Geo-visualisation for interactive spatial planning and decision-making: From Wow to Impact

Riedijk, A.; van de Velde, R.J.; Pleizier, I.D.; Hoogerwerf, T.; van Lammeren, R.; Balthussen, W.; Jansen, J.; Wynia, P.; van Uum, J.; van Wilgenburg, R.

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Definition study

A.Riedijk
R.J. van de Velde
I.D. Pleizier
T. C. Hoogerwerf
R.J.A. van Lammeren
W.H.M. Baltussen
J. Jansen
P. Wynia
J.H. van Uum
R. van Wilgenburg

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Authors

Arda Riedijk, Spatial Information Labaratory (SPINlab), VU Amsterdam.
Rob van de Velde, Spatial Information Labaratory (SPINlab), VU Amsterdam and GIS Competence Centre, Dienst Landelijk Gebied.
Irene Pleizier, Spatial Information Labaratory (SPINlab), VU Amsterdam.
Rosan van Wilgenburg, Spatial Information Labaratory (SPINlab), VU Amsterdam.
Tessa Hoogerwerf, Omgevingswetenschappen, Wageningen Universiteit.
Ron van Lammeren, Omgevingswetenschappen, Wageningen Universiteit.
Willy Baltussen, Landbouw Economisch Instituut.
Jan Jansen, Nieuwland.
Peter Wynia, Nieuwland.
Joost van Uum, Dienst Landelijk Gebied.

Contact

Vrije Universiteit Amsterdam
Faculteit der Economische Wetenschappen en Bedrijfskunde
Afdeling Ruimtelijke Economie/ Spatial Information Labaratory (SPINlab)
De Boelelaan 1105
1081 HV Amsterdam
The Netherlands
Phone: +31 20 5986099
Email: ariedijk@feweb.vu.nl, rvelde@feweb.vu.nl
Website: http://www.feweb.vu.nl/gis

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MANAGEMENT SUMMARY

RESEARCH GOALS (CHAPTER 1)

Due to the increasing complexity of spatial planning issues and the increasing demand of emancipated citizens for taking part in designing and deciding on spatial plans, a quality boost is needed in communication processes between governmental actors and citizens about land use. Geo-visualizations that can be created, presented and exchanged by all actors easily, such as the intuitive platform Google Earth, can very well contribute to an improved understanding, commitment and interest of participating actors in spatial transitions. However, scientific knowledge on the effects on decision and policy procedures is very limited and is characterized by fragmented case studies. Furthermore, practical examples are very fragmented. This research is written to respond to the demand for better insight into the meaning of geo-visualization in learning and working processes. This study is part of the joint research project Virtual Netherlands (Virtual NL), which focuses on the outcome of using geo-visualizations: what could geo-visualizations mean for specific planning phases and the involvement of actors? In this study therefore, an exploration has been made of scientific concepts and insights, research methods and techniques, best practices and user needs and infrastructural requirements, in order to define knowledge gaps and future research needs. The results of this study form the background and motivation for Virtual NL.

SCIENTIFIC CONCEPTS AND RESEARCH METHODS (CHAPTER 2 AND CHAPTER 3)

Contemporary socio-political issues that directly relate to the increasing use and development of, and need for geo-visualizations in participatory spatial planning can be summarised in four key concepts:

1. **Governance: balancing between complexity and simplicity**
   The expected increased use and development of web based interactive geo-visualizations in spatial planning issues is a logical move forward in dealing with the complexity of spatial developments; geo-visualizations simplify spatial settings in a realistic way and make spatial scenarios understandable for lay people.
2. **Interactivity: balancing between process and results**
   Web based interactive geo-visualizations are good supportive tools for generating, sharing and reflecting on different interpretations among actors and will subsequently contribute to achieving better process goals and in the end to achieving better project results and a broadly carried acceptance of the spatial transition.
3. **Information society: balancing between transparency and commitment**
   The democratic, accessible and bottom-up character of the Internet will support wider commitment and mutual understanding in spatial planning processes due to a combination of text and images on an interactive web based interface. Transparency in spatial planning therefore is highly valued but often not yet taken for granted.
4. **Social learning: balancing between learning by doing and institutionalisation**
   Scarce presence of and experience with web based interactive geo-visualization tools limit substantial use of such tools among actors, therefore a knowledge transfer point containing best practices, guidelines and experiences in combination with hands-on training sessions in pilot areas can benefit the knowledge dissemination.

Existing research on the effects of geo-visualizations teaches us that the aim of using geo-visualizations is to influence the participatory spatial planning process in a positive way. This positive effect could be on the actors who are going to reflect on the proposed plans as well as on the process itself. Geo-visualizations are expected to have a positive influence on the actors' willingness to make compromises as well as on the acceptance of the final plans. Moreover, geo-visualizations are expected to contribute to better communication and understanding among actors. Supposedly, the level of detail of a geo-visualization is very important in order to accomplish these effects.

Also in terms of the spatial planning and decision-making process in general, geo-visualizations are expected to have a positive influence; factors that seem to determine this are among others the total speed of the process, the increase in the number of participating actors, the increase in knowledge exchange, the quality and content of the plan, the satisfaction of the actors and the change in organisation of the planning and decision process. Moreover, it seems that a combination of low-tech (such as maps, face-to-face meetings, scale models, sketches) and high-tech (such as the Internet and various visualization tools) methods is most appropriate to have actors express their views and opinions.

Taken as a whole, literature review shows that structured research on well-defined geo-visualization effects on both actors and process has not been performed yet. Most articles come up with a wide variety of expectations, recommendations and case study-based advantages and disadvantages of geo-visualizations but they miss a coherent structure. Furthermore, the reviewed articles lack a well-defined method to measure and analyse the effects mentioned. The current status of research makes it difficult, but challenging, to further investigate geo-visualization effects on the planning process.

In chapter 3 therefore, several research methods and approaches are described that seem useful to study geo-visualization effects. Each of these methods and approaches has its advantages and disadvantages. The main strength lies in the combination of these methods and approaches to study the geo-visualization effects from a broad perspective.

Future research should focus on two main research lines: First of all, the effect of geo-visualization on actors is an important issue, because this automatically affects the whole planning process. In particular, the level of detail in geo-visualization is an issue, due to the opposite arguments that are made in literature (planning and decision contexts). Secondly, the potential of geo-visualization to increase the speed with which people gather and process information needs to be studied (learning contexts). Knowledge about this potential is important to get insight in the people's knowledge on and experience with complex spatial issues. For both research topics, a combination of research methods will be required: (web) surveys, questionnaires, assessments, observations and interviews to study the effectiveness of geo-visualizations that vary in level of detail for specific tasks.

BEST PRACTICES AND USER NEEDS (CHAPTER 4)

Geo-visualization tools are becoming more flexible and accessible for the general public as well as for professionals. While current use of geo-visualization is still restricted to serve as a mean to illustrate, visualise and present we are noticing a shift towards more interactive and participatory use of geo-visualizations. This shift is found in various initiatives and ideas from different actors dealing with geographic information such as *Dienst Landelijk Gebied*, *Stichting De Nieuwe Kaart van Nederland, Rijkswaterstaat,* the city of *Helmond,* the *Nederlandse Aardolie Maatschappij* and the *Project bureau Nieuwe Hollandse Waterlinie.* An interactive geo-visualization tool that aims at improving communication between stakeholders and at improving the spatial planning process in general should meet a number of criteria in order for end-users to be tempted to react and to start a creative process, these criteria include: intuitiveness, to be used on standard pc's, presenting a transparent picture of both integrated and detailed information, offering an interface to navigate from different angles and to explore different scenario's, presenting a challenging design and appealing to a common fascination of end-users. In sum, geo-visualizations in spatial planning are supposed to:

- Summarize, structure and present spatial plans;
- Enhance accessibility of plans and alternatives;
- Enhance comprehension and insight of the effects of spatial measures;
- Encourage lively discussion and active reflection;
- Discover new ideas, solutions and design defaults on time;
- Support the decision making process;
- Support building trust among actors.

INFRASTRUCTURAL REQUIREMENTS (CHAPTER 5)

Looking at the requirements of the different phases in the geo-visualization process one can conclude that, at the moment, many public sector organisations will lack the required technical resources and knowledge for setting up their own geo-visualization environment. This is an area in which the project Virtual Netherlands could play a significant role; providing both centralized facilities (Knowledge Transfer Point) and decentralized components (such as start-up packages for stakeholders to setup their own geo-visualization infrastructure). One of the envisioned project results of Virtual Netherlands is the establishment of a 'Knowledge Transfer Point' (KTP). This KTP aims at collecting, sharing and passing knowledge on deployment of geo-visualization tools to be brought into action for spatial transition processes. As a centralized facility, the KTP could provide:

- Knowledge dissemination about geo-visualization in spatial planning and plan implementation;
- Agreements about the interpretation and use of the geo-visualization according to the Participatory Spatial Planning (PSP) framework;
- Standards related to these agreements;
- Policy that supports the role of geo-visualization in PSP (a reasonable next step).

With regard to the (technical) requirements of a spatial infrastructure, the KTP can provide technical guidelines, ICT tools and manuals on the design and realization of an interactive geo-visualization platform. In the form of start-up packages, the KTP can assist in al phases of the geo-visualization process. These packages can consist of datasets that, because of their metadata, can easily be transformed into geo-visualizations. Furthermore, tools for upload and download of geo-spatial data to and from a geo-visualization platform (like Google Earth) are needed. Also, a web platform and/or a Google Earth based web service - meant for various smaller governments that will lack the required technical resources for setting up a geo-spatial web architecture on their own - could belong to the possibilities.

KNOWLEDGE GAPS AND FURTHER RESEARCH (CHAPTER 6)

This study has shown that available research is limited. There is a need for better insight into the importance of new communication and visualization tools such as Google Earth. Therefore the project consortium argues for a communicative approach - both in practice and in research - to geo-visualization, to respond to the need for transparency of policy and implementation in spatial issues. 'Virtual NL' according to the authors represents a way of communicating about spatial plans and scenario's: visual (or broader: sensual), accessible, open for interpretation, intuitive, and stimulating. The initiatives taken so far as regards to geo-visualizations in participatory spatial planning are promising; the authors therefore stress the need for further research on the effectiveness of geo-visualizations in interactive planning and decision-making.

Some critical questions need to be answered to fulfil the 'white spots' in scientific knowledge and to promote practical skills and experience. Two research lines are promoted, focussing on planning and decision contexts and on learning contexts. A set of research questions has been formulated that could guide future research within these two research lines. The questions are divided into five clusters: infrastructure, methodologies, cognition, social learning and policy & implementation.

TABLE OF CONTENTS

1 GEO-VISUALIZATION FOR INTERACTIVE SPATIAL PLANNING

1.1 INTRODUCTION

> *GlobeAssistant about Google Earth: "Don't bother trying to find an address, but fly directly to your hotel location to pick your ocean view hotel room, or fly to the neighbourhood where you'll be buying your new house. Just click on the image and additional information will pop-up; reservations, houses on-sale, whatever you wish to add to it (van der Heijden, 2005)."*

With Google Earth it is possible to present and exchange geo-information within a large user group. Why not use this potential to inform, present, discuss and interact about spatial plans? This study elaborates upon the possibilities of interactive use of three-dimensional (3D) geographic information (or geo-visualizations) in spatial transitions, keeping in mind the great potential of Google Earth as a medium to communicate.

Figure 1 Google Earth (PSPE, 2005a)

Every plan concerning the development of public space – whether it is city, nature, countryside or water related – asks for involvement of and communication between government, private actors and civil society. In this study we will call this involvement and communication 'interactivity'. Not only does interactivity contribute to a publicly carried spatial development, it also clearly exposes interest differences out of which solutions and compromises can be derived. More and more, interactive processes will be supported by geo-visualization techniques with which future spatial scenario's can become visible and more imaginable for actors. A geo-visualization pictures a certain area of concern, by 'flying' over the area the user can choose to see and experience changes in land development and can even manipulate this development to his or her own taste. Geo-visualizations are developed to excite people: they are supposed to stimulate people's creativity and involvement and to invite them to give information and to get informed.

This study is written within the framework of the 'Space for Geo-Information' program. This program funds several projects, among others Virtual Netherlands (Virtual NL). Virtual NL is a joint project with participants from 2 universities, 2 private companies and 2 (semi)governmental institutions. Virtual NL is inspired by the growing information, communication and participation need in geospatial developments. The project partners have the ambition of becoming the interactive platform where politicians, citizens, companies and civil organizations can present and exchange visualized information concerning spatial issues. In this study we focus on the exploration of state of the art studies and on defining knowledge gaps on the interface of geo-informatics, governance, communication and interaction. The fundaments lain in this research are being developed in 'interaction'. A consortium existing of users, scientists, process experts and technical specialists will take care of a valid definition of above mentioned knowledge need.

1.2 RESEARCH GOALS AND METHODS

This study aims at defining research objectives and –questions. By doing this, we will underpin extensive research on the effects of usage of geo-visualization tools on interactive spatial planning processes between government and society. Furthermore, we will present some important state of the art developments that according to us illustrate the relevance of geo-visualization tools for spatial planning. By combining existing theory and our aspirations concerning geo-visualization, both scientific and societal information needs will become visible. We first elicit two concepts that will be used frequently in this study: *Interactive Spatial Planning* and *Geo-visualizations.*

The terms 'Interactive' and 'participatory' in this study are often used as one and the same, when we use these terms we refer to Dalal & Dent (1993) who see interactive planning as one of the different levels[1] of participation that are possible. Interactive planning is defined by Dalal en Dent (1993: 108):

"People participate in joint analysis, which leads to action plans and the formation of new local institutions or the strengthening of existing ones. It tends to involve interdisciplinary methodologies that seek multiple perspectives and make use of systematic and structured learning processes. These groups take control over local decisions, and so people have a stake in maintaining structures or practices."

A geo-visualization is an interactive, virtual representation of one or more existing or future spatial scenarios. An important characteristic of geo-visualizations is that one can look at spatial data in several ways and from various angles; this strengthens insight into spatial information and increases generation of new ideas (Kraak, 2004). We distinguish 2D and 3D geo-visualizations: 2D maps can be simply visualised on a computer screen or even printed out and handed out as leaflets. 3D Scenes on the other hand offer a more surrounding and immersive environment to navigate through. In 3D geo-visualization, a regular solid scale model is combined with GIS approaches; the 3D effect of a scale model for visualising the future situation and the interactivity and adaptability of the GIS component are brought together. This combination is called VRGIS -Virtual Reality GIS (Hacklay, 2001). In sum, the meaning of geo-visualization as used in this study is derived from Kraak (2003) and is defined as follows:

"Geo-visualizations are visual geospatial displays designed to explore data and through that exploration to generate hypotheses, develop problem solutions and construct knowledge. Maps and other linked graphics play a key role in this process."

With respect to policy and planning procedures this study will focus on five aspects:

- Defining scientific concepts and insights about the effects of geo-visualization tools in policy processes and citizen-government interactions;
- Defining research methods and techniques to measure the effects of geo-visualization on interactive policy processes;
- Defining best practices and user needs concerning practical geo-visualization tools;
- Defining infrastructural and system demands for governments who wish to use geo-visualization tools;
- Defining knowledge gaps and research questions for future research.

To be able to formulate valid research questions in the final chapter, we aim at presenting a complete overview of information needs in terms of scientific needs as well as user needs. To achieve this we gathered a transdisciplinary research team, each member focussing on a certain aspect of this study. Desktop research on existing disciplines such as GIS, policy

[1] These different levels of participation are described as: passive participation, participation in information gathering, participation by consultation, participation for material incentives, functional participation, interactive participation and self-mobilisation (Dalal & Dent, 1993:108).

science, cognition science, and communication science is conducted. Furthermore, a set of interviews is taken with people from practice with technical, process or visioning skills. In the first and second annex, a list of respondents is inserted as well as the interview guide. These interviews serve to broaden our understanding of the expected effects of geo-visualization in participatory processes. Also, outcomes of this study were tested during the Mansholt debate in The Hague with the board of directors of the Ministry of Nature, Agriculture and Food Quality.

In connecting as much as possible with the user groups, our research team strongly holds to an action-oriented approach; our objective is to define the benefits and information needs of geo-visualization in participatory planning in accordance with respondents in order to support developments in geo-visualization and participatory planning.

1.3 EMPIRICAL AND SCIENTIFIC MOTIVATION FOR THIS STUDY

Due to the increasing complexity of spatial planning issues and the increasing demand of emancipated citizens for taking part in designing and deciding on spatial plans, a quality boost is needed in communication processes between governmental actors and citizens about land use. Geo-visualizations (see definition) that can be created, presented and exchanged by all actors easily, can very well contribute to an improved understanding, commitment and interest of participating actors in spatial transitions. However, scientific knowledge on the effects on decision and policy procedures is very limited and is characterized by fragmented case studies. This makes it hard to compare usable cases; this in turn seems to be caused by relatively high costs of geo-visualization tools and the low accessibility for large user groups. As we will see, the recent launch of Google Earth will expectedly overcome this barrier by offering a total new decade of access to geo-information. Yet another constraining factor concerns the limited knowledge and experience among policy makers, planners, architects and process managers in dealing with geo-visualization tools. This leads to a demand for better insight into the meaning of geo-visualization in learning and working processes. Furthermore, research on geo-visualizations is very often written primarily from a technical perspective emphasising technical tool requirements or characteristics. The project consortium tries to fill this gap by focussing more on the outcome of using geo-visualizations, what could geo-visualizations mean for specific planning phases and the involvement of actors?

In sum, the motivation for promoting use of geo-visualization in participatory planning processes is expected to yield the following knowledge and results:

- Improvement and more consistent tuning of diverse horizontal and vertical policy chains (among others in spatial planning, area-based policy, external safety, revitalising agriculture, etc.);
- Commitment, interaction and social support (and with that the opportunity to successfully implement policy) can increase vastly due to better communication channels that are more accessible and that appeal or trigger imagination;
- Better communication (through geo-visualization and through the results of the Virtual NL project) diminishes the chance at expensive and often irreversible planning mistakes;
- Better communication fits very well within the policy framework promoted by the national government and cabinet, which is called ‘Programma Andere Overheid’ or ‘Towards Governance’, a program that stimulates government-citizen interaction.

1.4 OUTLINE

In the following chapters we will explore both theory and practice. Chapter 2 offers a contextual frame where we'll touch upon issues that represent the social and scientific context in which this project will take place. This chapter helps us to formulate our research questions more profoundly. Chapter 3 deals thoroughly with what is already researched and what should be further examined about the effects of geo-visualizations on spatial planning processes. Chapter 4 will offer a practical insight of best practices, challenges and user needs. Chapter 5 then offers a technical guide for the implementation of the project; this chapter deals with the issues that should be taken care of when using an interactive web based infrastructure. Lastly, Chapter 6 will present lessons learned and knowledge gaps. Furthermore, the chapter will present the guiding ideas about the research methods to be applied to study the effects of geo-visualizations on participatory spatial planning.

2 VISUALIZATIONS IN A CHANGING SOCIO-POLITICAL CONTEXT

2.1 INTRODUCTION

In this chapter, social oriented developments are studied which are relevant in relation to the increasing use of geo-visualizations. Three developments will be correspondingly discussed in the following paragraphs: a) political changes in spatial planning, b) interactivity in spatial planning and c) the social tendency to communicate by graphics instead of written text. Based on these developments, a contextual frame will be presented with which the following chapters can be understood.

2.2 FROM GOVERNMENT TOWARDS GOVERNANCE

Tasks and roles of governments are changing. To conceptualise the complex relations and policy processes that characterise modern spatial planning, political and social scientists often refer to the terms 'multi-actor and multi-level governance'. This refers to situations where public policy takes places in different layers (municipal, provincial to national and European) in interaction with different governments and other actors. This situation differs strongly from a situation where the central government makes the plans and decisions. Governance is described as a means of policy making and governing in which governmental organisations and non-governmental organisations participate in mixed public and private networks; policy making no longer is done by a central dictated plan but by an open, complex and interactive process where several public and private actors participate and look for solutions that suite them all. The government in this respect does not function as a regulator solely but is increasingly taking the role as a facilitator of local and regional initiatives (see Arts & Leroy, 2003; Kooiman, 2003; Aarts & van Woerkum, 1999).

In her book '*Laveren tussen regio's en regels*' Boonstra (2004) has analysed policy changes and developments within three Dutch regions where 'integrated area-based rural policy'- projects are implemented. This regional, multi-actor and multi-level approach to rural problems however is characterized by a diminishing steering capacity of governmental actors. Not just the complexity of rural problems themselves seems to be an important causal factor. Various social scientific theories point in this respect to underlying societal factors such as changing relationships, fading borders, new networks and arrangements, new social movements and emancipated citizens within post-modern society. Key concepts are globalisation, individualisation, information and communication technology and the so-called risk society, which have severe consequences on such policy developments (see Giddens, 1990; Beck, 1992; Castells, 1996).

Boonstra describes how an integrated area-based rural approach offers opportunities for a way out of complex rural problems, she emphasises the learning process it entails. This learning process should result in a greater involvement of rural citizens, mobilisation of their knowledge and experiences and coming to creative solutions adjusted to specific regional circumstances. Furthermore, an integrated, interactive approach should help in regaining trust between rural citizens and the government and among rural citizens one another (Boonstra, 2004: 13).

In the changing relationships between government, market and civil society, governmental organisations are not solely governors anymore but increasingly tend to fulfil a facilitating role in order to optimize the public good. Civil actors on the other hand become more and more critical and emancipated in defining their needs and wishes. Spatial planning related issues can be characterized as social dilemmas. A social dilemma occurs when individual interests appear to conflict with more advantageous collective interests. In densely populated countries for example, scarcity of space requires people to choose between natural environmental 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 (Maarleveld et al, 2005).

In general it can be said that in every facet of today's society, we get to deal with more dynamic, complex and hard to gauge developments, which makes the search for a 'one fits all' solution very problematic. There is a growing need for pluriformity, since societal demands can no longer be resolved unequivocally (Van Woerkum, 2002:5). With that comes the role technology plays in contemporary society; information and communication technology has influenced the relation between people and their world tremendously due to its mediating role in this relation (Pieters & Becker, 2005). The role of ICT in spatial planning will be further discussed in paragraph 2.4.

In this context of changing relationships and unknown risks and challenges, it is utmost important to communicate in a clear, open and transparent way to the society in general and to actors in spatial transitions specifically. The following paragraphs draw a little deeper upon communication and interaction and the role of geo-visualization tools within spatial planning developments.

2.3 EVALUATING INTERACTIVITY IN SPATIAL PLANNING

> *Tell me, I forget.*
> *Show me, I remember.*
> *Involve me, I understand.*
> *(Old Chinese proverb)*

The described context in paragraph 2.2 asks for involvement of a variety of representative actors in a process for spatial development. This means that a great responsibility is placed upon governmental organisations in their new role as facilitators of actor dialogue, their task should be to make actors to better understand problem situations, to develop possible action alternatives and to undertake collective decision-making and action (Maarleveld et al., 2005). Although many national, provincial and regional policy plans proclaim the need for an integrated and interactive approach to spatial issues, it seems rather ambiguous for governmental actors to deal with this kind of pluriformity. A causal factor is that governmental actors on the one hand need to keep to legal instruments and policy frameworks with limited space for creativity, but on the other hand want to take a more reserved role where non-governmental actors have a certain freedom - the governmental credo is to 'steer on main lines', or '*sturen op hoofdlijnen*' but in practice the government seems to be too much occupied with regulatory details.

In the governmental quest for a new policy culture, a few characteristics are mentioned by Aarts and Van Woerkum (2002). Firstly, this new culture attaches importance to local differences meaning that every issue has its own contextual characteristics. Secondly, because of complexity of spatial issues there's a need for flexible solutions rather than fixed goals. Thirdly, more attention is paid to relational issues and processes; gaining trust and mutual understanding in a common task. The rationale behind these three facets is that a focus on this so-called pluriformity makes networks more able to deal much more flexible with spatial developments. In this new policy culture the *quality* of the process becomes increasingly important, this leads to a bigger attention to *process goals* such as:

- How do actors come to understand each other's views, interpretations, and preferences?
- Do they actually understand each other?
- How do participating actors perceive the effectiveness of the contacts?

- How do participating actors perceive the creative atmosphere in the process?
- How do participating actors perceive the created mutual understanding (Aarts and Van Woerkum, 2002:41)?

In an interactive process citizens are encouraged to play a more active role in spatial transitions. This does not mean that citizens only *criticize* existing plans, but that they deliver *ideas* to contribute to the planning process. In that sense, citizens are a source of knowledge and they become responsible for the interactive process (Edelenbos and Monnikhof, 2001). Involvement of citizens will raise when they have the feeling that their (different) opinions are acknowledged in the process and when they are taken serious. The opposite, when citizens' opinions are not acknowledged, will cause aggression and confrontation (Aarts and Van Woerkum, 2002). The effects of stimulating interactivity on spatial planning and decision process are summarized by Edelenbos and Monnikhof (2001). Interactive processes are supposed to increase:
- Social support for spatial transitions;
- Quality of decisions;
- Speed of decisions;
- Position and reputation of politicians;
- Representation of different participants.

A clear overview of the elements to evaluate participation in interactive processes is given by Edelenbos and Monnikhof (2001). When relating to the effects of the use of geo-visualizations, this scheme can function as a useful tool to evaluate the effectiveness of geo-visualizations:

	Process	Result
Width of participation	Activating and mobilising What possibilities do citizens and actors have to participate? Who are mobilised and reached by the mobilisation efforts?	Participation and representation Is the amount of citizens participating increased? Is the representation of actors increased?
Depth of participation	Stakes and viewpoints How did actors and citizens bring forward their views? Were all participants able to deliver ideas and viewpoints?	Contribution, share and influence How can the influence of citizens and actors be typified? Is the relationship between citizens and politicians improved?

Table 1 Elements to evaluate participation in interactive processes (Edelenbos and Monnikhof, 2001)

Efforts to enhance actor dialogue and involvement are often characterized as social learning processes. Social learning is a social scientific term identifying the learning processes that are taking place between participative systems like groups, networks, organisations and communities, in surroundings that are new, unexpected, insecure, conflictuous and hard to predict (Wildemeersch et al., 1997). This means that the parties involved slowly develop overlapping – or at least complementary – goals, insights, interests and starting points (Röling, 2002), and also build mutual trust and feelings of dependence and responsibility. Social learning is about the development of different perspectives on reality through interaction with others. According to Leeuwis (2003:5) there are four tasks that are of great importance from the point of view of social learning:
- Making the invisible visible;
- Organising comparisons between different contexts;
- Setting up experiments;
- Facilitating exploration.

In our opinion, geo-visualizations belong to the variety of communicative methods that exist to support social learning. In this respect we regard the increased use of geo-visualization as a communication tool that continues to be developed in order to contribute to spatial planning and decision processes. Until so far, geo-visualizations as discussed in the former paragraph have been used in various experimental settings, but it is unclear what the effects on planning and decision processes exactly are. In chapter 3 we will speculate upon the expected effects and present a literature review on existing knowledge on this subject. Before getting there, we devote a paragraph to a more philosophical exploration of the power of imaging.

2.4 THE MEANING OF GEO-VISUALIZATIONS FOR PARTICIPATORY SPATIAL PLANNING

The picture is worth a thousand words.
(Old Chinese proverb)

The power of imaging is all about improving communication between actors in interactive processes, we here present some major needs and challenges derived from literature and practice to benefit optimally from the use of geo-visualizations.

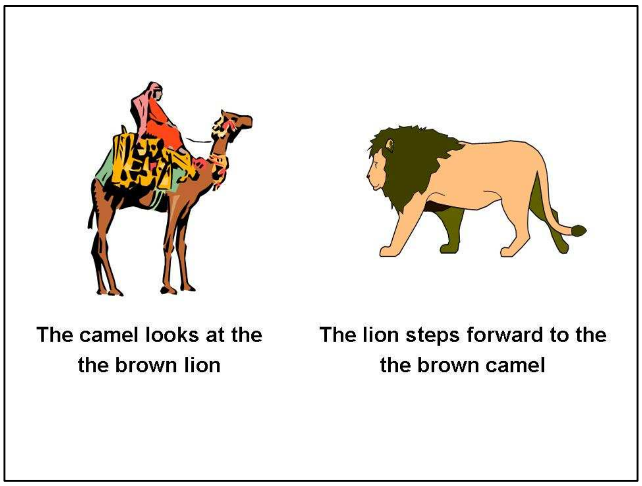


Figure 2 What is wrong in this picture? (PSPE, 2005b)

2.4.1 Images and interaction: needs and challenges

Speculating about the effects of geo-visualization in spatial planning and design processes the project consortium quickly realised that the power of geo-visualization lies in the image itself. 'Seeing is believing' can be put forward as the legitimization of geo-visualization. By seeing direct consequences of an intervention in a certain area in a virtual image, actors might all interpret the change differently, however they do use the same language to communicate with, namely the image itself. The same argument is used by King et al. (1989), who suggest that visualization is the key to effective public interaction because it is the only common language to which all participants within the same cultural context - technical and non-technical - can relate. In urban planning, a number of authors have studied the cognitive effect of 3D images in the planning process. Traditional 2D models are known to demand a great effort: the viewer first builds a conceptual model of the image before it can be analysed, which according to Bulmer (2001) "*can be an arduous task for even the most dexterous mind*". 3D Models on the other hand can stimulate spatial reality and allow the viewer to more quickly recognize and understand changes in elevation (Bulmer, 2001: 7). Langenorf (1992, cited in Bulmer, 2001) has formulated three premises on which use of visualizations in urban planning are based:

- To understand nearly any subject or consequence it is necessary to consider it from multiple viewpoints, using a variety of information;
- Understanding complex information about urban planning and urban design may be greatly extended if the information is visualised;
- Visualization aids communication with others (Langenorf, 1992, cited in Bulmer, 2001).

Geo-visualizations make it possible to explore a spatial environment by simply navigating through the area. This makes it much easier for participants without any planning experience to relate the visualized information to the real world (Maarleveld et al., 2005:5). In cognition science four types of functions of media used for visualization of spatial information have been described (Maarleveld et al., 2005): The function of *demonstration* refers to using media to give a realistic picture. The function of *putting into context* should support the user to put the detailed information against a bigger (spatial) context and may help the user to identify and position the given information. The function of *construction* is related to the creation of complex mental models by the user in order to understand information units and relationships. Graphs, diagrams or abstract layers are suited for this function. The function of *motivation* lastly refers to media intending to arouse the user interest and attention. This can be achieved by for example animations and interactive objects.

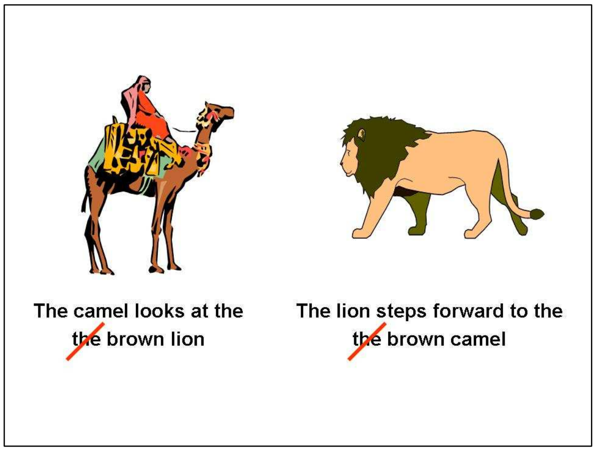


Figure 3 The power of images proved (PSPE, 2005b)

The three premises and four functions mentioned above refer to the effects one wishes to achieve in a spatial planning process. However, an important question is in which planning phases geo-visualizations would best fit. And furthermore, in what kinds of interactive setting geo-visualizations will show full advantage. Therefore we will first make some remarks about the nature of spatial planning. According to Van den Brink (2005), the starting point in every planning process is that there is a spatial problem that must be solved. Problem identification is then followed by the determination of the planning objectives. The next step is to develop scenarios that show alterative futures. These alternatives will be evaluated and decided upon by the relevant authorities. In each step there is room for public interaction. Also, in each step of the process different geo-visualization tools can be used, depending on the specific situation. In other words: geo-visualization is about creating an understandable message that is able to stimulate the dialogue. "*It goes without saying that later in the process more detailed data and information will be needed. A systematic analysis of the relation between planning process and public participation is therefore necessary,*" according to Van den Brink (2005).

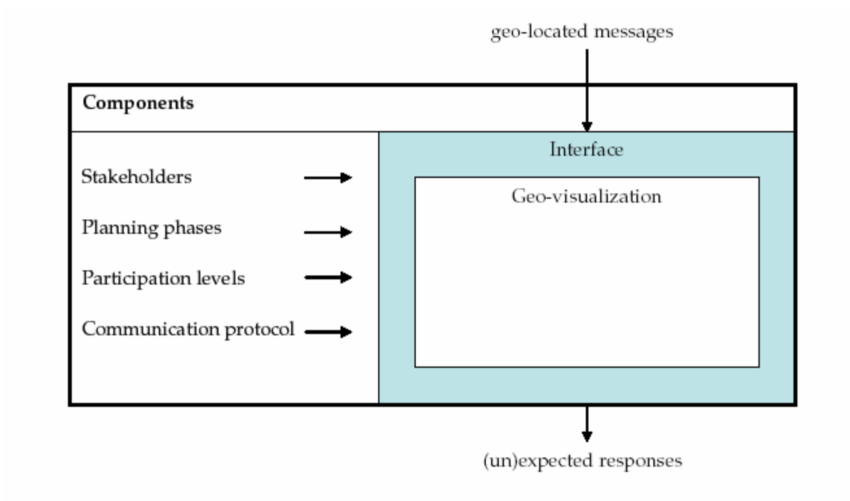
A first step in defining the use and benefits of geo-visualizations in interactive processes has been made by Bulmer (2001), this author distinguishes different types of visual communication (simulating, experiencing and communicating) and user interaction (passive and active) in urban planning processes to support the public at large and particular interest groups. The direct benefits for particular planning phases however are not given in this model.

Table 2 Different types of visual communication and user interaction (Bulmer, 2001:8)

	Passive	Active
Simulating	**Modelling**: e.g. simulation on the desktop	**Modelling and changing**: e.g. immersive Virtual Reality models of cities
Experiencing	**Observing**: e.g. exploring maps, designs	**Engaging and changing**: e.g. immersive & web based worlds
Communicating	**Displaying**: e.g. reading web sites	**Delivering**: e.g. making decisions about services

An effort to structure the construction and use of geo-visualizations for participatory spatial planning processes is initiated by Hoogerwerf et al. (2006). The authors will develop a conceptual framework by integrating the theoretical fields of spatial planning, participatory planning and communication. This framework will be based on the view that geo-visualizations should be adjusted to the specific planning issue and context in order to communicate spatial information effectively and efficiently to all actors via these geo-visualizations (Kingston, Carver et al., 2000; Al-Kodmany, 2002; Bishop and Rohrmann, 2003). The intention is that such a framework could in the future result in one of more theories on how to use geo-visualizations to communicate spatial information and spatial transitions to both professionals and lay people. The authors describe several criteria for the effectiveness of geo-visualizations divided into six components: actors, planning phases, participation levels, communication protocol, interfaces, and geo-visualizations. A brief summary and a visual representation of the tentative framework is given below:

Figure 4 Visual representation of the conceptual framework (Hoogerwerf et al., 2006)



In terms of the **actors-component**, criteria of geo-visualizations are:

- Geo-visualizations need to be able to express the preferences, visions and interpretations of the different groups of actors;
- Geo-visualizations need to make explicit differences and similarities between these preferences of different actors;
- Geo-visualizations need to facilitate the ease of annotating the process to allow actors to comment on value judgments, opinions definition and choice of alternative courses of action, interrupts, negotiations etc.;
- As actors are involved at different participation levels, the content and the graphic variables of the visualization will be affected;
- Geo-visualizations need to be understandable to different actors which work with different ontology's to communicate;

- Geo-visualizations need to be as accessible as possible to prevent that inexperienced actors will be intimidated by the geo-visualizations;

In terms of the **planning phases-component**, geo-visualizations should support the different activities specific for planning routines. This means that the information, which is typically used as input for or produced as output of the activity, is visualised and processed appropriately:

- In the phase of problem recognition, the geo-visualization should facilitate the analysis of opportunities and threats of different natures;
- In the phase of problem diagnosis, the geo-visualization should facilitate the determination of cause-effect relationships, including non-physical elements;
- In the design phase, the geo-visualization should facilitate the creation of different scenario's or solutions to the problems, the storage and retrieval of different versions and the possibility to leap back and forward between different scale levels;
- In the evaluation phase, the geo-visualization should facilitate the comparison between different scenario's;
- In the authorization phase the geo-visualization should reflect the influence of the information which was provided for by different actors;
- Some activities occur in every planning phase, geo visualizations should support activities like voting, recollecting data from the past and the integration of different types of media (land-use maps, photo's or video's).

In terms of the **participation levels-component**, there are five levels of participation: informing, consulting, advising, co-producing and co-deciding. The input actors will give needs to be facilitated by geo-visualizations in every level of participation. Furthermore, a geo-visualization should make clear the relation between the actors and their behaviour to create a social framework since not all actors are involved during the whole length of the process.

In terms of the **communication protocol-component**, the authors describe several communicative settings varying from actors being at the same place at the same time (e.g. a meeting) to actors being at a different place at a different time (e.g. an Internet forum). These protocols impose several conditions to geo-visualizations:

- Geo-visualizations can support different time protocols by allowing users to anchor or annotate arguments to places in the geo-visualization and to visualise the arguments made about particular places (argumentation maps);
- Same place protocols can be supported by geo-visualizations, which can be displayed on single large display devices with which the actors can interact simultaneously. An important disadvantage is that these big and heavy devices however are not moveable;
- Different time, different place protocols require geo-visualizations that support the use of email lists, Internet discussion groups and plan reviews via websites.

The **interfaces-component** of the framework describes the devices, which facilitate various forms of interaction between actors and geo-visualizations. These devices provide the opportunity to give feedback on the proposed geo-visualizations. Conditions imposed to geo-visualizations by interfaces are:

- A geo-visualization can be displayed and interacted with via different interfaces. Each interface will facilitate one or more forms of interaction. The forms of interaction are: navigation, selection-manipulation-elaboration-explanation, immersive experiences, interaction with simulation model, and interaction with other actors.
- Ideally geo-visualizations should facilitate the form of interaction, which maximizes the engagement of the targeted actors. Most likely, however, the selection of the interface will be restricted by practical conditions, such as the availability of the hard- and software with which the interface can be constructed.

In terms of the **geo-visualizations–component**, Hoogerwerf et al. (2006) describe the knowledge deficits in the field of the effectiveness of geo-visualizations. This is due to what Slocum et al. (2001) describe as the broad range of users that need to perform a broad range of tasks with geo-visualizations (Slocum et al., 2001). Another difficulty is the broad variety of cognitive issues that are involved when 3D geo-visualizations are used as communication tools (Bill, Dransch et al., 1999; Dransch, 2000; Fairbairn, 2001; Yun, Yufen et al., 2004). A participatory spatial planning process imposes specific conditions to geo-visualizations, as described in the previous components, related to both these issues. Lammeren en Hoogerwerf (2003) state that geo-visualizations can support *interaction in* the 3D virtual environment (orientation, movement, navigation, explanation, elaboration and manipulation) and *interaction of* the 3D virtual environment (the user is able to define the settings of the viewer (interface) mode that could influence the way the 3D environment is experienced by the user). Interaction also deals with the ability for users to give feedback on proposed transitions via text messages, a forum, or voting systems. In current viewers of applications for geo-visualizations, some of these interaction methods are included. However, there is no overview available about the interaction methods that are required for users in specific planning phases or participation levels when they are performing a certain task in the planning process.

Two important features of geo-visualizations seem to be the degree of *detail or realism* in the represented objects and the *intelligence* of objects. The level of detail greatly influences the perception, opinion and decision on proposed spatial transitions of the landscape (Sheppard, 2001; Al- Kodmany, 2002). Therefore Hoogerwerf et al. (2006) argue that research on how to adapt the level of detail of geo-visualizations to the users as well as to the tasks they have to perform is extremely important. Furthermore, the intelligence of geo-visualizations is an important feature. Intelligence refers to the extent to which objects in the virtual environment have a certain behaviour that corresponds with objects' behaviour in the real world. An example of object intelligence is the way users are allowed to interact with the environment and its individual objects. Some geo-visualizations provide users the opportunity to select and manipulate the position of appearance of objects, and therefore are able to give feedback on the proposed transitions or propose themselves alternative transitions. It seems necessary to research which specific intelligence is required in geo-visualization for specific actors and planning tasks (Hoogerwerf et al., 2006).

2.4.2 ICT providing increased opportunities to achieve involvement

The Internet is playing a tremendously crucial role in today's society. Recent statistical research shows that in 2005 nearly 80 percent of Dutch households have access to the Internet. Of this Internet use, one third is on the account of young people in the age of 12 to 25. Also, governmental services are increasingly offered online (CBS, 2006). A random exploration of Dutch spatial issues on the Internet will give many informative websites about national, provincial or municipal spatial transitions. Moreover, in election periods citizens' are encouraged to use the Internet to define their voting choice or participate in online referenda. This tendency is also called e-democracy: democracy via the Internet. At least three possibilities for e-democracy are to be distinguished: representative (elections), consultative (referenda) and participatory (discussion) (Pieters & Becker, 2005). One will also find some municipalities presenting their local land use plans ('*bestemmingsplannen*') online, however very few of them offer interfaces for bringing reactions to these plans online. In an interview, Arend Ligtenberg – researcher geo-informatics at Alterra – says in this respect:

"Interactive websites hardly exist, and such websites combined with geo-visualizations are even rarer. Often there is a possibility to react by email but not with the aim to participate in design or decision. Furthermore, the official authorities are not yet equipped for this, one does not know how to deal with that many reactions."

From literature we can learn that the expectations of the Internet are high. According to Doyle, Dodge and Smith (1998), GIS and other related technologies through public participation can be seen as a precursor to the role the World Wide Web could take as a distribution mechanism within any process where consultation may be required. "*Virtual Reality now embraces a variety of systems from the totally immersive, centralized, single user tools with which it began, to the entirely decentralized, remote and anonymous technologies spawned by the net,*" says Daniel Bulmer in the Online Planning Journal (2002). It is exactly the anonymous character of the web that Bulmer finds most promising. Traditional methods of public participation quite often involve a confrontational atmosphere that can discourage participation. Also the restricted time and the actual geographic location can restrict the possibility of widespread attendance. In participation over the Internet, barriers like time, location and confrontation fade (Bulmer, 2001). Not only written participation should be facilitated on the Internet; geo-visualizations play a very important role in communicating with the public. Geo-visualizations transform abstract information into easily understandable graphics and above all geo-visualizations should be used to visualise people's perceptions in order for these perceptions to become dynamic and interactive and more meaningful (Al-Kodmany, 2001).

In sum, the Internet is regarded among scholars as a very suitable tool to organize, to present, to communicate and to interact about spatial information. It is supposed to make spatial planning more democratic, more accessible and more bottom-up. What seems to be missing however is a true web based interactive platform in which geospatial information is visualised to achieve better participation, better process results and in the end a better spatial transition. In this regard, the recent launch of Google Earth on the Internet is received among researchers and policy makers as very promising. As illustrated in the journal 'GIS Development' (Gupta, 2005):

"[…] Google had simply given access with Google Earth. Access to geographic information in a fairly democratic way in the hands of everyone (having Internet*), without discriminating on the basis of who is who – government, staff, academician, student, NGO, private sector, defence staff, etc. It has made any restrictive regime – of withholding geographic information – a big joke."*

The lessons learned in this paragraph are twofold. Firstly, geo-visualization tools on the Internet are expected to yield many benefits in terms of communication and participation, however little research on the true effectiveness is available. Secondly, increasing development and usage of such tools, like Google Earth, illustrate the popularity, usability and accessibility of such tools, it is however obvious that widespread use of the geo-visualization tools in spatial planning is not yet institutionalised.

2.5 Drawbacks

In the former paragraphs we have seen that geo-visualizations will expectedly play an increasing role in policy developments, communication and interaction among government and society, and in the use of information technologies. There are however some issues to consider when discussing the effectiveness of geo-visualizations, issues which need to be taken into account while doing research or while planning interactive processes. These issues will be touched upon briefly.

In terms of discussing the technical requirements of users of geo-visualizations, it is important to realise that users do not know what they require because the technology is opening up new opportunities and possibilities, which generate new requirements all the time. The fact is that citizens may have no requirements because they don't have a clear idea of what the technology may offer them. They have needs, or hopes, regarding an improvement of their quality of life rather than requirements or opportunities for particular technologies (Intelcities, 2004). A central asset in this discussion is also the way in which online services are divided across social groups and their respective levels of income: *"Online developments may be technically possible, but the socio-economic structure of such services should lend itself to equal access"(Intelcities, 2004)*. Furthermore, we should not take for granted that actors are stimulated by the anonymity of the Internet: research by Leeuwis et al. (1997: 23) has shown that during an experiment (held in 1996) to increase citizen participation by using an Internet forum the participants of the debate were very eager to know the background of the people. It seems also important to make a distinction between comments and opinions made personally and comments and opinions made on behalf of the organisation (Leeuwis et al., 1997: 83). From a technical as well as a psychological perspective we can conclude that special attention in an open debate supported by the Internet should be given to 1) accessibility of the technology, 2) skills to use the technology and 3) the representation of social actors on the Internet.

In terms of the assumed discursive power of visualization, it is according to Van Herzele (2005) often overlooked that the use of maps (GIS) are in fact a product of a particular mode of thought in geography. In her book, Van Herzele argues that maps are practices of knowledge-power, they actually are not so value neutral. As an abstraction of reality, cartographic 'facts' bring some aspects to the forefront and leave other aspects in the background. As such, through selecting and emphasising, they may have some political effect. Furthermore, one should take into account the risk of putting to much detail in a GIS image. GIS users are tempted to add more parameters to the system to reflect more information in a cartographic image. As a consequence, the indicator system won't fulfil its main function any more: simplifying communication. An indicator system full of details is only meaningful to experts and not to the community itself. What Van Herzele is saying is that planners should not only rely on GIS images in planning processes. GIS can serve as a proactive way of assessing the effects of possible options of spatial development from multiple perspectives by means of GIS based simulations, however these multiple perspectives originate from people who express different identities. Van Herzele (2005) says in this respect:

"Planners need to go beyond the identification of interests and preferences and should attempt to discover why people come to make their claims. Attention should be paid not only to the ways in which issues are discussed, but also to the substantive issues in question, as well as to the cultural identities that influence people's ways of giving meaning, value and expression."

To summarize, there are two aspects of applying geo-visualizations that planners need to be aware of in interactive processes:

1. Internet based interactive processes could exclude certain interest groups from participating due to technological and psychological barriers, therefore attention needs to be paid to: accessibility, skills and representation of social actors.
2. Geo-visualizations are not value neutral; care should be taken not to reduce possible alternatives because of fixed images. Geo-visualizations require flexibility and interactivity to expose underlying cultural identities of actors.

2.6 CONCLUSION

In this chapter we touched upon some societal issues that directly relate to the increasing use and development of, and need for geo-visualizations in participatory spatial planning. By trying to bridge communication science, policy science, spatial science, cognitive science and geo-information science it becomes clear that a lot of work has been done already. However, there is still a lot of work to be done. By means of conclusions, four key concepts derived from this chapter will be given.

Governance: balancing between complexity and simplicity
The expected increased use and development of web based interactive geo-visualizations in spatial planning issues is a logical move forward in dealing with the complexity of spatial developments; geo-visualizations simplify spatial settings in a realistic way and make spatial scenarios understandable for lay people.

Interactivity: balancing between process and results
Web based interactive geo-visualizations are good supportive tools for generating, sharing and reflecting on different interpretations among actors and will subsequently contribute to achieving better process goals and in the end to achieving better project results and a broadly carried acceptance of the spatial transition.

Information society: balancing between transparency and commitment (or social carrying capacity)
The democratic, accessible and bottom-up character of the Internet will support wider commitment and mutual understanding in spatial planning processes due to a combination of text and images on an interactive web based interface. Transparency in spatial planning therefore is highly valued but often not yet taken for granted.

Social learning: balancing between learning by doing and institutionalisation
Scarce presence of and experience with web based interactive geo-visualization tools limit substantial use of such tools among actors, therefore a knowledge transfer point containing best practices, guidelines and experiences in combination with hands-on training sessions in pilot areas can benefit the knowledge dissemination.

In the following chapter, a scientific exploration of the effectiveness of geo-visualizations in interactive spatial planning processes is given.

3 GEO-VISUALIZATION AND INTERACTION: WHAT IS KNOWN?

3.1 INTRODUCTION

This chapter gives an overview of expected effects of geo-visualizations on the participatory spatial planning process and the actors that are involved in this process. By means of a literature study, the available knowledge about these effects will be described. Several research methods and techniques from scientific literature will be distinguished and described. Moreover, this chapter will focus on promising research methods to study specific effects of geo-visualizations in the future.

3.2 GEO-VISUALIZATION EFFECTS IN LITERATURE

The aim of using geo-visualizations is to influence participatory spatial planning and decision-making processes in a positive way. This positive effect that geo-visualizations have or are expected to have could be on the process itself as well as on the actors who are going to reflect on the proposed plans. The effects on the planning process itself can of course not be seen separated from the effects on the actors as these actors are part of the planning process itself. However, for the description in this chapter they are taken apart. Several effects of geo-visualizations, which are expected or demonstrated in case studies described in literature, will be described in this paragraph. In scientific literature, a huge number of papers can be found in which geo-visualizations are studied in or for participatory spatial planning. Most of these papers focus on progress or outcome of the planning issue, or solely on the technical aspects of the constructed geo-visualizations. Only a limited number of papers pay attention to effects that geo-visualizations have had on the process and/or the actors involved in the process. And within this limited number of papers, the type of geo-visualizations that is used varies enormously. In this paragraph, scientific literature is reviewed to gain knowledge about what is already known in scientific literature about the effects of geo-visualizations. The literature that is reviewed is carefully selected, based on the geo-visualization types that were used. This paragraph will only deal with recent studies that used visualizations that are static or dynamic two-dimensional or three-dimensional visual representations of geo-data and have a link with participatory spatial planning. In paragraph 3.2.1, we will focus on the effects that geo-visualizations are expected to have on the actors; paragraph 3.2.2 describes the expected effects on the whole participatory spatial planning process. By doing this, knowledge deficits will become clear.

3.2.1 Geo-visualization effects on actors

One of the goals of using geo-visualizations in the spatial planning process is to improve the communication between the actors in the planning process, resulting in a plan that is widely accepted by most actors participating in the process. In literature is assumed that geo-visualizations will improve the communication in the process (Haklay, 2001; Harrison and Haklay, 2002; Manoharan et al., 2001) and therefore create widespread knowledge about the plans. It is not so easy to simply list the effects of the use of geo-visualizations in the planning process because there are multiple cause and effect relationships. The one effect will cause another and so on.

In literature is suggested that, in particular 3D, geo-visualizations are more effective and efficient for actors of the planning process to recognize the area under study and understand proposed spatial changes rather than with 2D static maps (Al-Kodmany, 2001; Sarjakoski, 1998). The *improved understanding of the proposed plans* leads to several side effects. For example, another effect of geo-visualization is that the citizens or actors become *more involved* in the planning process. This is due to the fact that the actors can respond to the plan (by Internet) and get the feeling that they are actually contributing to the process (Al-Kodmany, 2002). This will cause them to have a *positive attitude* towards the planning process. This positive attitude is then a new effect caused by the feeling of involvement (Kingston et al., 2000).

In diagram 1, we visualised the relationship between the different effects on the actors in the planning process. Starting with the geo-visualization and resulting in a spatial plan accepted by most of the actors. The starting point in describing the effects on the actors in the planning is the geo-visualization itself. As this is the new factor in the planning process, this causes the change in the process and therefore causes the described effects.

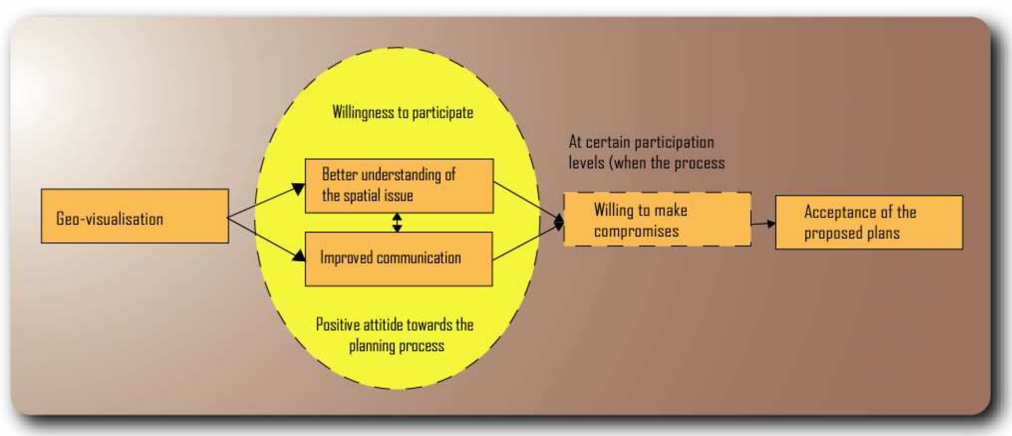


Diagram 1 *Relationship between geo-visualization effects*

The diagram shows that the geo-visualization has two main direct effects, which are again responsible for a set of other effects. The main effects are the *improved communication* between the actors in the process and the *improved understanding* of the plans among the actors. The two effects seem rather similar, but are not the same. The communication involves the information available to the actors and therefore more input for discussion between the interest groups. The improved understanding includes a better insight in the output of the plans (Al-Kodmany, 2000; Appleton and Lovett, 2003; Bishop et al., 2001; Sarjakoski, 1998). It is clear what is planned and what it is going to look like. The actors are expected to understand the geo-visualization and create a clear view of the proposed plans.

This improved communication and better insight in the plans will result in a positive attitude towards the planning process and therefore willingness to participate. The citizens will have the feeling they understand the plans, that is why they can comment on the plans and get the feeling they are being heard and can contribute to the planning process. The actors feel they are taken seriously and do therefore have a positive attitude towards the planning process. The positive attitude and willingness to participate will result in the willingness to make compromises. Only when the plans are fully understood it is possible to understand the wishes of all actors and have a better insight in the possible alternatives. The positive attitude will also result in a better understanding of the motivation for the proposed plan causing a *willingness to settle for an alternative plan*. A clearer communication and understanding will enable a discussion driven by knowledge and mutual understanding. The results of a complete plan for which every actor has been able to give input will lead to a *generally accepted plan*. The final effect of the use of geo-visualizations in the participatory planning process is broader acceptance of the plans: All actors are able to understand the details of the proposed plans, they know about the targets and restrictions and are therefore more satisfied with the final plan.

Research has been done on the use of geo-visualization in spatial planning processes. During public meetings, actors were supplied with information using geo-visualizations. The main research focus in the literature is, however, not the final effect of using these geo-visualizations, but more the general attitude and experience of the actors involved in the process. These articles only describe the character of the meeting that was planned, the background of the participants and the group process itself, answering questions like: Were the actors satisfied? Was the research team satisfied? None of the found articles gives an overview of methods to measure the actual effects of the geo-visualization on the actors within the planning process.

Although the exact effects are not known yet, Geertman (2002) provides lessons learned about Public Participation GIS (PPGIS) in spatial planning, which are based on (unstructured) observations. Several PPGIS tools are used in a number of case studies and the effects of these tools are studied. Four main effects are observed by Geertman (2002):

- The tools helped to *bridge* the communication between actors with different background, speaking a 'different language';
- The tools helped the participants *to articulate* their thoughts, *to express* their visions, and *to discuss* their ideas with others in the participatory planning process;
- The tools helped *to enhance the structure* of relevant workshop information and made it *more explicit* (by means of the arrangement of spontaneously expressed thoughts and in the storage of the results of the brainstorming session);
- The tools *stimulated discussion* and *generated enthusiasm* in the process of creating and evaluating sketches.

Furthermore, the search in literature on geo-visualization effects resulted in several opposite experiences on the level of detail issue. For example, Appleton and Lovett (2003) argue that a higher level of detail makes it easier for people to relate geo-visualizations to the real landscape (Appleton and Lovett, 2003). In correspondence to this experience, Al-Kodmany (1999) argues that photo-realistic visualizations can be effective tools to inform citizens. Together with Sarjakoski (1998), he argues that the reason is that these visualizations are a very close representation of reality and participants need little interpretation to understand this information (Al-Kodmany, 1999; Sarjakoski, 1998). On the other hand, Appleton and Lovett (2005) and Warren-Kretzschmar and Tiedke (2005) pay attention to the fact that high level of detail within geo-visualization may cause negative effects, like bias and misunderstanding (Appleton and Lovett, 2003; Warren-Kretzschmar and Tiedtke, 2005). Also Al-Kodmany (1999) states that using such realistic visualizations in the early phases of a planning process can also result in raising undeserved expectations and creating the sense that the proposed transformations are already fixed. Superfluous information and overly detailed visualizations can also overload citizens, which will make focusing on specific issues more difficult in the later process (Al-Kodmany, 1999).

In his articles, Al-Kodmany (1999 and 2002) has observed some effects of geo-visualizations on participatory planning processes in Chicago, Illinois (US). In this case study, several geo-visualizations tools were used to encourage maximum public input and participation. The target group of the geo-visualizations was mainly community residents. The effects that are described in the papers are based on (unstructured) observations of first hand experience by Al-Kodmany. For example, digital GIS maps helped community members in developing alternative design solutions and it also helped in visualizing current urban development examples in the city. Moreover, the GIS maps helped to resolve disagreements between actors, thus fostering consensus, and helped to identify neighbourhoods' problems of which planners would not otherwise be aware (Al-Kodmany, 1999). Also photo-manipulation was used in the process to bring attention to subtle design issues. The team found that by providing highly realistic images of potential design alternatives embedded into the actual neighbourhood context, participants could more easily make communal decisions (Al-Kodmany, 1999). The main conclusion about the visualization tools was that each of these tools was highly effective in promoting resident participation in the planning and design process. GIS maps were most effective for problem identification and brainstorming, while photo-manipulation using computer imaging was most useful for exploring solutions to previously defined design issues.

3.2.2 Geo-visualization effects on the process

Our idea is that geo-visualizations should be effective communication tools for actors to share and exchange their knowledge and ideas about specific spatial problems. Based on this view, geo-visualizations are expected to increase the communication of actors in each phase of the planning and decision-making process, and therefore the total *speed* to pass through these processes should be increased.

Moreover, geo-visualizations are expected to motive the individual actor to share and exchange ideas, which leads to an *increase in the number of participating actors*. The technology to present geo-visualizations via the Internet is also a huge advantage to reach a large number of actors (Al-Kodmany, 2002; Kingston et al, 2000; Lange, 2002). The *increase in sharing and exchanging knowledge and ideas* influences the content of the plans and the decisions that are taken. It is expected that the *content changes in terms of the quality of the plan***.** Overall, geo-visualizations are expected to influence the *actors' satisfaction to participate* in planning process in a positive way, due to the emphasis on sharing and exchanging knowledge and ideas. In literature, another effect of geo-visualizations is sometimes suggested. This suggestion is that geo-visualizations could lead to *changing the current organization of the planning and decision-making process* (Al-Kodmany, 2002). Geo-visualizations offer a wide set of possibilities to share and exchange spatial information between actors, which could lead to organizing the process of participation in a more effective and efficient way. Unfortunately, there are no concrete ideas yet how to organize these processes in a way that geo-visualizations can optimally be used.

In his studies, Al-Kodmany (2002) found that computerized tools can significantly enhance, or even transform, public participation planning. According to Al-Kodmany, there is general agreement in the literature that the ideal method for public participation would combine the best aspects of low- and high-tech method (Al-Kodmany, 2002). In his words:

"Traditional, non-computerized tools are not capable of the sophisticated analysis, display, and visualization that may enable the public to make more informed decisions. However, if used alone, computerized tools may lack the ability to draw people into meaningful interaction with the data and each other. Traditional tools may create a social learning environment that enables participants to talk about a project together, to interact with other actors, and to propose ideas. Professionals must be aware that high-tech tools must do better at interactively engaging the public if they are to be used as stand-alone community planning tools" (Al-Kodmany, 2002)."

Kingston et al. (2002) studied the use of web based GIS in a village-based case study, West Yorkshire in northern England. In this study, the web based GIS was used as a parallel exercise to a traditional 3D scale model. The paper does compare the usability of the two communication tools, but describes some advantages and disadvantages of the web based GIS. One of the advantages was that the comments of the public could directly be saved in the system, which saved time and money. Kingston et al. describe that with the physical model, comments made by the public had to be collated manually and had to be put in a database. The compilation and analysis of this database could take several weeks. Furthermore, both the tools offered the opportunity to express views and opinions. While the scale model restricted the length of the text to express views and opinion, the web based GIS offered the opportunity to express more articulated views or comments about issues. The other described advantages and disadvantages did not relate to geo-visualization effects on the process itself.

In another article about PPGIS, Harrison and Haklay (2002) describe two main expectations of PPGIS, based on the wider PPGIS literature, which are not studied yet. The first expectation is described as "the belief that the public needs access to more and better information if GIS is to empower local communities (Elwood & Leitner, 1998, Harris & Weiner, 1998; Talen, 1999)". Harrison and Haklay express their concern about the need to provide interactive systems that permit users to manipulate data in ways they feel are meaningful and which permit *community-generated information to be added* to more conventional data. The second expectation is described as "to facilitate a more *interactive and collaborative approach to planning* in which local people and members of the local authority, developers and local councillors meet together to discuss development proposals". Finally, Harrison and Haklay express a concern about the need to ground the development of PPGIS as a planning tool in people's experiences of both the planning system and IT as a whole – much as critical GIS theorists have advocated (Curry, 1998; Pickles, 1995). In this regard, Harrison recognizes that "*different user groups are likely to have different needs and that wider social attitudes are likely to impinge often in quite subtle ways on public attitudes to the potential use of PPGIS as a planning tool*" (Harrison and Haklay, 2002).

3.2.3 Integration

Summarizing, geo-visualizations are expected to have a positive influence on the actors' willingness to make compromises as well as on the acceptance of the final plans. Moreover, geo-visualizations are expected to contribute to better communication and understanding among actors. Supposedly, the level of detail of a geo-visualization is very important in order to accomplish these effects. Also in terms of the spatial planning and decision-making process in general, geo-visualizations are expected to have a positive influence; factors that seem to determine this are among others the total speed of the process, the increase in the number of participating actors, the increase in knowledge exchange, the quality and content of the plan, the satisfaction of the actors and the change in organisation of the planning and decision process. Furthermore, it seems that a combination of low-tech (such as maps, face-to-face meetings, scale models, sketches) and high-tech (such as the Internet and various visualization tools) methods is most appropriate to have actors express their views and opinions.

Taken as a whole, the reviewed articles show that structured research on well-defined geo-visualization effects on both actors and process has not been performed yet. Most articles come up with a wide variety of expectations, recommendations and case study-based advantages and disadvantages of geo-visualizations but they miss a coherent structure. Furthermore, the reviewed articles lack a well-defined method to measure and analyse the effects mentioned. The current status of research makes it difficult, but challenging, to further investigate geo-visualization effects on the planning process.

3.3 RESEARCH METHODS: NEW CHALLENGES

The literature review shows that both the number of studies and the research methods for studying geo-visualization effects are very limited. It is remarkable to see that very few of the mentioned effects have actually been measured. Authors like Al-Kodmany (1999, 2000, 2001, 2002) and Harrison and Haklay (2002) rely on their observations when judging the behaviour of citizens presented with a virtual representation of spatial plans in their living area. They do not use means of quantifying the effects of the geo-visualizations. Instead, they monitor the actors working with the geo-visualizations and evaluate their responses to the new plans during the planning meetings.

In the research that was reviewed here, mainly observations were used. In some of the articles, the research method was not even mentioned; therefore, we assume that the described effects were studied by unstructured observations. The literature review on the effects of geo-visualization did not result in an overview of research methods, which have proven to be effective or ineffective.

There seems to be a need to define and measure the effects of the geo-visualizations in the spatial planning process. When combining several research techniques, it will be possible to stick a value on the effects that the geo-visualizations have on the actors in the planning process. When it is difficult to test the results because the population is not entirely fool proof, i.e. the population is too small or too homogeneous; it is advisable to use multiple methods to test the same thing. The more results the more rigid the conclusions become.

Possible methods to find out how the actors feel about the planning process are to interview the people involved in the process. To strengthen these results, it will be necessary to hold questionnaires. The difference between the *interview* and *questionnaires* is that with the latter, the questions are set. The people filling in the questions will be able to give a rating to the set questions. An interview on the other hand is more open. The subjects are set, but not the exact questions. People who undergo the interview will be able to express their feelings more and give an opinion on matters that seem most important to them. Especially the questionnaires are suitable for quantitative analysis. Multiple choice answers or Likert scale rating will allow for statistical analysis of the results.

Methods like an *assessment* are suitable for testing the increase of knowledge. At the starting point of the experiment the test group will have to make an assessment. This is necessary to determine the level of knowledge at the start of the experiment. At the end of the experiment a similar assessment will have to be held to test the increase of knowledge of the test group. In case of testing the effects of geo-visualization within the planning process, assessments can be used to test the actors' increase of knowledge of the plans. To make the results solid it will be necessary to have a monitoring group that learns about the spatial plans not by using geo-visualizations. This group will also experience an increase of knowledge. When comparing the result of the test group and the monitoring group it will become possible to compare the two processes and prove that geo-visualizations are more effective than conventional methods.

Another possible method to do research in a spatial planning process is *Action Research*. Carr and Kemmis (1986) give the definition of action research as follows:

"Action research is simply a form of self-reflective enquiry undertaken by participants in social situations in order to improve the rationality and justice of their own practices, their understanding of these practices, and the situations in which the practices are carried out (Carr and Kemmis, 1986: 162)."

This method involves using several methods to test and measure the behaviour of participants. Actors participating in the research project are tested to see how they experience the use of geo-visualization in the planning process and they are consulted on how use of the geo-visualization tool can best be improved. Action research will be useful for finding out how able the actors are to use the new visualization method in the planning process. By continuously adjusting the geo-visualization to user requirements, the research contributes to a most optimal use of the tool.

There are also different *models* that can support the research on the effects of geo-visualization on the planning process and on the actors in that process. One such model that specifically applies to the willingness for people to adopt a new technology is the *Technology acceptance model (TAM)* (Davis, 1986). The model approaches the acceptance of new tools, such as new geo-visualization tools, from the users' point of view. The technology acceptance model is a combination of factors that influence a user when he or she is in the situation to either adopt or reject a new technology. It has been analysed that there are a few main factors that influence the adoption of a new technology. These factors include perceived usefulness and perceived ease of use. The TAM relates these factors and can be used to quantify the level of adoption of a new technology such as geo-visualization. In the case of Virtual NL it is necessary to determine how useful the actors think that the geo-visualization is and how easy it is to use. If the actors think it is too hard to operate and/or when they think the tool is not useful, these actors are most likely to reject the geo-visualization tool.

Another theory useful when doing research in groups is *Social Learning Theory* (Bandura, 1977). It is important to know how the group setting will influence the behaviour of the actors in the planning process. In a participatory planning process citizens will influence the behaviour of one another. The social learning model deals with communication, cooperation and reflection within a group. The model can serve as guideline when interpreting the behaviour of the actors in the planning process and will help in explaining why the geo-visualization contributes and how because of social activities. For example, we can say that the geo-visualization was a success or failure because of the behaviour of the group. People were discussing vividly and explaining each other the functionalities of the visualization tools.

3.4 Discussion and Conclusions

This chapter provides insight into the current state of knowledge of geo-visualization effects on both the planning process and the involved actors. Although in literature the need for research on geo-visualization effects is stressed (Slocum et al., 2001; Ball, 2002; Wood et al., 2005), the knowledge on this subject is still rather fragmentized and limited in number. Moreover, no concrete research methods to study geo-visualization effects are suggested in literature. Therefore, paragraph 3.3 described several research methods and approaches that seem useful to study geo-visualization effects. Off course, each of these methods and approaches has its advantages and disadvantages. But to our opinion, the main strength lies in the combination of these methods and approaches to study the geo-visualization effects from a broad perspective.

Based on the described expectations from literature, we think that two research topics have priority in studying geo-visualization effects. First of all, the effect of geo-visualization on actors is an important issue, because this automatically affects the whole planning process. In particular, the level of detail in geo-visualization is an issue, due to the opposite arguments that are made in literature. On the one hand is argued that a higher level of detail makes it easier for people to relate geo-visualizations to the real landscape; while on the other hand is argued that high level of detail within geo-visualization may cause negative effects, like bias and misunderstanding. Secondly, the potential of geo-visualization to increase the speed with which people gather and process information needs to be studied. Knowledge about this potential is important to get insight in the people's knowledge on and experience with complex spatial issues. For both research topics, a combination of research methods as described in paragraph 3.3 will be required. In particular, we think of (web) surveys, questionnaires, and interviews to study the effectiveness of geo-visualizations that vary in level of detail for specific tasks. A combination of interviews, questionnaires, assessments, observation and the TAM model seems appropriate to study the speed with which people gather and process spatial information.

We are now ready to link theory to practice. As we will see in the next chapter, many initiatives have raised lately that use the potential of geo-visualizations with the aim to accomplish the above described effects. The following chapter therefore presents some interesting practices describing how governmental organisations, private companies and researchers already anticipate on the power of geo-visualizations for participatory spatial planning.

4 PRACTICE, EXPERIENCES, AND EXPECTATIONS

4.1 INTRODUCTION

Present communication tools for spatial planning, such as maps and reports ask for specific expert knowledge for interpretation. This inaccessible character that could exclude people from participating in a spatial planning process is starting to change due to the rising popularity of virtual and 3-dimensional geo-visualization tools. As will be seen in this chapter, current visualization tools are becoming more flexible and accessible due to dynamic developments that change the limits of hard- and software continuously: more and more data files become available, exchangeable and manageable, tools are further developed to manage, combine and open up data files. In this chapter three focal points are discussed: 1) Geo-visualization: trends and future 2) Best Practices, and 3) Expectations from professionals. In other words, practice, experiences and expectations are central elements in this chapter. We will elaborate upon these elements by presenting the results of desktop research, interviews, and consortium meetings.

4.2 GEO-VISUALIZATION: TRENDS AND FUTURE

Graphical presentation of information has a long history; cartographic maps are some of the earliest existing geo-information visualization tools. Geo-visualization techniques that support communication on spatial conflicts, challenges and future scenarios have been in the spatial planners' toolkits for decades (Lammeren et al., 2003). Geographical information systems (GIS) have been developed from the early seventies and have already been widely used in actors' dialogues in third world countries (Harris et al., 2002) as well as in the developed world (Harrison and Hacklay, 2002). GIS has also proven to be a good tool supporting interactive planning processes, which will be shown later in this paragraph. We first start with an overview of *common trends* that according to the project consortium extend possibilities to increase use of GIS by more actors in participatory spatial planning:

- Large availability of data (pictures, geomorphologic data, contour maps and aerial photographs);
- Tools are developed to improve presentation and analysis of the data;
- Computers are becoming faster and more powerful to handle the data in combination with tools;
- More and more people are familiar with the Internet and its possibilities;
- Governments increasingly use the Internet as a platform for sharing and exchanging information;
- Internet connections are becoming more powerful for up- and downloading data;
- Tools are developed for building 3D geo information systems and animations;
- Standardization in interoperability of GIS systems (Open GIS, world wide standards) makes exchange between and integration of different data sources easier.

Technological developments make it possible to communicate a realistic picture of present and future spatial scenarios to groups of people involved or interested in spatial transitions. We assume that GIS systems can support better involvement of actors, this *involvement* can however only be realised if the future GIS systems meet the following *criteria*:

- It can be used by people without knowledge about spatial planning (intuitive interfaces);
- It can be used on ´standard´ computer (systems) (e.g. Internet browser);
- It offers a transparent picture (clear symbology);
- It has options to display the overview plan but also to zoom in to particular details and to retrieve extra information from those details;
- It has options to view the spatial area from different angles;

- It offers possibilities to analyse effects of different scenarios;
- It is challenging for people to use it.

When we take a look at the *present use* of GIS in Dutch spatial planning, it becomes clear that GIS is mainly being assigned as a *presentation tool* for spatial plans rather that an *interactive tool*. 'Spatial plans' are all plans confirmed and described in the current Spatial Planning Act and in the Decree on Spatial Planning by municipalities, Provincial authorities, Water Boards and Ministries. These plans range from strategic to operational. Examples of such plans are: local land use plans, local and regional structure plans, provincial regional spatial plans, reconstruction plans and the national spatial planning key decision ('*Planologische Kern Beslissing'*). Only municipal land use plans are juridical binding for citizens, companies and societal organisations. Next to policy guidelines, regulations and explanations, a spatial plan always contains maps (ground plans or lay outs) in which planning objects are visualised as dots, lines and fields on a topographic or cadastral background (Bulens et al., 2002). Textual publications containing photographs and images, and geographical information presented on 2D maps are often used in spatial planning to illustrate, visualize and to obtain an overview of the planning situation at hand, e.g. a sense of distance, size, etc. Visualization in this respect is used as a presentation tool towards the involved actors rather than as an interactive tool or instrument to influence the planning process. Visualization in its current use mainly serves spatial planners in planning within the spatial prerequisites, it helps them to communicate the plans to the outside world by means of maps (digital or analogue) or scale models.

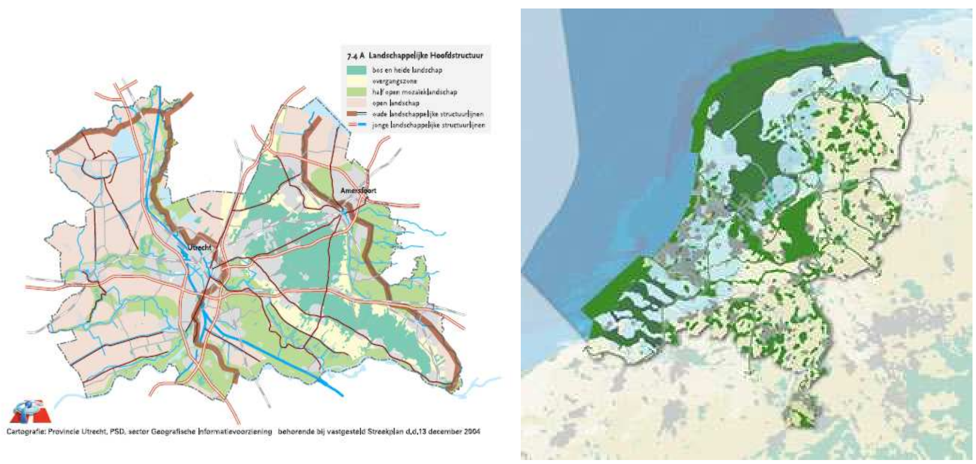


Figure 5 The province of Utrecht, Landscape Structure of the regional structure plan (left) and Nota Ruimte, Nature development in The Netherlands (right) (Source: www.provincie-utrecht.nl and www2.vrom.nl/notaruimte)

Jankowski and Nyerges (2001) state that new developments of the 1990s, focused on the Internet, opened new possibilities for better access to spatial information and enhanced benefits from its use. The authors describe the justification for the development of GIS technology into what they call 'Participatory GIS' (geographic information systems that are designed and used by groups with multiple actor perspectives):

"While the mainstream GIS technology concentrated on easy-to-use, ubiquitous mapping and spatial analysis tools, it lacked a capability to collate interests and interactions to support collaborative spatial decision making (CSDM), for example, in the context of face-to-face meetings. This and other capabilities (e.g. supporting collaborative work distributed in space and time) are needed to enhance widespread citizen participation in public decision making, such as land use planning, and to bring to a fuller realization the democratic maxim that those affected by a decision should participate directly in the decision making process (Jankowski and Nyerges, 2001:4)."

GIS use has expanded in society in the last decade faster than any other information technology. The method of presenting 2D visualization has been gradually extended with presentations that make use of computerized 3D-visualizations (see Batty et al., 2000). 3D visualizations help to give a realistic picture of future changes in landscapes and allow the user to relate information and reality more easily. In this way, participants without any planning experience can easier relate the visualized information to the real world (Maarleveld et al., 2005). Above is summarized by Dias et al. (2003) as follows:

"In an approach where transparency is a key word and where inhabitants and enterprises are involved, high quality mapping of current and future situations is needed, so that, together wit real world information (Multimedia), the people involved can understand the proposed plans and proposed changes. And to be efficient, this new approach had to be built based on a geo-information infrastructure which supports open plan processes and participation."

With the expanding accessibility and usability of GIS, the benefits of GIS for participatory spatial planning become more visible. In this study we are trying to find valid arguments to promote use of geo-visualizations in participatory spatial planning and we will define knowledge gaps that need to be filled in order to optimize the effectiveness of geo-visualizations. To illustrate these arguments we think it is very important to show some 'best practices' on the edge of communication, geo-visualization and spatial planning.

4.3 BEST GEO-VISUALIZATION PRACTICES

Geo-visualization is a field of expertise that is developed and used by several professional actors in spatial planning. We will now introduce some inspiring examples of different ways in which geo-visualizations are used and communicated; these examples illustrate the popularity of geo-visualization in spatial planning. All practices, as will be shown, represent an interactive component of spatial planning by means of geo-visualizations. It is quite interesting to notice the experimental character of all practices. The following practices will be discussed:

1. Experimenting with geo-visualizations for Land and Water Management;
2. Geo-visualizations and participatory planning: learning by doing in five European regions;
3. Virtual Reality in civil engineering;
4. Landscape impact visualization in Dutch oil and gas industry;
5. Helmond Virtuocity: Virtual participation platform in real-time 3D on the Internet;
6. Stichting 'De Nieuwe Kaart van Nederland';
7. Project bureau 'De Nieuwe Hollandse Waterlinie'.

4.3.1 Experimenting with geo-visualizations for Land and Water Management

The Dutch Governmental Service for Land and Water Management (Dienst Landelijk Gebied), together with the National Service for the Implementation of Regulations (Dienst Regelingen), started the GIS-Competence Centre in January 2005. Their goal is to stimulate use of spatial information and knowledge about GIS within the Ministry of Agriculture, Nature and Food Quality and within Provinces. In their spatial projects, DLG uses GIS to analyse the use, quality and future scenarios of green space developments and also for policymaking, implementation and accountability. DLG holds a large amount of geographical data, which are consulted, analysed and visualised with GIS. Visualization can be done through a 2D map or a 3D animation that can be played on every pc. DLG develops Virtual Landscape Viewers; these virtual environments are created to support discussions in the participatory process of design and decision-making in spatial projects. They represent a mix of reality and future in order to understand the visual effects form a specific spatial plan implemented in a local area, it enables users to imagine how the future physical elements, such as buildings or trees will look like and how they will be integrated in the area (Dias et al., 2003).

Figuur 6 A virtual flight over the Groningen-Meerstad study area with intuitive navigation buttons. The layers in pink and blue represent the future changes and can be set visible or not and contain links to (geo) multimedia data. Data management, interface design, user interaction options and the data display are designed according to cognitive design principles (Dienst Landelijk Gebied, 2006).

Elsa Voorsluijs (Project organisation 'Ruimte voor de Rivier) shows the benefits of 3D visualization in an interview with DLG, a free translation: "*For many people it's hard to imagine the consequences of moving a dike. What does it mean for people living or running their business there? A 3D-visualization enables us to show what happens to an area when flooded. That way these people have a clear picture of the consequences related to their personal situation.*" Voorsluijs and her colleague Rob Lambermont both think that this instrument needs to be developed further, from a communication and presentation instrument to a design instrument (Dienst Landelijk Gebied, 2005).

DLG has introduced interactive plan making with the intention that it should result in a qualitative better plan, more understandable and supported by the locals. The process of planning can result in more mutual understanding, trust and involvement than with regular processes. The basic condition of an interactive process is the idea of having a better result, when the knowledge and experience of the participants is used. Within DLG geo-visualization until now is mainly used in the planning process to inform and communicate realistic scenarios and their impact on landscapes and citizens. Furthermore it is used for consultation within the project team during the design phase. It supports the planning process in a more interactive and understandable way and stimulates discussions among the stakeholders. Through interactive planning by making use of geo-visualization DLG aims at mutual understanding, involvement and commitment in order to accelerate the decision-making process. The use of geo-visualization is a search to improve the level of participation by organizing information and interactive planning sessions and to explore the possibilities of the Internet.

4.3.2 Geo-visualizations and participatory planning: learning by doing in five European regions

The New University of Lisbon, Portugal, is known as a key player in geo-information development and participatory spatial planning. In interactive sessions with either community members or school children, the Portuguese government stimulates public participation in spatial issues. Because of their knowledge and experience, Portugal participates in the project '*Participatory Spatial Planning in Europe*', funded by the Interreg IIIC program for regional development. This cooperative project between 5 member states (The Netherlands, Belgium, Portugal, Spain and Poland) and 10 different partners, aims to improve spatial information exchange in participatory regional planning through renewed interactive approaches that make use of geo-visualization. Adopting and adapting state-of-the-art concepts, methodologies, geo-ICT technologies and instruments for geo-visualization and communication in spatial planning processes can achieve this. Currently these interactive approaches are lacking, unknown and un(der)developed in spatial planning, according to the project partners.

The added value of this project is to consolidate existing knowledge and know-how, and to accelerate the transfer and renewal of geo-visualization and communication approaches among diverse regional and cultural settings. In 2007, geo-visualization and communication approaches will be developed and applied in diverse regional and cultural settings of Europe to announce spatial prospects, to present and communicate ideas, policy intentions and plans for redevelopment in a (semi-) realistic manner. The long term impacts of this project are a substantial acceleration in the implementation of democratic policy intentions and an improvement in the effectiveness of policies by using new concepts, methodologies and instruments to support participatory spatial planning. Furthermore, re-enforcement of community involvement and responsibility of citizens and governments will be realized, as well as improvement of public support concerning regional development. At this moment, these impacts are already visible. As a result, new ideas are developed by partners to enhance citizen-government interaction and to reach out to a new target group, the general public. Examples of these new ideas are to create a handbook containing best practices, to use Google Earth as a web basis for an interactive platform and to let secondary school children participate in planning issues by 3D-viewers. Remarkably, the PSPE project so far has generated responses by itself. People using 3D visualizations are seeing direct benefits resulting in application of these methods in various contexts.

For more information on PSPE: www.pspe.net.

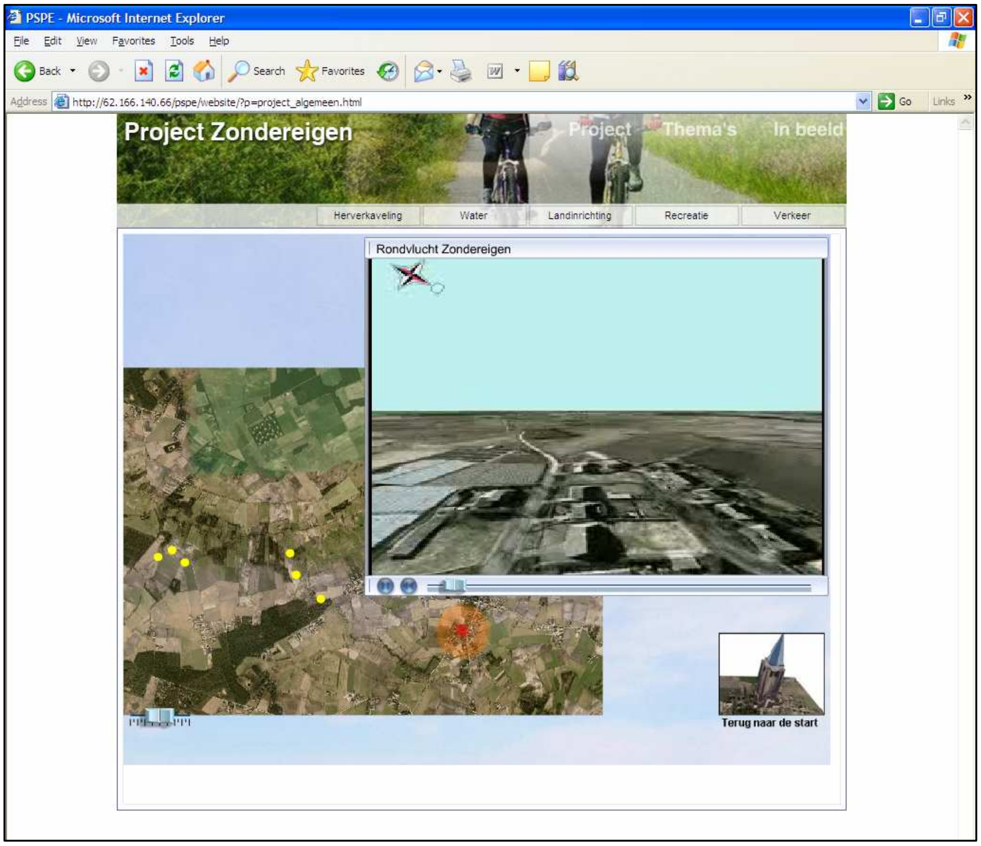


Figure 7 Example of an interactive website developed by the Belgian partners of PSPE. With this website, the Vlaamse Land Maatschappij presents factual information about the land consolidation project 'Zondereigen' with special attention to different themes such as agriculture, nature, recreation, water, cultural heritage. Most impressive however is the role the image takes on this website. By means of a video, a photo archive, photo simulations and geo-visualizations the website visitor is guided along the project location. Furthermore, the website offers possibilities for participation and consultation of the website visitors. (At the moment of publication the website is still under construction at the Vlaamse Land Maatschappij).

Figuur 8 In the city of Barreiro (Portugal), citizens can give comments on issues concerning their living environment. The recorded sound files stay attached to a specific geographical area. The system stores the information and later the messages can be listened and interpreted. First results:
- People are easily involved and show interest in using the tool to leave their comments;
- The municipality has answered to complaints left by citizens;
- Young citizens have been successfully involved;
- Older people can understand the proposals easily;
- The tool allows people to have a better understanding of the scale of some problems (PSPE, 2005a).

4.3.3 Virtual reality in civil engineering

Rijkswaterstaat, the Dutch Directorate-General of the Ministry of Transport, Public Works and Water Management, increasingly uses virtual reality to shape, design, discuss, calculate, present and to communicate about engineering projects. According to the organisation, the design and decision potential of virtual reality is enormous but yet quite fallow within governmental organizations due to the impression among certain groups that virtual reality is expensive and complex. In their report on virtual reality, Rijkswaterstaat discusses the visual added value of virtual reality applications in civil engineering. Being a governmental service that deals with large infrastructural projects that affect many actors, the organization is a key actor in promoting participatory planning. For this reason, we consider the added values discussed underneath as crucial for spatial planning in general. Rijkswaterstaat distinguishes four virtual reality functional areas: communication, design, realization and simulation. Every group has its special added values that are described below (Rijkswaterstaat, 2004).

Virtual reality as a communication tool

- Use of virtual reality decreases the length of public participation procedures and public information: fewer petitions are presented and more social support is obtained, just as better argumentative comments. This makes the decision-making process more efficient and faster.

Virtual reality as a design tool

- Commitment in the early stages of a planning process is crucial; this is acquired through virtual reality.
- Interpretation differences disappear because of the transparency of the process: an unambiguous image evolves; connection between physical objects is easy to see and to assess.
- Design errors are discovered in an early stage and visualization changes the design process into an integrated iterative process.

Virtual reality as a realization tool

- The added value of virtual reality becomes bigger when models used in the design process, are used in realizing the project in combination with GIS and GPS.

Virtual reality as a simulation tool

- By simulating new traffic situations one can evaluate road safety in advance.

Other added values

- Virtual reality contributes to corporate reputation.
- Virtual reality contributes to better communication on the longer run.

4.3.4 Landscape impact visualization in Dutch oil and gas industry

The NAM, Nederlandse Aardolie Maatschappij B.V., (50% Shell, 50% ExxonMobil) is the largest gas producer in The Netherlands. NAM's core activities are exploration and production of oil and - especially - natural gas in The Netherlands and at the Dutch part of the Continental Shelf. About half of NAM's annual gas production comes from the large

Groningen gas field. The other half is produced from several dozens of small gas fields, both onshore and offshore. During the whole process NAM expressly takes into account the interests of all people concerned. The safety of staff and those living nearby and care for the environment are important values for the company.

In the Assen headquarters, NAM uses a large concave screen presenting 3D visualizations to study problem areas. The virtual landscape is built from aerial photographs and vector data. A GIS database contains the outlines of houses, centrelines of roads, etcetera, which are automatically added to the landscape. Together, this forms a very recognisable, realistic 3D visualization that is used internally for project meetings but also externally in public meetings to present and to investigate the consequences of putting a drilling rig in residential areas. In these external meetings with either citizens or governmental organizations, the visualization tool is presented on a regular screen using a laptop and beamer; the system thus is very portable. Through interactive steering, people can fly or drive a virtual camera through the landscape. They can view alternative scenarios by shifting 3D objects onscreen during meetings, for example replacements of drilling locations or different pipeline colours.

Why does NAM pay that much attention to geo-visualizations? Firstly, as indicated by Reinier Treurs (head External Affairs), geo-visualizations are useful in projects where location matters, for instance in residential areas. If this is the case, for example around the village of Schoonebeek (in the Northern Dutch Province of Drenthe) where about twenty drilling locations and a big plant are to be redeveloped, NAM uses geo-visualizations to create understanding and to address fears and scepticism among citizens, for example about the often feared subsidence of the soil. Secondly, NAM uses geo-visualizations as a tool to obtain social acceptance. *"When people experience the spatial changes in its context on the screen, a frequent reaction is that the impact on landscape isn't as severe as expected,"* says Martin van der Voet (Geomatics). Lastly, Reinier Treurs considers geo-visualizations as a logical move forward in external communication; whereas fixed movies or PowerPoint presentations serve as a presentation tool, geo-visualization tools are designed to anticipate on users' involvement by lending themselves to the purpose of interacting with the image.

4.3.5 Helmond Virtuocity: Virtual participation platform in real-time 3D on the Internet.

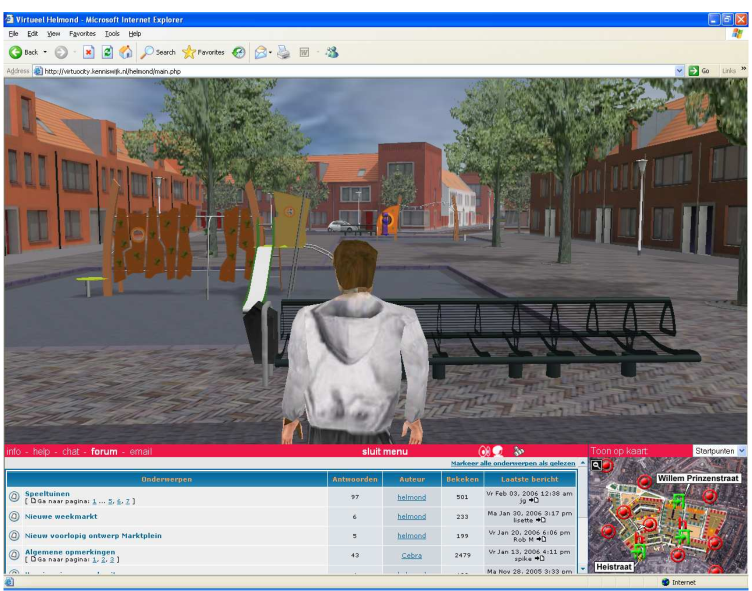


Figure 9 *Helmond Virtuocity: Walk around in your future neighbourhood and discuss plans with other residents and the local government (http://virtuocity.kenniswijk.nl/helmond*)

A large part of the city centre of Helmond is available in the form of a very realistic virtual reality environment, Virtuocity. Everyone with an ADSL of broadband Internet connection can visit it: Walk around in the streets of the town; step on a bus for a 'guided tour'; chat with other visitors that are online; and give their opinion on different subjects like housing programs and design of public spaces. This 3D district on the Internet is said to be a major success. This is not an opinion shared only by the residents of Helmond, but also by many people outside the town. Thousands of visitors have already been able to take a realistic look at the past, present and future of a part of Helmond current being redeveloped. In certain cases, it is even possible to walk around inside the buildings to explore the interior and view from the windows.

Virtual Helmond is increasingly offering residents a platform for their ideas and opinions. "*Virtual Helmond has been implemented for local residents and of course for anyone else interested in developments in the district. We want to find out what people think of the latest developments in the area. As a result, we are encouraging people to contribute their thoughts. That certainly applies for town centre residents – after all, it is their neighbourhood where the changes are constantly taking place*", explained Bauke van der Berg, project leader of Virtual Helmond. According to him, it is an excellent tool for improving public involvement in municipal plans. "*Anyone who wants to can "visit" the area, and see how it is going to look like in the future. You can also see how certain parts of the town used to look, and their current status. In other words, an all-round picture of the buildings as they used to be, in their current condition, and what will be put in their place, in the future.*"

Visitors to the virtual district can also put their questions and opinions to representatives of the municipal authorities. Recently, for example, chat sessions were held with aldermen Ruud van Heugten and Kees Bethlehem. There are also opportunities for participating in online polls, and everyone can share their opinions in the forum. In this project, the Municipality of Helmond worked together with Cebra B.V., a Dutch Company in Eindhoven that developed the technology behind Virtuocity. 'Kenniswijk' subsidized the project. The technology of the Virtuocity is recently also picked up by the municipality of Apeldoorn, be it in a somewhat different approach. The platform can be suitable for many different applications, ranging from communication tool for (urban) development to computer games. Visit http://virtuocity.kenniswijk.nl/helmond for more information.

4.3.6 Stichting 'De Nieuwe Kaart van Nederland'

Google's new, free web GIS environment 'Google Earth' offers an enormous amount of geo-information in an attractive and usable, accessible way. Google Earth realizes a synthesis of information, communication and location and introduces with that a new era in geo-informatics (Gemeente Apeldoorn, 2005). Private companies take up the potential of Google Earth very quickly: since beginning of December 2005 it is possible for potential buyers to check house locations on Google Earth. A part of the database of Funda.nl is available on Google Earth and helps potential buyers to locate houses of their interest. Users can navigate with the Google Earth infrastructure to any place in the country to locate houses. With a single glance one can relate the house location to the neighbourhood, the accessibility, the surroundings, etc.: factors potential buyers are interested in (see http://beta.funda.nl/googleearth.asp).

Not only private companies anticipate on this new development; both the general public and professionals have a need to get a clear overview of planned spatial changes, according to the project organisation of '*De Nieuwe Kaart van Nederland*' (the new map of Holland)'. Nirov, the Dutch association for professionals in housing and urban planning, runs this project. Therefore, they developed an interactive web based GIS infrastructure to offer citizens and professionals an overview of complex and layered planned spatial changes (from municipal to national and from nature to urban development) up until the year 2015. Visitors of www.nieuwekaart.nl can download Google Earth and the future spatial plans of the whole country to their computer. Since its launch in November 2005 already 5000 users have downloaded the files. The website also contains an interactive map based on GIS and a discussion forum. The website attracts around 900 visitors a day.

Fascinating about this initiative is the fact that the project organization tries to bring spatial planning to the outside world. It tries to grasp the complexity of Dutch spatial planning in an ordered and user-friendly way. When a citizen wants to buy a new house, he/she will be interested in the plans of the government in the surroundings of the house in the future. This website gives that information. Again, with a single glance one can *navigate and find out* how the surroundings will be influenced in the near future. Speaking of transparency, this is a great example of citizen-government communication. Another interesting facet of '*De Nieuwe Kaart van Nederland*' is the forum that is attached to the website. In an interview with Jan Kadijk from the project organization, it became clear that this forum does not work the way they hoped it would work; people are hesitant to give the first reactions and discussions mainly concern technical problems about getting the data. This is however understandable; the project-organisation '*De Nieuwe Kaart*' collects and presents facts and the website is not the proper place to complain or adhere to the plans presented. This democratic interaction about the plans should be facilitated by the responsible government A trigger for a good forum according to Kadijk is a *common fascination*, which for example becomes manifest in the website for high rise-adepts, www.skyscrapercity.com. When thinking about the interactive platform in the Virtual NL project, this should be taken into account.

4.3.7 Project bureau De Nieuwe Hollandse Waterlinie

'De Nieuwe Hollandse Waterlinie' (NHW) is a grand project under the responsibility of the Minister of Agriculture, Nature and Food Quality. The project bureau NHW, which is under the jurisdiction of Dienst Landelijk Gebied, manages the project. The NHW was a military line of defence from the former Zuiderzee at Muiden till the Biesbosch. The defence weapon of this line was the water, based on an ingenious water management system of floodgates, inundation canals and existing waterways and dikes. The eastern, open landscape of the 85 kilometres long line of defence would be inundated in case of war to protect the western urbane landscape. The NHW was built from 1815 to 1940 but has never been put to practice. Nowadays, the NHW traded its defence function for the functions of historical awareness and regional identity. The NHW is an excellent test case for geo-visualizations and interactive processes because there's a lot of societal and historical interest, commitment by national, regional and local governments and the area is interesting for educational purposes. The case is suitable for experimenting with geo-visualizations (simulating flooding of the floodgates) since there is high availability of geo-data.

At the moment a 3D visualization of the NHW area is developed, this tool is meant as a presentation tool towards the general public and will be exposed at for example visitor information centres. Also, the tool will be placed on the Internet: www.hollandsewaterlinie.nl. Web visitors will then be able to fly, to inundate, to find information and to see changes in landscape with the interactive 3D visualization tool. A next step concerning Internet communication will be to not only offer information but also to create an open space platform to generate new 'local' knowledge concerning the specific location.

In our interview with director Arnold van Vuuren we asked him how participatory methods would fit in the NHW. A range of enthusiastic ideas followed. First of all, there are four concepts that characterise NHW that are *not* discussable:

1. Open (east) versus urbane (west) landscape;
2. Unity (the NHW as one integrated line of defence) versus diversity (the local approach);
3. The historical message: using the robust, old, grey, military structure combined with the scenic and cultural history of the area for a unique development of the landscape;
4. And, social involvement: accessible new functions for water, living, working, recreation and tourism.

Figure 10 Aerial photograph of the fortified town Naarden, part of the Northern Nieuwe Hollandse Waterlinie (www.hollandsewaterlinie.nl)

Figure 11 De Nieuwe Hollandse Waterlinie from North to South (www.utrecht.nl)

Within these four central concepts the local implementation will be far more suitable for discussion and interactivity, according to van Vuuren. The local implementation by municipalities will be more controversial and open for debate and commitment. Several practical cases illustrate this: eastern municipalities get to deal with restrictions on their urban expansion to maintain the open space; in 'De Bloemendalerpolder' new houses need to fit into the NHW concepts; in 'De Bilt' a new function for the former business terrain needs to be found; the 'Fort bij Vechten' is a popular site for recreational activities that will be developed further in accordance with stakeholders; the design and location of a bicycle/pedestrian bridge over the Amsterdam-Rijnkanaal near Nieuwegein asks for citizens involvement; and, more small scale, individual military objects spread along the line located in agricultural parcels need to be revived. In sum, there are many issues around the NHW that ask for public involvement. The NHW program office is currently looking for communicative methods that stimulate this involvement.

The NHW is a program which connects and improves historical identity and contemporary land use. The variety of sites within the HWL will be given extra meaning by either promoting new blue, green of red[2] functions within the existing historical sites. These new functions hire themselves for public participation, according to Van Vuuren. Geo-visualizations can support imagination and discussion about the area by representing the (historical and future) local value as a part of an integrated concept.

4.4 DREAMS AND EXPECTATIONS

We have now introduced a selection of developments and initiatives taken up by private and/or public institutions. Each deals with communication and geo-visualization in its own way: through the Internet to reach a wider public; aiming at improving public participation; aiming at improved understanding and public awareness; and last but not least, bridging a gap between government and citizen. Text (reports, official publications) will serve a subordinate goal, whereas location based images will come to the forefront as images speak for themselves and invite people to give their comments, opinions, experiences, and

[2] Blue = Water; Green = Nature/Landscape; Red = recreation, tourism, housing and employment.

emotions. Furthermore, the availability of the intuitive Google Earth infrastructure will make the realisation of an interactive platform very feasible.

It is to be expected that this trend will expand: the geo-visualization will be the central mean in exploring problem situations from multiple viewpoints in order to contribute to a better understanding between civil, governmental and private actors. Furthermore, the need for location based information (the availability of information by location) will increase, meaning that internal (information source within the organization) and external (information exchange with citizens, companies, politicians, NGO's and other public organizations) communication processes within public sector organizations should be adapted to the use of geo-visualization tools. According to the policy directors at the Mansholt Debate in The Hague, the current use of geo-visualizations is limited and should be expanded.

Discussing the potential of a web based interactive infrastructure with the respondents (see annex 1), they were asked to shine their light on the potential of Google Earth as an interaction tool. The respondents agreed on the benefits of one open standard tool for data exchange and that it is in this respect very wise to connect to big initiatives such as Google Earth or other to be developed infrastructures (ESRI, Microsoft); more involvement and cooperation between the actors involved requires an intuitive infrastructure to exchange data, information and ideas.

The most important lesson derived from these interviews however is the emphasis that needs to be put on communication. A further explanation is required: an infrastructure that is intuitive, accessible, up-speed, attractive and interactive will not be enough. Nor the immersive, realistic geo-visualization in itself will be enough: in a participative process it is extremely important to reflect on and to analyse *the reasoning behind* certain assumptions. This means that professionals should give feedback to citizens or other commentators about what has been done with their comments and contributions. Only when citizens know that they are taken serious and are heard, a form of commitment can be established. Listening however is still a weakness of many planners and politicians, according to our respondents.

Respondents agree that Google Earth can support in creating that understanding, professionals can use the medium to communicate to all actors. Through Google Earth, you could show 3D images and use those to invite people to tell their story. 3D then forms a tool to communicate. In other words, the geo-visualization should *tempt to react* and to *start a creative process* of designing and comparing and should therefore be combined with additional (textual or visual) information about the area involved. Respondents agree that geo-visualizations are very useful tools in all planning phases: from problem definition to implementation. Geo-visualizations are considered as an important medium to communicate contributing to the overall communication processes and realisation of social support in a spatial transition. In sum, geo-visualizations will improve understanding of and involvement in spatial transitions; they will rear qualitative plans since bottlenecks become visible; they will contribute to the process goals in general; and they will speed up the decision making process since cases become much clearer (visualised).

4.5 CONCLUSION

From this chapter we can derive several requirements for an effective use of geo-visualizations in participatory spatial planning. We have seen in this chapter that geo-visualization tools are becoming more flexible and accessible for the general public as well as for professionals. This advances the future use of geo-visualization as a participative method in spatial planning. While current use of geo-visualization is still restricted to serve as a mean to illustrate, visualise and present we are noticing a shift towards more interactive and participatory use of geo-visualizations. This shift is found in various initiatives and ideas from different actors dealing with geographic information such as Dienst Landelijk Gebied, Rijkswaterstaat, De Nieuwe Kaart van Nederland, the municipality of Helmond, the Nederlandse Aardolie Maatschappij and the Nieuwe Hollandse Waterlinie.

However, these best practices almost seem to disguise the fact that skills, knowledge and experience among professional actors in spatial planning is very limited. The main conclusion of the Mansholt debate illustrated this: within the Ministry of Agriculture, Fishery and Food Quality there is still lack of knowledge about the use and power of geo-information. Therefore, by performing this study we contribute to better insight into the possibilities and needs concerning geo-information for participatory spatial planning.

An interactive geo-visualization tool that aims at improving communication between stakeholders and at improving the spatial planning process in general should meet a number of criteria in order for end-users to be tempted to react and to start a creative process, these criteria include:

- Intuitiveness;
- To be used on standard pc's;
- Presenting a transparent picture of both integrated and detailed information;
- Offering an interface to navigate from different angles and to explore different scenario's;
- Presenting a challenging design and appealing to a common fascination of end-users.

To conclude this chapter, an overview of the main objectives for geo-visualizations in participatory spatial planning is given. In sum, geo-visualizations in spatial planning are, according to our team, supposed to:

- Summarize, structure and present spatial plans;
- Enhance accessibility of plans and alternatives;
- Enhance comprehension and insight of the effects of spatial measures;
- Encourage lively discussion and active reflection;
- Discover new ideas, solutions and design defaults on time;
- Support the decision making process;
- And support building trust among actors.

Chapter 5 embroiders on this chapter by presenting infrastructural requirements in order to pursue our goals and to do this in a most efficient way.

5 INFRASTRUCTURAL REQUIREMENTS FOR INTERACTIVE GEO-VISUALIZATIONS

5.1 INTRODUCTION

The previous chapter concluded with an overview of what are, according to professionals, the main requirements for the interactive infrastructure to be developed. Embroidering on this, this chapter aims at giving a more detailed description of the main components to think of when implementing this infrastructure. The main question is: what are the requirements for a (governmental) spatial data infrastructure for deployment of geo-visualization tools in spatial planning? In order to define the requirements for geo-visualization in a Spatial Data Infrastructure, it is first necessary to give a description of the main components of this infrastructure.

5.2 COMPONENTS OF A SPATIAL DATA INFRASTRUCTURE

A spatial data infrastructure (SDI) can be defined as a collection of policy, datasets, agreements, standards and knowledge providing a user with the geo-information needed to carry out a task (Executive order 12906, 1993).

The infrastructure concept is closely related to the current practice of public governance in a network setting, with many stakeholders involved in spatial planning and plan implementation. The various stakeholders have different experiences, capabilities and interests concerning geo-visualization. An effective infrastructure facilitates each stakeholder in carrying out a task, and can also contribute to co-operation between stakeholders.

For the purpose of this study, the components of a SDI are re-named as follows:

- *Policy.* The policy component entails the definition of policies that support the role of geo-visualizations in participatory spatial planning. This includes policy guidelines focusing on process quality and process efficiency issues, such as data sharing, information dissemination, decision-making procedures, and the involvement of citizens.
- *Agreements.* Agreements are a necessary component to support transactions within the SDI. Agreements can take the form of an informal understanding and willingness to share and combine forces. Contractual arrangements are a second form.
- *Data (and standards).* The SDI contains data as main content. Standards exist or need to be defined for exchange of data and to transform datasets into geo-visualizations. These standards can be defined at meta-data level or at structural levels (data models and file structures).
- *Technology (and standards).* Technology is an essential component of an SDI. Without appropriate tools, other components cannot be implemented. It should be noted that the purpose of the SDI is not to deploy geo-visualization tools. Instead, these tools enhance the effectiveness of an SDI, and the SDI supports end-users to integrate geo-visualization techniques into their workflows.
- *Knowledge.* In order to integrate geo-visualization techniques in workflows, end-users need knowledge, experience and skills. Users need to train or be trained in handling the other components. Also, the gained knowledge, skills and experiences should be disseminated.

5.3 REQUIREMENTS OF GEO-VISUALIZATION IN A SPATIAL DATA INFRASTRUCTURE

As mentioned above, the main content of an SDI is data. To put into action the use of geo-visualization for spatial planning, the SDI can provide methods for standardisation of the process of geo-visualization and the related data management. Distinguishing the phases in this process can be helpful in assessing the requirements of geo-visualization in a SDI. The phases that can be distinguished during this process are as follows:

- Inventory of the pre-conditions;
- Data acquisition;
- Data storage and processing;
- Presentation of data, communication and collection of feedback.

Note that the last two phases can be iterative, interactive presentation sessions can lead to more data processing and adjustments in the plans and models. Also the different planning phases of a project will require additional data processing and follow-up presentations of adjustments and outcomes of feedback. Underneath the different phases will be explained:

Inventory of the pre-conditions

First step in the technical process of geo-visualization is an assessment of the pre-conditions. Depending on the goals to be achieved and the required level of detail, different platforms can be selected: from Google Earth as global interactive platform for visualization of large-scale projects (fly-over) to a photorealistic, immersive virtual world such as Virtuocity (walkthrough) for smaller scale visualizations. These platforms can both serve as a communication medium for the professionals involved in the panning process, as well as a presentation platform for the public. Questions that should be answered are: What is the level of interaction that is required between the stakeholders on this platform? How are the citizens to be involved, to what extent and during which phases of the planning process? Which data (source data and processed data) is required, and what does this imply for the software and hardware that is needed? What are the costs involved when deploying a specific platform for a specific project? Each governmental organization has its own information systems, developed according to its own needs, and depending on the organisation certain knowledge, platforms and data will already be present and deployable.

Data acquisition

When a suitable platform for communication is selected, GIS reference data (source data) are gathered from available data sources. A geo-visualization will at least need (detailed) aerial photographs as a reference (0.5 – 5m resolution), which can be used in combination with basic topography layers and road maps for orientation. On an Internet based platform, reference data that might be available at the level of third party providers can be 'harvested' from these existing data infrastructures and 'live linked' to the scene, on the basis of WMS or WFS OGC specifications (OpenGIS Web Map Services or Web Feature Services).

The plan data that is already available (in form of sketches, maps, blueprints, designs) can be geo-positioned in the GIS system or used as presentation material. If necessary, extra GIS layers can be digitized from raw data at this stage. Also an inventory of 3D-objects that are already available, such as buildings houses, trees, or other structures can be performed at this moment. For new structures, the material produced by architects involved can be used as input.

Data storage and processing

Data storage

The GIS and plan data that were collected in the previous phase will often have to be converted to the required formats and structures to be used in the presentation and communication stage. Because of the large amount of data that is likely to be used (and generated) during this phase, it is important for an efficient management of all this data to set-up a Spatial DBMS (Spatial Data Base Management System), a database in which the objects can be managed and maintained together with their geographical representation and additional metadata. All objects, whether they are 2D or 3D GIS maps, 3D models, animations, images etc, have a relationship with each other, with a specific geographic position on earth or with a specific moment in time (e.g. in the planning process). These relationships can be managed and maintained in this database system, which will serve as a Content Management System (CMS). Central storage of these objects in a database avoids data duplication, and increases accessibility of the data throughout the projects lifecycle, by the different project divisions and members and by different applications or services. Note: Standards for the storage of geometry of real 3D data do not yet exist; most spatial databases and standards only provide storage mechanisms for 2D data.

The results from interactive design mechanisms used by professional plan makers, and the feedback received from users derived from polls, voting systems for different scenarios and discussions on Internet forums can also be a part of this system. A registration of the actors together with their comments on different scenario's and plans will give the stakeholders a structured registration of the feedback, to support the decision making process.

Tools and knowledge in the construction of geo-visualizations

To be able to and to explore different scenarios by navigating from different angles through and around the planning project, a 3D visualization platform is required. Specialized tools and knowledge are essential at this stage.

GIS data can be used as input for 3D geo-visualizations. These GIS data can be used to put them into a 3D-platform (like Google Earth) of whole of The Netherlands as a topographic background or you can use them into specific 3D-tools (like SketchUp) in which professionals can make sketches and alternatives.

The construction of specific 3D models that are necessary for the geo-visualization is specialized work, and often requires the input of 3D/CAD experts. Though this may seem expensive at first sight these models can be (re-)used throughout the whole lifecycle of a planning project in the different stages (by developers of the project during the design phase, for communication with the public and for promotion of the project. Conversion of data from and to a specific (3D) platform or format and integration with GIS data requires still 'human intervention'. Processed plan data, source data and 3D models can be loaded into 3D visualization software. Individual data layers must be manipulated, adjusting colour, height, scale, position and texture of the objects. Aerial photographs can be combined with digital elevation data such as AHN (Detailed Height Map of The Netherlands) in a GIS to construct a realistic view of the landscape. Predefined fly-routes can be made to help the construction of fly-over movies for presentation, or guide users along a fixed path.

Reducing costs

As mentioned above, manual processing and modelling will often be required during the data modelling. Building upon data structures and existing data management in the organisation will reduce costs in a conversion process. E.g. when a 2D GIS database of a project area in an urban environment is already present, adding information on height and texture to polygon objects, and 3D models (trees, lanterns, etc) to point locations can speed up a conversion from 2D to 2,5D and 3D in a partly automated process significantly. Another example is the research conducted by CycloMedia (producer of cyclorama images, panoramic photographs that give a 360 degree view of the surroundings) to automate the creation of 3D worlds for platforms like Virtuocity (Helmond) from these cycloramas.

Presentation of data, communication and collection of feedback

Web based platform

The web and its protocols should be at the base of the interactive presentation of geo-visualizations, being the standard from an interoperability viewpoint. The fact is that the web as an information system can be continuously extended while preserving its structure, in particular by the recent addition of web services. Publication of sketches, animations, photo's, panoramic views, movies, documents using a project based web platform will allow both involvement and informing of the public, as well as a (restricted access) communication platform between professionals involved in the project.

Web mapping application

An interactive map, be based on a web mapping application, following standard cartographic protocols for the Internet can serve as a communication tool for online editing of sketches by adding points, lines and polygons that can be directly stored in the CMS together with the accompanying (meta) data.

Internet Forum

An interactive Internet Forum, as mentioned in chapter 4, can be a powerful tool to assess public opinions on specific topics or phases of a design process, as long as the content is inviting to discussion. The web platform can provide content in form of polls, propositions and choices of different scenarios to trigger and lead specific discussions. An advantage of polls is that the outcome can easily be calculated in an automated process; in case of open forum discussions one has to be able to deal with many reactions.

3D platform

For the 3D presentation of planning sites, an additional plug-in or web based 3D platform will always be required. Looking at the large amount of data involved, distribution of this data based on streaming technology based on the virtual location of the user, is a big plus. An advantage of Google Earth as a platform for geo-visualizations is (apart from being an easy and intuitive tool with which a considerable amount of people is already familiar) its open structure and the possibility to extend this platform with the addition of extra data layers, annotations and web services (E.g. Funda/Globe Assistant service) based on open standards (XML). The most important source data (aerial photographs, road maps) is readily available for use. Any other additional information, available on the web based project platform, as downloadable 3D structures, in the CMS or anywhere else on the Internet can be linked to the appropriate location (their geographical (XY) location) through a technically fairly standard procedure or web service. An attractive and effective presentation of spatial plans can interact in both directions: the 3D client can be launched from a website or 2D map, and URL's can be viewed from the 3D client either way. Users/citizens can give their comments by adding annotations on the map, which can be shared with the rest of the community.

Summarizing, the technical requirements for geo-visualization in a spatial data infrastructure are as follows:

- A relational Spatial Database Management System (and Content Management System) for the storage of data in a structured and accessible manner, together with the accompanying metadata;
- 3D-Tools for professionals: For conversion from and to the 3D-Platform and GIS-software for easily making of sketches and alternatives in 2D or 3D;
- A readily deployable, Internet based 3D-platform to enhance accessibility of plans, increase insight in the present and future situation of a planning area. 3D platforms based on streaming Internet technology (like Google Earth) in which 2D and 3D files of projects can be imported;
- A web based platform for specific projects for communication with the public, collecting feedback from different actors, presenting dynamic information from the CMS, containing a standard web mapping application for the GIS maps and enabling interaction with the 3D platform.

Above is visualized in the next scheme:

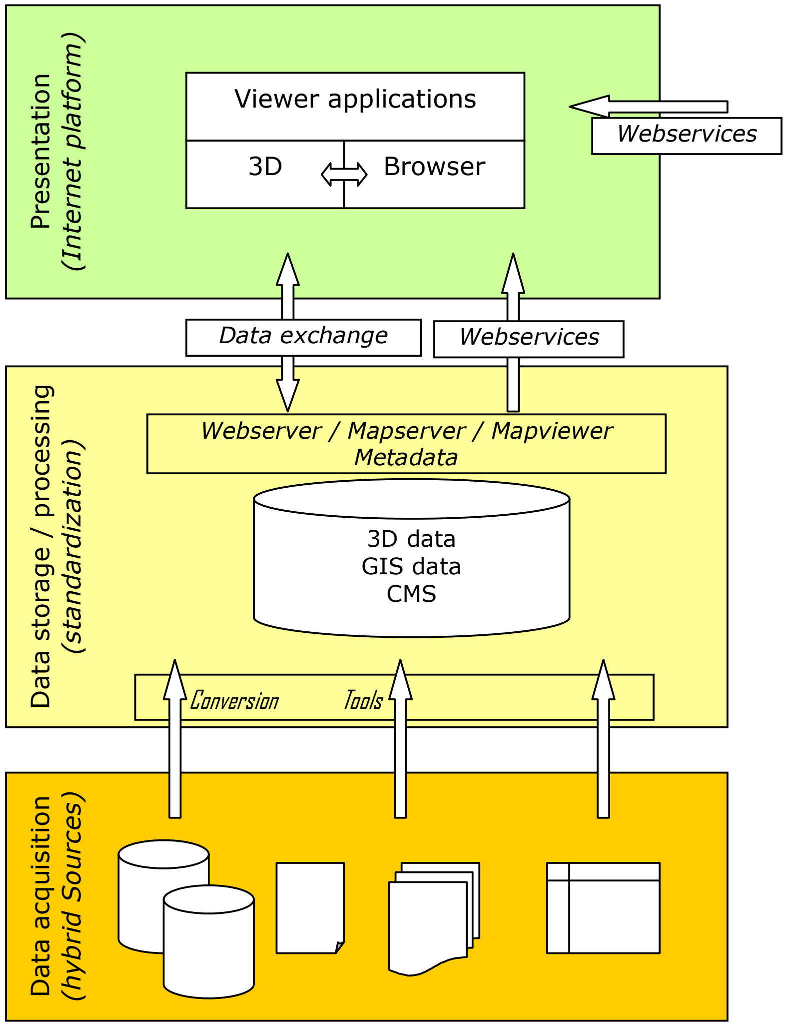


Figure 12 General overview architectural framework geo-visualization

5.4 BENEFITS OF A SPATIAL DATA INFRASTRUCTURE FOR GEO-VISUALIZATION

Looking at the requirements of the different phases in the geo-visualization process one can conclude that, at the moment, most governments will lack the required technical resources and knowledge for setting up their own geo-visualization environment. This is an area in which the project Virtual NL could play a significant role; providing both centralized facilities (Knowledge Transfer Point as described below and in Chapter 6) and decentralized components (such as start-up packages for stakeholders to setup their own geo-visualization infrastructure).

One of the envisioned project results of Virtual NL is the establishment of a 'Knowledge Transfer Point' (KTP). This KTP aims at collecting, sharing and passing knowledge on deployment of geo-visualization tools to be brought into action for spatial transition processes. As a centralized facility, the KTP could provide:

- Knowledge dissemination about geo-visualization in spatial planning and plan implementation;
- Agreements about the interpretation and use of the geo-visualization according to the Participatory Spatial Planning (PSP) framework;
- Standards related to these agreements;
- Policy that supports the role of geo-visualization in PSP (a reasonable next step);

With regard to the (technical) requirements of a spatial infrastructure, the KTP can provide technical guidelines, ICT tools and manuals on the design and realization of an interactive geo-visualization platform. In the form of start-up packages, the KTP can assist in al phases of the geo-visualization process. These packages can consist of datasets that, because of their metadata, can easily be transformed into geo-visualizations. Furthermore, tools for upload and download of geo-spatial data to and from a geo-visualization platform (like Google Earth) are needed. Also, a web platform and/or a Google Earth based web service - meant for various smaller governments that will lack the required technical resources for setting up a geo-spatial web architecture on their own - could belong to the possibilities.

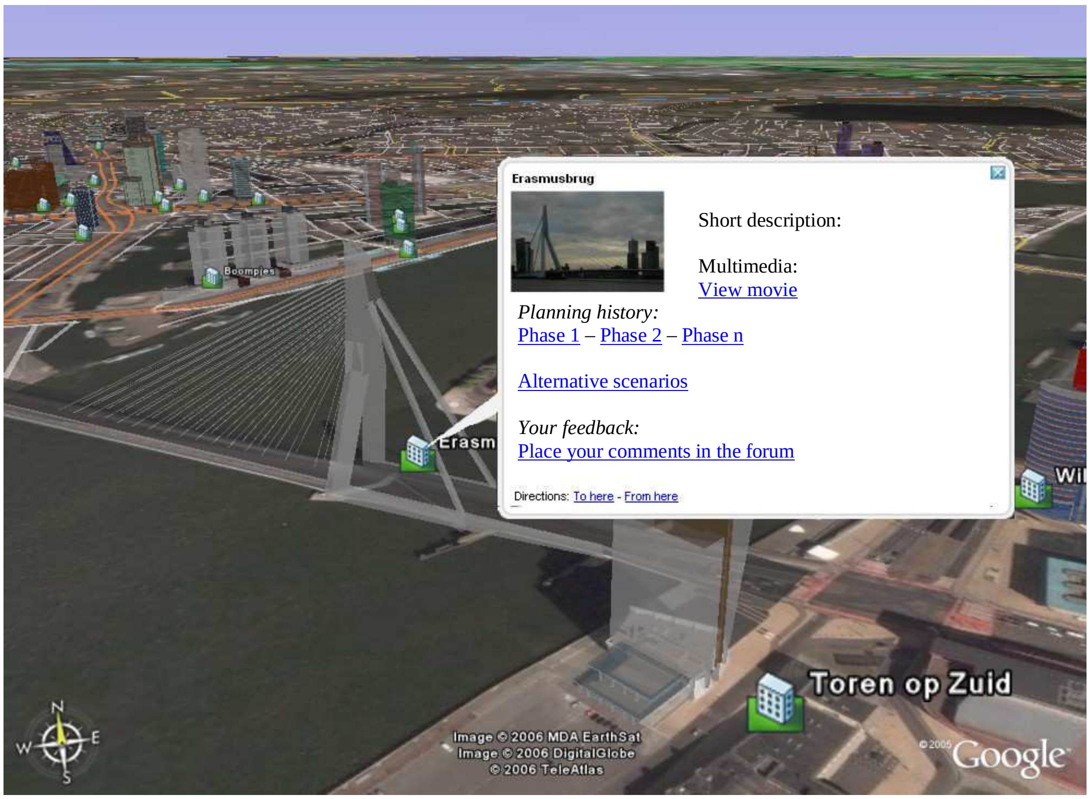


Figure 12 Example interface Google Earth (Models by students at the Hogeschool Rotterdam, 2005)

6 CONCLUSION

6.1 INTEGRATION

The previous chapters have given a broad overview of the social, scientific and technical context in which use of geo-visualizations is beneficial. This study attempts to bridge technical GIS science with social sciences by offering a guide to various social developments, criteria, best practices, technical requirements and research needs. As explained in chapters 2 and 3, a communicative approach - both in practice and in research - to geo-visualization is needed to respond to the need for transparency of policy and implementation in spatial issues. 'Virtual NL' according to the authors represents a way of communicating about spatial plans and scenario's: visual (or broader: sensual), accessible, open for interpretation, intuitive, and stimulating. The initiatives taken so far as regards to geo-visualizations in participatory spatial planning are promising, the authors therefore stress the need for further research on the effectiveness of geo-visualizations in interactive planning and decision-making. To complete this study, some lessons learned and research guidelines are presented in the following paragraphs.

6.2 LESSONS LEARNED: THE IMPORTANCE OF GEO-VISUALIZATIONS

The inherent objective of geo-visualizations in this study is to enhance interactivity between spatial planning actors. In spatial planning the words 'interactivity', 'participation' and/or 'co-decision' seem quite institutionalized. However, planning practice shows that planners, governors, architects and other parties encounter problems in actually involving and using perceptions of citizens or actors. Innovative technological interfaces try to address this problem by visualizing geo-information in order to support communication processes. These interfaces require technical skills, money, and face-to-face interaction settings – barriers that prevent professional staff to apply geo-visualization tools. The Internet may potentially overcome these barriers. More and more organisations use this medium to present spatial information and to gather peoples opinions; a true web based interactive geo-platform to support co-design, planning or (extents of) co-decision on spatial issues however does not yet exist. With the launch of Google Earth, these barriers are to be overcome: The introduction of 'Google Earth' established a worldwide standard for obtaining and sharing geospatial data publicly. Unique for such new information and communication platforms is the combination of worldwide coverage, powerful visualization, intuitive three-dimensional (3D) interfaces and a heavy user oriented approach that enables the user to obtain and exchange geospatial data very easily.

In chapter 2, four key concepts were distinguished: governance, interactivity, information society and social learning. This conceptual framework represents the socio-political context regarding geo-visualizations. Below, we posited a number of important lessons derived from the former chapters; these lessons will again highlight the social and scientific relevance of a 'Virtual NL':

- Geo-visualizations have special meaning for so called interactive, participatory, bottom-up planning issues rather than for top-down planning procedures. This implicates that geo-visualizations are very suitable for spatial projects characterized by an open planning process where multiple actors are to be involved in all planning phases;
- The digital revolution will make the use and further development of geo-visualizations ever more popular and natural. To promote geo-visualizations, we should anticipate on this development by facilitating means and knowledge transfer;
- Applying geo-visualizations is a learning process; skills, knowledge and experience form major barriers. Skills and knowledge need to be overcome by training

professionals (by means of knowledge transfer). Experience needs to evolve gradually, professionals and other actors need to be guided;
- The inventory of best practices shows how much attention is already paid to interactivity and geo-visualizations. This illustrates a need for standardisation of practices and transfer of knowledge about these practices in order to facilitate use and development of geo-visualization tools;
- There is no univocal method to study the effects of geo-visualization on spatial planning. A search for the right combination of methods is needed;
- Before defining the method to study the effects, the effects we wish to study need to be made operational;
- Geo-visualizations are supposed to:
  - Summarize, structure and present spatial plans;
  - Enhance accessibility of plans and alternatives;
  - Enhance comprehension of and insight in the effects of spatial measures;
  - Encourage lively discussion and active reflection;
  - Discover new ideas, solutions and design defaults on time;
  - Support the decision making process;
  - And support building trust among actors;
- Looking at the requirements of the different phases in the geo-visualization process one can conclude that, at the moment, most governments will lack the required technical resources and knowledge for setting up their own geo-visualization environment. This is an area in which the Virtual NL project partners could play a significant role, providing both centralized facilities (Knowledge Transfer Point) and decentralized components (start-up packages);
- Besides Google Earth, it is likely that other such initiatives will rise during the projects timeframe. These developments need to be followed accurately in order to use the most suitable infrastructure.

6.3 RESEARCH AGENDA

To conclude this study, we will present some critical questions that need to be answered to fulfil the 'white spots' in scientific knowledge and to promote practical skills and experience. A transdisciplinary approach to the effectiveness of geo-visualizations is needed in order to establish true impact in participatory spatial planning. This study has been performed to contribute to the institutionalization of geo-visualizations: geo-visualizations from Wow to Impact.

According to the authors, future research should focus on the effects of the new geo-information and communication platforms, which come available by integrating geo-data, the Google Earth platform and specific to-be-developed participation tools. Two research lines are important. First of all, the effect of geo-visualization on actors is an important issue, because this automatically affects the whole planning process (planning and decision contexts). Secondly, the potential of geo-visualization to increase the speed with which people gather and process information needs to be studied (learning contexts). The authors have formulated a set of research questions that could guide future research within these two research lines. The questions are divided into five clusters: infrastructure, methodologies, cognition, social learning and policy & implementation.

Questions regarding infrastructure
- How to make the infrastructure as interesting, attractive and intuitive as possible to reach a large variety of actors and to anticipate most effectively on cognitive and mental processes?
- Which level of abstraction or detail needs to be worked with?

Methodological questions

- Which effects are to be measured?
- Which methods are to be used to define effectiveness of geo-visualization in a spatial planning process?

Questions regarding cognition

- Do participants recognize the virtual environment in the visualization tools?
- Do participants identify the proposed spatial changes in the virtual environment?
- Do participants understand the impact and consequences of these proposed spatial transitions?
- Do participants learn more?
- Do participants enjoy learning more or will they just learn to use a new tool?

Questions regarding social learning

- Do stakeholders perceive such visualization tools as useful for sharing knowledge and ideas about their environment?
- Do stakeholders perceive such visualization tools as stimulating and satisfactory for participating in spatial planning processes?

Questions regarding policy and implementation

- Do geo-visualizations contribute to a more cost-efficient procedure?
- How to deal with increased (digital) data, which will follow from the interactive geo-visualization platform?
- What are critical success factors to reach out to the general public?

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ANNEXES

ANNEX I RESPONDENTS

Respondent	*Organisation*
R. Kramps	Provincie Noord Brabant
A. Ligtenberg	Alterra - Wageningen UR
J. de Kroes	WING Proces Consultancy /Mapcom Support Wageningen UR
S. Verhagen	WING Proces Consultancy /Mapcom Support Wageningen UR
Prof. Dr. C. van Woerkum	Wageningen Universiteit
J. Kadijk	De Nieuwe Kaart van Nederland
A. van Vuuren	Programmabureau Nieuwe Hollandse Waterlinie
B. van der Berg	Project Leader 'Virtual Helmond', Gemeente Helmond
Wilfred Veldwisch (Geomatics)	Nederlandse Aardolie Maatschappij (NAM)
Martin van der Voet (Geomatics)	Nederlandse Aardolie Maatschappij (NAM)
Hans Ardesch (Land and Lease)	Nederlandse Aardolie Maatschappij (NAM)
Reinier Treur (Hoofd External Affairs)	Nederlandse Aardolie Maatschappij (NAM)

ANNEX II INTERVIEW GUIDE (DUTCH)

1. Introductie: functie,organisatie

2. Betrokkenheid met geo-visualisatie omschrijven

3. Ons uitgangspunt: Geo-visualisatie tools leveren een kwaliteitssprong in communicatie en interactie over ruimtelijke planning in Nederland. Vooral de introductie van Google Earth biedt vele mogelijkheden.

   Deze sprong wordt gemaakt door:
   a. Transparantie te vergroten (participanten krijgen een uniformer beeld);
   b. Meer betrokkenheid bij het proces (drempel tot deelname wordt verlaagd);
   c. Vergrootte transparantie en betrokkenheid leidt tot meer inzicht en begrip in ieders positie en wensen;
   d. Meer tevredenheid over het eindresultaat;
   e. Betere afstemming van beleid doordat meerdere beleidsvelden integraal getoond kunnen worden.

   Het speelveld van ruimtelijke planvorming wordt gekenmerkt door:
   a. Verschuiving binnen de overheid van government naar governance.
      Binnen overheid veranderende rollen in verschillende lagen (overheid, provincie, gemeente) en tijdens het proces ook andere rollen.
   b. toenemende complexiteit (schaarste ruimte, meer claims)
   c. Meer technische mogelijkheden (3D, computers, data, tools etc) en de kracht van verbeelding.

Onderwerpen voor interview:

A. Veranderende overheid (afhankelijk van geïnterviewde een beeld vragen wat en hoe ze dit ervaren).

1. Veranderende rollen van verschillende partijen? Welke ontwikkelingen ziet u en hoe beoordeelt u die? Actoren zijn: Nationale overheid, Provinciale overheid, Gemeenten, Burgers, boeren en buitenlui, Derden die service leveren m.b.t. planvorming.

2. Hoe wordt betrokkenheid diverse partijen beoordeeld?

3. Welke groepen actoren dienen meer betrokken te geraken bij de planvorming?

4. Wat zijn belangrijkste knelpunten/ drempels voor de geringe betrokkenheid (denk aan vertrouwen, kennis, invloed, techniek, tijd, geld….)

5. Wat bepaalt momenteel in uw ogen de kwaliteit van de communicatie over planvorming en interactie tussen partijen in planvorming.

B. Rol geo-visualisatie

1. Gebruik geo-visualisatie: huidige en mogelijke rol in toekomst

2. Aan welke eisen moet systeem voldoen om de toekomstige rol te kunnen spelen? (3D, animaties, gebruikersvriendelijkheid (en wat houdt dit in), kosten voor gebruik, benodigde kennis voor gebruik, benodigde techniek voor gebruik)

3. Wat zijn in uw ogen de voordelen die verkregen worden als er een geo-visualisatie systematiek beschikbaar komt die aan de gestelde eisen voldoet?

4. Wie zijn de gebruikers van de geo-visualisatie producten?

C. Gebruik van Geo-visualisatie

1. Voor welk(e) doel(en) zou je Geo-Visualisatie kunnen en willen inzetten (uitgangspunt is dat aan de gestelde eisen is voldaan) Voorbeelden van doelen zijn: Demonstratie, presentatie en planvorming.

2. Ziet u een bepaald groeipad voor gebruik Geo visualisatie (zo ja welk en waarom?)

3. Hebt u bepaalde wensdromen?

D. Elementen /eisen aan geo-visualisatie tools

- Gebruikersvriendelijk (wat verstaan we er onder, elementen)
- Beschikbaarheid (via www, voorwaarden)
- Prijs
- Inzetbaarheid in verschillende fasen van plan- en besluitvorming (van grof naar detail invulling)
- Werken volgens een uitgekristalliseerde standaard/ of vrijheidblijheid

E. Stellingen (schalen van sterk oneens, oneens, neutraal, eens, sterk eens)

1. Het beschikbaar komen van geo-visualisaties via communicatie platforms zoals Google Earth zal de kloof op het terrein van regionale planvorming tussen de boven- en onderlaag in de samenleving vergroten doordat de bovenlaag in staat gesteld wordt via deze weg een substantiële inbreng in de besluitvorming te leveren en de onderlaag niet.
2. Door geo-visualisatie wordt een eenduidiger beeld verkregen van ieders wensen waardoor het onderlinge vertrouwen toeneemt.
3. Geo-visualisatie verbetert afstemming tussen verschillende beleidsvelden door alles in een plaatje te presenteren.
4. Geo-visualisatie verbetert de kwaliteit van de inhoud van plannen.
5. Geo-visualisatie verhoogt de snelheid van beleidsvormingsprocessen doordat een eenduidig integraal beeld ontstaat bij alle betrokkenen.
6. Geo-visualisatie komt in de plaats van rapporten (nu rapport met kaart, straks 3d Visualisatie met gesproken toelichting).
7. M.b.v. geo-visualisatie zijn overheden in staat om hun plannen beter te presenteren.
8. M.b.v. geo-visualisatie zijn overheden in staat “de burgers” in de planvorming te betrekken.
9. 3D visualisatie is een effectief middel in het kader van ruimtelijke plan- en besluitvorming (doelbereik).
10. 3D visualisatie is een efficiënt middel in het kader van ruimtelijke plan- en besluitvorming (kosten/opbrengstverhouding i.v.m. alternatieven).