Facilitate Stakeholder Dialogues in Land and Water Management Planning

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6.1 The stakeholder dialogue context addressed

As discussed in the chapters of this book, coping with complex natural resource management problems calls for an approach that involves stakeholder dialogues. Stakeholder participation is essential because of the character of the natural resource management problem addressed. Many of the natural resource problems faced may be characterized as a social dilemma. A social dilemma occurs when people find themselves in a situation in which their individual interests appear to conflict with their collective interests. In such situations people will often choose in favour of their individual interests though this choice is both individually and collectively disadvantageous. Well-known examples of such dilemma situations are the prisoner's dilemma and Hardin's tragedy of the commons (Hardin 1968, Ostrom 1990). In particular the latter example has shown how people in social dilemma situations will make choices that are not sustainable for the natural resources involved.

However, research and practice in natural resource management have pointed out that people are able to make more sustainable choices in social dilemma situations (Ostrom 1990, Ostrom et al. 1995, Gunderson et al. 1995). Essential in coping with such situations is that stakeholders understand the problem situation and the manner in which their decisions and actions interact and have consequences for the natural environment. Thus, to resolve such dilemma situations, the stakeholders involved will need to collectively reflect on and act in the situation they are facing. Stakeholders need to develop a shared understanding of the problem at hand, explore alternatives, take action, and evaluate outcomes. Stakeholder dialogues may contribute to understanding the different perspectives, insights and actions that lead to the problem situation and its resolution.

In this chapter, we will focus on experiences in facilitating stakeholder dialogues for sustainable land and water management planning. In land and water management, planning different social dilemma situations may be encountered. For example, rice farmers in the Philippines may choose to forego collective maintenance of the terrace system for short-term livelihood decisions. Or in the Netherlands, scarcity of space requires people to choose between natural environment interests and housing development interests when towns want to expand and develop houses in river plains. In addition, the growing number of actors involved, an increasing amount of information to be processed, and uncertainties involved contribute to the complexity of land and water management planning.

In a number of cases, geo-visualisation tools have proven to contribute to collective reflection and action processes in stakeholder dialogues. Cartographic and dynamic geo-visualisation of problem situations and possible action alternatives may help stakeholders to better understand the situation they face, to develop alternatives and to undertake collective decision-making and action. Accordingly, geo-information visualisation tools may provide a means to facilitate stakeholder dialogues for more sustainable land and water management planning. In this chapter we will further discuss and illustrate the value of geo- visualisation tools in this context.

With regard to theory, we draw on the perspective of planning as a learning process (Friedmann 1987, De Geus 1988, Van der Vlist 1998, Maarleveld 2003). This type of planning perspective helps to provide insights into collective reflection and action processes in land and water management planning. To better understand the possibilities of geo-based visualisation tools to facilitate stakeholder dialogue and decision-making, we draw on insights from geo-information science and cognitive science (Van Lammeren and Hoogerwerf 2003, Batty et al. 2002, Bill 1999, Weinman 1988). The main theoretical bases are discussed in Section 6.2. In Section 6.3, three case examples are presented and discussed in light of these insights. In conclusion, we draw a number of lessons in terms of facilitating stakeholder dialogues and the quality of geo-visualisation tools.

6.2 Theoretical perspectives for facilitating stakeholder dialogues through geo-information visualisation tools

In this section, insights from planning and learning theory are discussed to gain a better understanding of collective reflection and action processes that may play a role in stakeholder dialogues in land and water management planning. In addition, the potential of geo-information visualisation tools in such stakeholder dialogues is discussed in terms of developments in geo-information science and cognitive science.

6.2.1 Planning as learning

There are many different ways to regard planning undertaken in land and water management. In his review of major planning traditions, Friedmann (1987) distinguishes planning as social reform, policy analysis, social learning, and social mobilisation. Each of these perspectives has its own strengths and weaknesses. In this article we will focus on planning as learning in order to gain insight into the collective reflection and action processes to be facilitated in stakeholder dialogues. Studies on regional planning involving spatial, environmental and water management policy support such a focus (Van der Vlist 1998). In various fields directly or indirectly related to spatial planning, a learning viewpoint has also been found to act as a potential perspective for bringing about change for sustainable development. For example, in development practice a learning approach has been found conducive to developing sustainable community and farmer practices (Korten 1980,1984). Organisational and management practice and theory have turned to learning as a means to effectively cope with a more interconnected world and, as a consequence, with a more complex and dynamic business environment. In order to cope with such complexity, collective learning and organisational learning have been put forward (De Geus 1988, 1997, Senge 1990, Argyris and Schön 1996). In the field of policy analysis, learning has been used as a factor to explain and improve policy development (Glasbergen 1996, Eberg et al. 1997). For researchers and practitioners in natural resource management, learning has provided a means of capturing and managing sustainable development as an ongoing process versus a stable end state (Lee 1993, Finger and Verlaan 1995, Gunderson et al. 1995).

The notion of learning captures the link between understanding and action necessary to develop knowledge continuously and the ability to use it. This is illustrated in Kolb’s learning cycle in Figure 6.1. Concrete experiences may be reason for reflection. One’s window on the world (normative cognitive frame) determines which issues are viewed as problematic and which are not. Abstract conceptualisation may lead to the development of new ideas. These ideas need to be tested in practice, which leads to new concrete experiences.

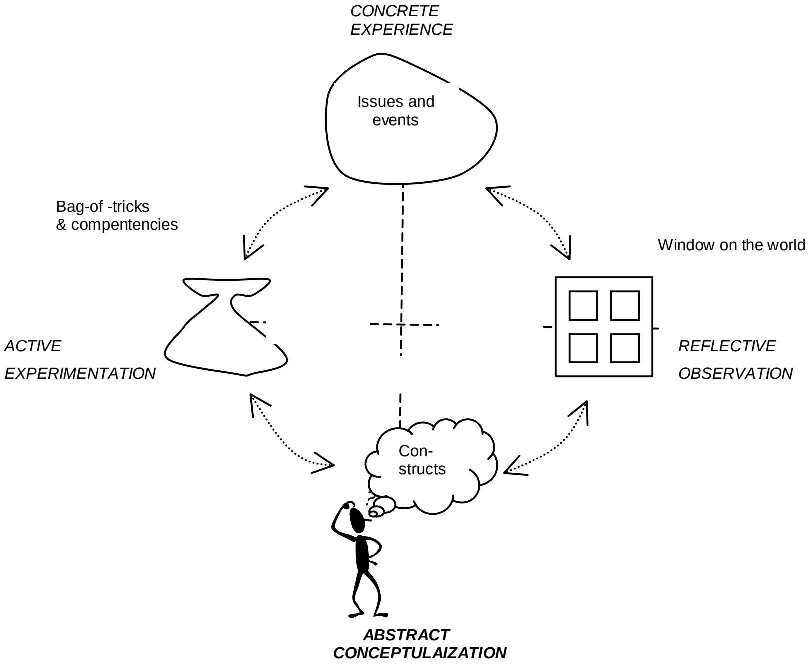

Fig. 6.1 Kolb's learning cycle (adapted from Kolb 1984).

Planning may be viewed as a learning process, as illustrated in Figure 6.2. People involved need to become aware of a problem issue, analyze the problem more closely, explore options, implement the option of choice, and monitor and evaluate whether actions have the desired result. As most planning processes involve a number of people, there is dialogue and decision-making throughout the process.

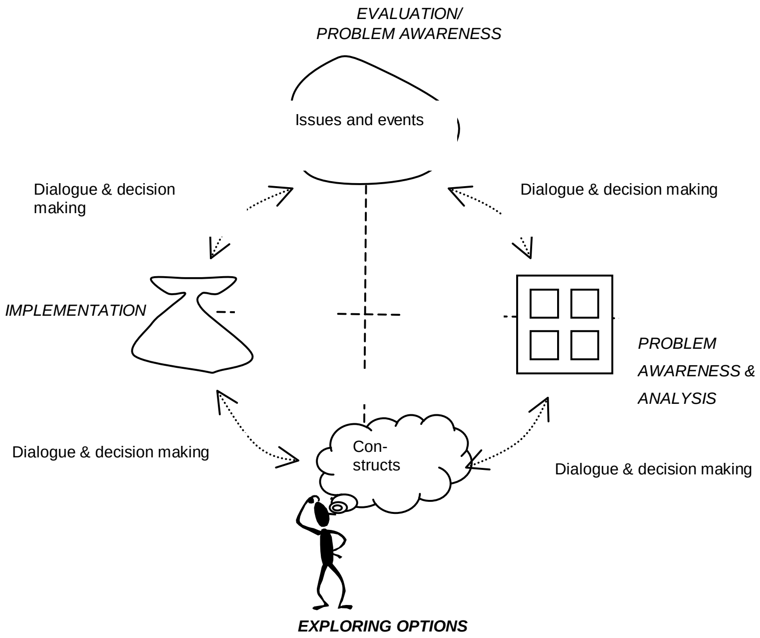

Fig. 6.2 Planning as learning.

Moreover, the constituting components of a planning cycle also entail learning cycles. Problem awareness and analysis, exploring options, implementation, and evaluation all involve cycles of concrete experience, reflection, abstraction and experimentation. As such, planning may be viewed as a complex of multiple learning cycles.

Viewing planning from a learning perspective draws attention to a number of insights to take into account when facilitating stakeholder dialogues. These insights may be summarized in terms of four questions: Who is learning? What is learned? How is it learned? and Why is learning taking place?

Who is learning?

In terms of the question of who is learning, the stakeholders involved in the learning process are an important point of focus (Lee 1993, Röling 1994). Systemic change, i.e., change in the normative frames that guide people's behaviour, has been found to occur primarily when all parts of the system learn to understand how the system works (Weisbord and Janoff

2000). Thus, to realize sustainable land and water management planning, the whole range of stakeholders, all having their own perspective, need to be involved in the learning process. Collective understanding by stakeholders of how the system they are a part of works is a starting point for learning to renew (see “What is learned?”).

What is learned?

The learning loops of Argyris and Schön (1996) are helpful diagnostic concepts to distinguish various aspects of what constitutes learning. In Figure 6.3, the three levels of learning loops distinguished are visualized. Single-loop learning takes place when the results of decision-making and action are evaluated in terms of the way they contribute to realizing goals and expectations. A mismatch between expectations and performance is resolved by improving actual practices so that they will better meet existing goals and expectations. These goals are based on underlying values and assumptions. When a mismatch leads to the questioning of existing goals and expectations, it is possible to distinguish double-loop learning. Such learning leads to a reframing of values and assumptions that underlie behaviour. The cognitive frames questioned may be individual windows on the world as well as collective ones embedded in organisations and institutions. In this questioning process, people may learn that common underlying values and assumptions underlie the contradictions and dilemmas they are facing. Such shared values and assumptions may be the basis for new joint goals. Such deep, systemic change enables a collective to renew.

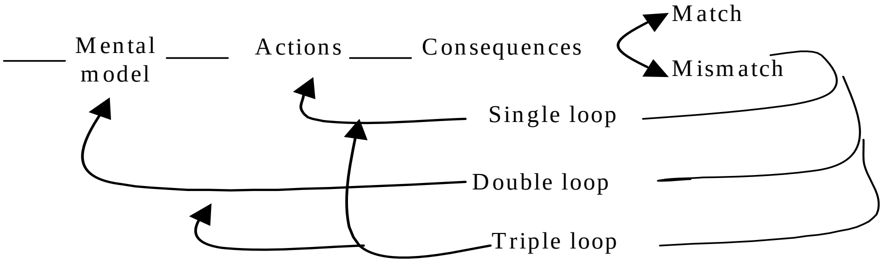

Fig. 6.3 Single, double, and triple loop learning.

Triple-loop learning may be viewed as a specific type of double-loop learning, namely, when such learning concerns the way learning itself takes place.

How is it learned?

Kolb's learning cycle in Figure 6.1. illustrates how learning may take place. Different people have been found to have different biases for ways of learning. In such learning biases, different aspects of the learning cycle dominate. Three different learning modes may be distinguished. In learning through direct experience, concrete experiences and active experimentation form the basis of learning. A bias for reflective observation characterizes learning through observation. Furthermore, abstract conceptualisation is characteristic of learning through abstraction, i.e., extracting common features from seemingly diverse responses and formulating rules of behaviour that go beyond what has been experienced or observed.

Why is learning taking place?

Learning may be triggered by both proactive and reactive motivations for change. On the one hand, some people have an innate desire to create and develop. Such proactive motivations also provide triggers for learning and change. On the other hand, some people will react negatively and even resist change when mismatches between expectations and performance make clear that a previously set goal will need to be adjusted. In other words, maintenance of existing cognitive frames may trigger people's learning.

6.2.2 Geo-information visualisation tools as a means to facilitate stakeholder dialogues and decision-making

Geo-visualisation techniques that support communication on spatial conflicts, challenges and future scenarios have been in the spatial planner's toolkits for decades (Van Lammeren 2003). Graphical presentation of information has a long history. Maps are some of the earliest existing geo-information visualisation tools. Cartography has had, and continues to have, an important role in the graphical presentation of geospatial information (Fairbairn 2001). Fairbairn (2001) defined cartographic representation "as the transformation that takes place when information is depicted in a way that can be perceived, encouraging the senses to exploit the spatial structure of the portrayal as it is interpreted." It is very hard to imagine stakeholder dialogues in planning without maps playing a significant role to inform, communicate, and design.

Geographical information systems (GIS) date back to the early seventies. First applications of GIS originated in landscape architecture and physical planning. GIS have become a useful tool in visualising complex computer-based data for spatial land and water management plans. In a field where transparency is of key importance and where many public and private stakeholders are involved, high quality mapping of current and future situations is needed. Developments in information technology have made it possible to efficiently store, manipulate, and visually present complex and large amounts of data. Moreover, developments in information technology enable the development of geo-information infrastructure, which supports participation of stakeholders in planning processes. For example, interactive technology developed for computer games may be adapted for geo-visualisation tools. Geographic information systems have already been widely used in stakeholder dialogues in third world countries (Harris and Weiner 2003) as well as in the developed world (Harrison and Hacklay 2002). In both cases, GIS has proven to be a good tool to support an interactive planning process. GIS allows instant interactivity, can visualise the plans in 2D at various locations, and can be instantly altered to process the comments and suggestions from all stakeholders involved.

The presentation of spatial plans to stakeholders and participants in planning processes mostly makes use of 2D visualisations. Gradually this method of presentation has been extended with presentations that make use of computerised 3D visualisations (see Batty et al. 2002). 3D visualisation provides an effective way of presenting large amounts of complex information to a wide audience. 3D visualisations help to give a more realistic picture of future changes in landscapes and allows the user to relate information and reality more easily.

A combination of scale models and GIS seems to be an ideal basis for 3D presentation and development of spatial plans. For many years, planners have combined real world representations with virtual/future objects in scale models to represent future changes in the landscape. Such scale models have been used to present detailed spatial plans to the public. This type of representation has been found to be easy to comprehend and to give a good overview of the plans. However, a scale model also has numerous disadvantages. A scale model might be a large, rigid, solid thing that can only be kept at a specific location. In the field of spatial planning, this location is usually a project office or an information centre. Moreover, interaction with a scale model is difficult. Background information cannot be offered on the fly, and new ideas cannot be visualised instantly.

In combining the scale model and GIS approaches, the 3D effect of a scale model for visualising the future situation and the interactivity and adaptability the GIS component are brought together. This combination is called virtual reality or VRGIS (Hacklay 2001). A 3D computer model is generated that shows the current or future situation (Dias et al. 2003, Verbree 1998). Users can explore the model by simply navigating through the virtual reality environment. Virtual reality can be very useful for presenting large amounts of information effectively to participants within spatial planning. Participants without any planning experience can effortlessly relate the visualized information to the real world. Virtual reality is described by Fisher and Unwin (2002), as "the ability of the user of a constructed view of a limited digitally-encoded information domain to change their view in three dimensions causing update of the view presented to any viewer, especially the user".

There are important cognitive aspects related to visualisation, perception and understanding of spatial information to take into account when developing geo-visualisation tools. Understanding the different information dimensions and media types and how these relate to different senses is useful for understanding how to develop geo-visualisation tools for spatial objects and spatial planning processes (Bill 1999). The media used for visualisation of spatial information may have four types of functions according to cognition science (Weinman 1988):

– the function of demonstration,
– the function of putting into context,
– the function of construction,
– the function of motivation.

The *function of demonstration* is achieved by using media to give a realistic picture (demonstrate the idea, object or landscape). This can be achieved with the support of photos, videos or virtual reality. The media with the *function of putting into context* should help the user put the detailed information into a bigger context, like an overview of the area (for spatial context), or sounds that are related to a particular area may help the user to identify and position the given information. The f*unction of construction* is related to the creation of complex mental models by the user (mental models are constructions of knowledge about information units and relationships). Abstract media of pre-prepared information is best suited for this function, such as graphs, diagrams or abstract layers. Finally, the media can have the *function of motivation*. Media with this function intend to arouse the user's interest and attention. This can be achieved with animations, interactive objects, e.g. interactive flyovers are a typical example of this function (Bill 1999).

Besides the media functions, when developing a system to visualize and perceive spatial information, one should pay attention to cognitive processes of:

- Short-term memory's limited cognitive capacity;
- Increasing important information;
- Avoidance of overloading a single sense;
- Supporting double encoding of information.

Because *human short-term memory* is only able to process seven information units at the same time, the spatial information system should not provide too much information simultaneously. Multiple representations can overcharge the human cognitive capacity, but they can also emphasize important information and improve information processing, if used in the right way. (Maps, pictures, sounds, and videos can be used in combination to *increase important information*). Also, a combination of visual and sound information helps the user's perception by avoiding the *overload of a single sense*. The human memory can store information in pictorial and textual formats (*double encoding*), so pictures in combination with written or spoken text should be used to describe information (Bill 1999).

6.3 Geo-visualisation practice in the facilitation of stakeholder dialogues and decision-making in land and water management planning

In this section three cases are discussed in which geo-visualisation tools have contributed to facilitating stakeholder dialogues in land and water management planning. For each case a brief overview of the case context, the geo-visualisation tool used and its effect, and the lessons learned are presented. The different cases have been chosen because they illustrate how geo-visualisation tools may play a role at various phases of a planning cycle. The cases discussed are: joint learning for water management in the Ifugao, Philippines (planning cycle: realizing the problem); visualizing consequences of flood management choices in the EU (planning cycle: exploring alternatives); and flying through planned urban expansion in Groningen, the Netherlands (planning cycle: abstraction/experiencing the future).

6.3.1 Realizing the problem: Joint learning for watershed management in the Ifugao, Philippines[1]

The case context

The landscape of the Ifugao consists of rugged mountains, low-lying hills, and an alluvial area along the Magat River. The province is located about 320 kilometres north of the Philippines' capital city Manila. The Ifugao's centuries-old rice terraces are world famous for their ingenuous engineering in extreme environmental conditions. The terraces reach the highest altitude (1600m) found in the Asia-Pacific region. They are a well-built, extensive engineering and hydraulic system, using traditional skills. Research has shown that this traditional agro-ecological system has been able to support a relatively high population density for many centuries without depleting its natural resources. As such, the Ifugao terraces have been added to the UNESCO World Heritage List of cultural and natural properties considered to be of outstanding value.

However, closer inspection makes visible the crumbling walls of the terrace system. Abandoned and broken-down terrace walls, thinning forests, landslides, erosion, slash-and-burn farming, extremely high poverty of inhabitants, loss of traditional knowledge, irresponsible tourism, and dependency on government and project support are just a number of the problem issues facing the Ifugao people and the terraces. So while ecologists and conservationists regard the terraces as one of the soundest soil and water conservation structures ever built by people, Ifugao has the largest area affected by moderate to severe erosion in the region.

Local, regional and national public and private efforts have been undertaken to reverse the situation. However, divergent views, goals and working methods of the different actors involved have led to clashes as organisations involved try to work according to their own development paths. As a result, not only has the erosion of the environment not been stopped, but the interacting network of external and local stakeholders has created a situation in which, at the time of the research of Gonzalez (2000), the divergent views and goals clash rather than converge toward a collective understanding of the problem situation and a working strategy.

The GEO-visualisation used and its effect

In order to better understand spatial dimension of the Ifugao's problem situation, Gonzalez combined aerial photographs and remote-sensing data

[1] Gonzalez (2000)

and discussed them with local inhabitants. The GIS visualisations were also used in discussions with provincial board and other stakeholders involved.

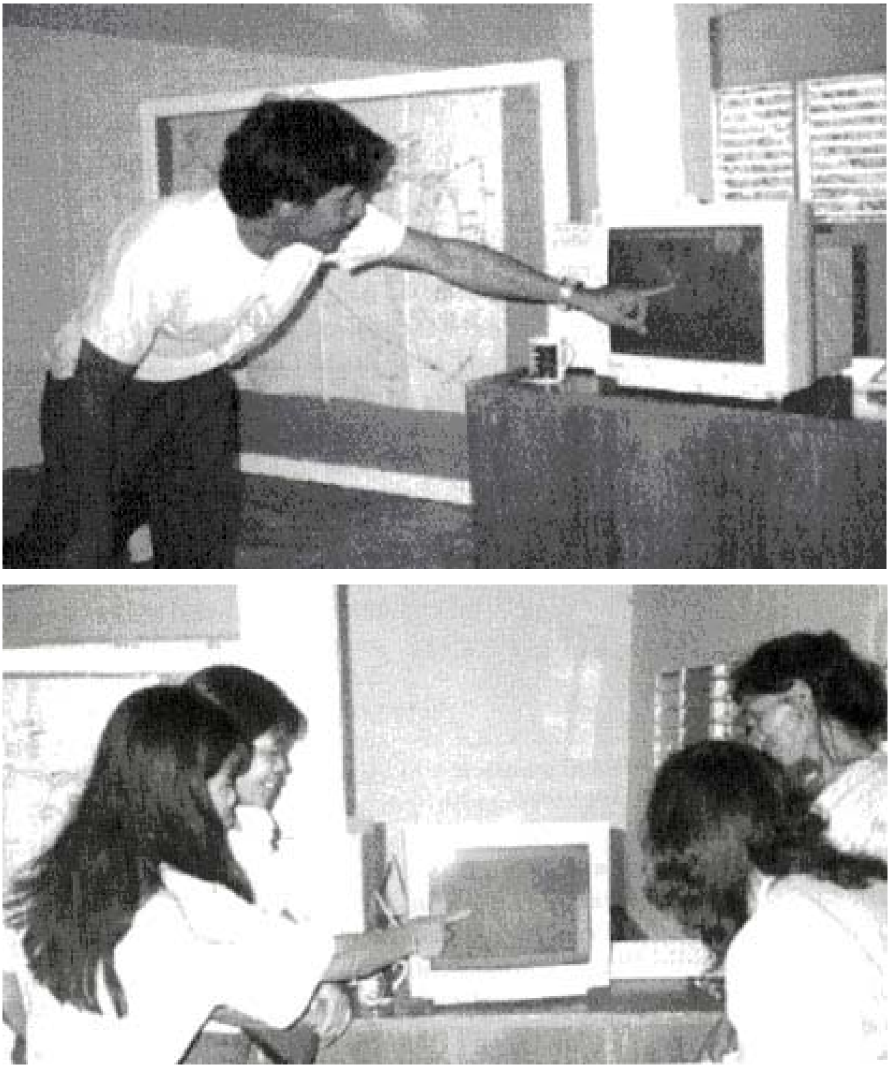

Fig. 6.4 Combining maps, aerial photos, and GIS to discuss and understand the watershed management problems.

Because the Ifugao is a rather remote area, some creativity on the part of the researcher was necessary. The battery of the "jeepney", the local transportation, provided power for the computer laptop. The locals proved capable of greatly improving the data, as traditional terrace management revolved around geographical agricultural dimensions. In the discussions of the maps, people (locals and outsiders) became more aware of boundary issues and degradation problems. Locals were so enthusiastic that they decided to start watershed monitoring with the help of the GIS visualisation tool. Overall, the geo-visualisation tool helped with the functions of putting into context, of construction, and of motivation.

Lesson learned

Direct involvement of local Ifugao stakeholders in developing GIS-based watershed management data and visualisation has made a twofold contributed to learning. On the one hand, the approach taken has improved integration of quantitative and qualitative spatial information available from the local level up to international levels. On the other hand, anchoring the development of GIS and its outcomes in the experience of local stakeholders has created a tool for facilitating a dialogue of ideas about the space that the Ifugaos are managing with others (see Figure 6.5).

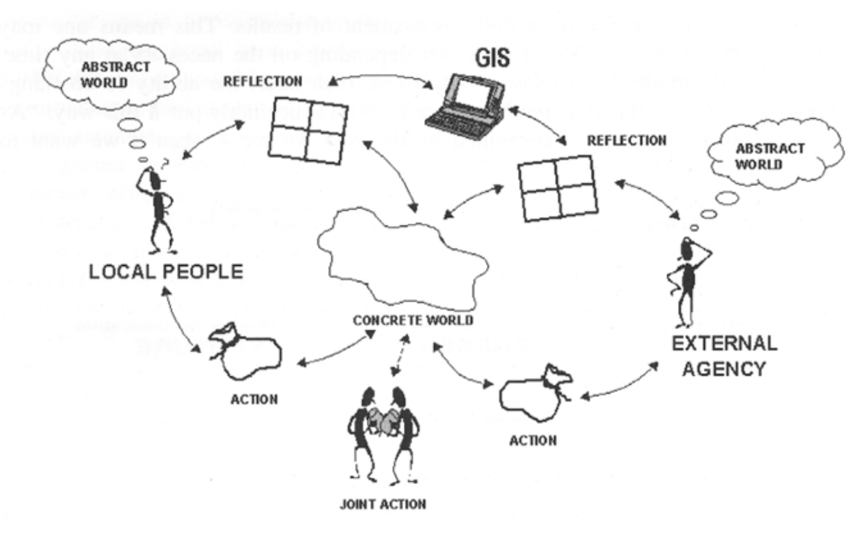

Fig. 6.5 GIS-assisted learning in planning.

With GIS at their disposal, stakeholders were able to construct alternative perspectives about their environment (e.g. as map layers) and discuss or negotiate them (e.g. as screen displays, overlays, aggregation) in order to arrive at shared knowledge, and hopefully the wisdom to act accordingly. The researcher gained new insights with regard to the meanings people ascribe to and agree upon regarding their environment. Seeing together the area they live in on a regional level, local people realized how they fared compared to others. They also learned new GIS techniques and thought of new, local applications. At the provincial level, stakeholders recognized the potential of the use of GIS tools in management activities, such as settling boundary disputes, monitoring reforestation projects, and getting an overview of terrace conditions. Overall, local, provincial, and outside stakeholders were involved in the learning process that involved single, double, and even triple (learning how to learn) loop learning. Learning took place by direct experience but also by observing how others used the GIS tool. Moreover, successfully using the GIS visualisation tool involved learning by abstraction. The learning process was at first triggered by reactive motivations for change, but slowly more proactive triggers started to play a role.

6.3.2 Exploring alternatives: Visualizing consequences of flood management choices in the EU[2]

The case context

Floodscape is a project that aims to demonstrate that flood management can be achieved by making space for water during flood events while maintaining normal use of the land. In addition, the project aims to involve local stakeholders in this new approach to flood management. It is a four-year transnational, EU-funded project with partners in the United Kingdom, Belgium, the Netherlands and Germany. The project is financed and promoted as part of the Interreg IIIB program that aims to generate interregional cooperation across Europe.

River and coastal flooding has become a frequent occurrence across many parts of Europe. Floods have demonstrated their ability to cripple cities and towns, destroy homes and businesses, power supplies, transport infrastructure, and communication systems. In recent years, flooding has increased noticeably. Climate change has resulted in more frequent rainfall and an increasing number of storms, all causes of flooding. As cities grow,

[2] www.floodscape.net

many natural flood plains have been built upon in response to high demand for housing. Such housing development reduces space available to rivers for floodwater and means that flood defences have to be built to protect properties.

In the past, floodwater has been controlled by building walls, embankments, gates, and barriers. As climate changes and its consequences have become more unpredictable, new solutions need to be found. Higher flood defences are no guarantee for flood damage prevention. Building higher defences is also expensive and has major impact on the landscape, wildlife, and people's enjoyment of river spaces.
In this project, a new approach has been developed to manage flooding that will benefit people by:

- restoring wetlands and river habitats, making space for nature;
- providing open and aesthetic riversides;
- enabling easy access to and egress from the river.

The Floodscape project aims to gain experience with this approach in seven pilot actions in the participating countries.

One of the pilot actions is taking place in the *Hurwenense Uiterwaard* in the Netherlands. The *Hurwenense Uiterwaard* is part of the Rhine flood plain of the river *Waal*, a tributary of the Rhine. The foreland of this tributary is expected to be able to contribute to the flood-risk reduction plan for the Rhine flood plain. The challenge is to meet targets for flood-risk reduction through means other than raising existing dykes. In this light, possibilities are explored for large-scale nature-development programs in flood plain areas, for example, lowering the winter bed, creating parallel side channels to the river channel, and creating large-scale pools. For the *Hurwenense Uiterwaard*, such an approach provides opportunities to explore the development of new natural habitats such as marsh vegetation, rough grasslands, and possible river bound forest.

Pollution of sediments as a result of former industrial activity is a problem for large parts of the *Hurwenen* floodplain. Large quantities of polluted soil need to be extracted and disposed of in an environmentally sound way. The *Hurwenense Uiterwaard* pilot action, therefore, seeks to develop more space for water to manage flood risk, create sustainable nature conservation, and maximize agricultural and recreational opportunities as well as to address the problem of soil pollution. The pilot action was further developed during 2003 – 4 in an environmental impact assessment process (EIA) that includes:

- formulation of an area development plan for the floodplain;
- assessment of the plan in terms of different options for its development;

- undertaking of specific research, e.g. ecological and archaeological surveys;
- community consultation and involvement in preparation of the plan;
- relationship with the EU Habitat Directive: *Hurwenen* is to be appointed as a Habitat Directive protected area.

The combination of the area development plan and the environmental impact assessment has made the planning process and finding of solutions more complex because competing national objectives (flood relief and nature development) need to be balanced.

The development of the area plan and the EIA is expected to be an iterative process. The planning process involves different planning cycles in which area consultations and a local advisory group participate. The advisory group includes representatives of local community organisations, local business, representation the local branch of the provincial agricultural organisation, local fishing and hunting organisations, and local nature, environment and landscape organisations. The Advisory Group constantly re-evaluates results of the planning process and where necessary call for further research, analysis of additional options, and re-evaluation of existing alternatives.

The GEO-visualisation used and its effect

Fig. 6.6 Geo-information based visualisation of water retention effects in *Hurwenense Uiterwaard.*

The Service for Land and Water Management, a national government organisation responsible for the implementation of rural development, has developed a geo-visualisation tool in which geo-information data (geomorphologic data, contour maps) is used in combination with aerial photographs of the *Hurwenense Uiterwaard* to visualize effects of different choices to allow plain flooding. In Figure 6.6., both the current situation and two alternatives in the first planning document are visualized as they appear in the GEO-visualisation tool. This tool is interactive. In the right hand corner of the computer screen, users can manipulate the water level and see the water-retention effects accordingly. The geo-visualisation tool is used in the discussion with experts, decision-makers, and will - in the next phase of the tool's development – also be used with people in the area. In a later stage in the planning process, alternatives and their effects will also be visualized in greater detail. Overall, the geo-visualisation tool has aided with the functions of putting into context, of construction, and of motivation.

Lessons learned

The geo-visualisation tool contributes to an increased understanding of the effects of the different alternatives. The visualisations have helped to make clear what the different experts involved mean with their sometimes complex jargon. The proverb a picture says more than a 1000 words has been proven once again. Such understanding improves the quality of the problem analysis, discussion, and decision-making regarding the possible alternatives. The quality of the discussions and decision-making will increase commitment of stakeholders and contribute to the EIA. Improved communication:

- increases transparency of the planning process;
- speeds up decision-making;
- increases possibilities for stakeholder participation.

In terms of learning, at this point in the planning process, experts are primarily involved. By direct experience, they are learning about the effects of their communication and how to be more effective communicators. The EU project contexts provide a proactive frame for the development of the GIS visualisation tool.

6.3.3 Experiencing the future: Flying through planned urban expansion in Groningen, the Netherlands[3]

The case context

Groningen Meerstad is the name of a housing development project on the eastern side of the city of Groningen (see Figure 6.7), which is located in the northern part of the Netherlands and has 175,000 inhabitants.

[3] www.meerstad-groningen.com

Fig. 6.7 Bird's-eye view of the urban housing development project *Groningen Meerstad*, the Netherlands

Meerstad is a complex project with different, at first sight contradictory, goals and many stakeholders. The city of Groningen has been searching for new locations to construct housing developments for a growing population and its demand for quality housing. In this respect, Groningen is not different from many other cities in the Netherlands or for that matter in the world. Initially, administrators, civil servants and project developers expected that the eastern part of the city would not need to be developed for housing until after 2010. However, successful economic development has made shorter-term housing developments at this potential location necessary. In 1998 plans to this end gained momentum when a design for multi-functional development of housing, landscape, and water management was nominated by STIR (*Stimulerings fonds Intensief Ruimtegebruik*), a fund set up by the Dutch Ministry of Housing, Spatial Planning and Environment that aims to stimulate multiple land use. The Groningen project aims to combine housing development with water and nature management. A creative spatial design and the choice to "invest a priori in landscape" make this project an innovative example of the implementation of the "red for green" policy principle. The current situation is an agricultural area of 4,000 hectares. A new urban settlement with 10,000 dwellings in a landscape of high quality (environmentally friendly light industry and sufficient room for recreation and leisure) will be developed. A lake of 650 hectares with recreational, water buffering, and storage purposes is central in the landscape development. The name *Meerstad* is a word play in Dutch, meaning both ‘more city’ as well as ‘lake city’.

From the beginning, *Meerstad* started as an open planning process. Starting point for the development of *Meerstad* is an open communication process in which participants work together to create a final master plan in 2006. In 2004 and 2005 several sub-plans were scheduled for completion, resulting in a final master plan in 2006. The actual implementation of the master plan will start in 2006 with an end in 2020. Together, the governing bodies, private companies, local citizens, and societal organisations have created a concept master plan in 2003. The main objective of this open planning process is to take into account the wishes, ideas and thoughts of all stakeholders: in other words, to compare all the needs and demands of the different groups of stakeholders, resulting in a master plan. The challenge in this process is to create a high-quality land use in a balanced way for all stakeholders and to enable all land-use functions in one area by using a multi-sectoral approach.

The GEO-visualisation used and its effect

The Service for Land and Water Management has developed a virtual landscape for the Groningen *Meerstad* project, and a prototype has been “filled” with local Groningen data to allow stakeholders (and others interested) to fly through the newly planned urban development. The virtual landscape viewer integrates different geospatial datasets into a 3D landscape through which stakeholders are able to fly over to “zoom in”, for which more detailed and different geo-referenced data is used. The user interaction is made possible through the keyboard, mouse movements and clicks, or any other computer interaction hardware like a joystick, similar to that used in computer gaming. The interaction hardware allows the user to move in the landscape freely. Moreover, a user can increase and decrease speed and click on objects to retrieve extra multimedia information. Other features of the virtual landscape include the possibility to follow predefined paths and move to relevant predefined positions.

Orientation and navigation concepts are related to the “travel metaphor”. A user is able to:

- identify the current position through an orientation map of the overall landscape;
- reconstruct the route that leads to that position;

– distinguish the different options for moving on from the current position via the menu buttons;
– distinguish direction movements; a compass indicates the direction the user is facing.

Recognisable landmarks act as orientation points for relevant places and also contain multimedia links to extra information. Links can be pictures, videos, web pages, sound, and messages, and the virtual landscape tool generally contributes to the functions of demonstration, construction, and motivation.

Lesson learned

In the Groningen *Meerstad* project, the stakeholders group is numerous and heterogeneous, with different sensibilities and varying interests and concerns about the project. It is fundamental to communicate the complex information involved in an understandable manner. In this way, stakeholders will have a same understanding of the goals and consequences of the project. A 3D geo-visualisation tool such as the virtual landscape provides an effective way of presenting large amounts of complex information to a wide audience, including those with no Geographic Information Systems (GIS) or mapping experience. The system design has taken into consideration cognitive principles and is able to integrate high-quality mapping of the current situation, 3D representations of the future, and (geo) multimedia (regarding real world information). Stakeholders have indicated that the virtual landscape tool helps them to understand the proposed plans and proposed changes. Moreover, stakeholders have fun using the virtual landscape to fly through the newly planned urban development. Such a mood motivates participants for discussions and commitment to the project.

6.4 Conclusion: Seeing is believing

Facilitating stakeholder dialogues

The theoretical insights with regard to planning as learning and the use of GIS visualisation tools, as well as the cases discussed, make clear that facilitating stakeholder dialogues plays an important role in sustainable land and water management planning. The problems faced are complex in nature. This complexity makes it impossible for any single individual to resolve them all. In other words, different individuals will need to work together in order to gain an understanding of the problems faced and their resolution. For example, understanding the erosion problems faced in the Ifugaos, exploring alternatives for flood management in the *Hurwenense Uiterwaard*, and planning a new urban housing development project in Groningen *Meerstad* all require the involvement of various people with diverse interests and knowledge. The problems faced are also complex in nature in the sense that no one single, objective solution exists. Often new knowledge needs to be developed and new combinations of existing knowledge established; solutions are the result of learning and negotiation processes among stakeholders. The three cases presented illustrate how different stakeholders with different perspectives interact in terms of individual and collective learning. In creating opportunities for interaction, stakeholder dialogues can facilitate linking learning cycles of people involved in land and water management planning.

Facilitating stakeholder dialogues with geo-information visualisation tools

Both the theory and cases discussed underscore the value of geo-visualisation tools to facilitate stakeholder dialogues for sustainable land and water management planning. Geo-visualisation tools stimulate functions of demonstration, of putting into context, of construction, and of motivation. Through these functions, geo-visualisation tools contribute to important aspects of stakeholder dialogues. The cases presented show how different 2D and 3D visualisations help stakeholders get a realistic picture of the situation (demonstration); understand how their situation fits in a larger picture (putting into context); give meaning to the planning process (construction); and arouse participants' interests and attention (motivation). Depending on the use of the geo-visualisation tool in the planning process, these functions may be triggered at the individual and/or collective level.

Quality of geo-information visualisation tools

The value of geo-information visualisation tools in stakeholder dialogues not only depends on the manner in which the tool is used in land and water management planning but also on the quality of the tool. This means taking into account quality standards with regard to visual materials used and the user friendliness of the tool. The quality of the tool is dependent on the degree to which stakeholders are able to recognise their environment and relate it to the changes occurring or desired. Geo-visualisations need to take into account the possibilities and limits of people's cognitive capacity.

This often means limiting both the quantity and complexity of information. It can also mean trying to involve different senses to avoid the overload of a single sense. The case studies and the learning perspective also point out that involving stakeholders in the tool design and analysis, i.e., participatory technology design and participatory planning processes, empowers the individual and collective reflection and the action taking place.

Overall, it may be concluded that geo-visualisation tools are useful to involve people in stakeholder dialogues for land and water management planning. Visualisation is powerful in different ways. More than fifty percent of the neurons in the brain are used in vision. In addition, visualisations helps to make visible collectively what may be hidden in the thinking and action of individuals. Thus geo-visualisations tools provide a means to facilitate and improve the quality of stakeholder dialogues.

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