The suitability of visualisations with a different degree of realism for participatory spatial planning

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Abstract

Participation of several actors, including citizens, public organisations, and private enterprises in spatial planning is becoming a common way of dealing with complex planning issues. Participants can be involved in the planning process with a different role and amount of influence, which is determined by the participation level. At these different participation levels, spatial information is exchanged between the participants. Recently, 3D computer-generated visualisations are being introduced to facilitate the information exchange about spatial transformations in rural landscapes. However, the necessary degree of realism of visualisations to exchange this information at different participation levels has so far been neglected in research.

This research focuses on professionals' preference for realism of visualisations for participatory spatial planning. In this research, an Internet survey was conducted with planning supporting professionals such as landscape architects, landscape planners, and GIS experts. In the survey, three visualisation types were used with a varying degree of realism. Professionals had to value the suitability of these visualisation types for four different types of use. They also had to choose one visualisation type as most suitable at the different participation levels. The results of the survey suggest that the semi-realistic and realistic visualisation types are highly suitable for use types such as analysis, design and presentation. Furthermore, the results suggest that semi-realistic visualisations type is highly suitable at most of the five participation levels that were used in the survey.

Keywords: Landscape visualisation, Public participation, Communication, Realism, Virtual landscapes.

1. Introduction

The landscape is pressured by space demanding urban functions such as housing, business, recreation, and traffic. Therefore, the integration of all these claims in the same landscape leads to complex planning issues. A common way of dealing with these issues is to invite citizens, public organisations, and private enterprises to participate in the planning process (Webler, Tuler & Krueger, 2001). Professional planners consider their knowledge and experience, and that of other participants, important for successful realisation of landscape transformations (Bryner, 2001; Klijn & Koppenjan, 1999; Luz, 2000; Roe, 2000). The involvement of the participants greatly influences the consensus and support for the proposed transformations and the way information is communicated during the process (Appleton & Lovett, 2005; Moote, Mcclaran & Chickering, 1997; Shepherd & Bowler, 1997). The role and influence of participants in the process is characterised by the level of participation that is practised (Arnstein, 1969; Dalal-Cayton & Dent, 1993; Edelenbos, Monnikhof & Galesloot, 1998; Rowe & Frewer, 2000).

Several visualisation methods have been used the last decades to disseminate the type and impact of spatial transformations of the landscape to participants (Appleton, Lovett, Sünnenberg & Dockerty, 2002; Orland, 1994; Tress & Tress, 2003). Nowadays these visual representations are increasingly generated by geographic information systems (GIS), which offer the opportunity to visualise two-dimensional (2D) geo-data in a three-dimensional (3D) way. The technology to construct realistic 3D visualisations has increasingly improved over the past twenty years in contrast to the knowledge about when and how to use these realistic visualisations in the planning process. Realism of visualisations is an important subject for research because of the influence realism can have on participants' perception, opinion and decisions about the planning issue involved (Appleton & Lovett, 2005; Ervin, 2001; MacFarlane, Turner, Stagg & Lievesley, 2005; Perkins, 1992; Sheppard, 2001; Slocum, et al., 2001). Depending on the participants' nature and participation level, the information type and intensity that is provided to participants should determine the degree of realism of visualisations.

Preceding research related to participation levels results in several participation ladders, in which the participants' involvement strongly varies (e.g. Arnstein, 1969; Burke, 1979; Dalal-Clayton & Dent, 1993; Edelenbos, Monnikhof & Galesloot , 1998; Pröpper & Steenbeek, 1999; Rowe & Frewer, 2004; Wiedemann & Femers, 1993). Together with the participants' role and influence, the communication protocol and information exchange also changes. Rowe and Fewer (2000) describe how the lowest levels are characterised by top-down communication and a one-way flow of information, while the higher levels aim at dialogue and two-way information exchange. The majority of participation ladders consist of four to seven participation levels that can be used depending on the planning situation and the decision context.

Preceding studies on realism mostly focus on “whether, how and to which degree” (Lange, 2001) computer-generated visualisations can validly represent real environments (e.g. Bergen, Ulbricht, Fridley & Ganter, 1995; Bishop, Ye & Karadaglis, 2001; Bishop & Rohrmann, 2003; Daniel & Meitner, 2001; Oh, 1994; Orland, 1994). Other studies investigate the perceptual judgments on less realistic visualisations such as wire-frame and simple surface models (Bergen, Ulbricht, Fridley & Ganter, 1995; Oh, 1994). Recent studies related to realism of visualisations indicate that particular environmental features may need more realistic presentation by computer-generated visualisations in order to give viewers a good idea of the visualised landscape (Appleton & Lovett, 2003; Bishop & Rohrmann, 2003).

In one of the few studies about realism in visualisations for participatory spatial planning, Al-Kodmany studies the use of visualisations with a different degree of realism in different phases of the participatory process (Al-Kodmany, 1999, 2001, 2002). Al-Kodmany (1999) argues that photo-realistic visualisations can be effective tools to inform citizens. The reason is that these visualisations are a very close representation of reality and participants need little interpretation to understand this information (Al-Kodmany, 1999; Sarjakoski, 1998). Using such realistic visualisations 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 visualisations can also overload citizens, which will make focusing on specific issues more difficult in the later process (Al-Kodmany, 1999).

Although Al-Kodmany indicates some advantages and disadvantages of realism of visualisations related to the planning phase. No research, however, focuses on the relation between the degree of realism and different levels of participation. Knowledge about this subject is needed to avoid the dissemination of unintentional misleading messages to participants in the planning process. Dissemination of such messages can result in unfocused design discussions, undeserved expectations of participants, expensive and unchangeable planning decisions (Al-Kodmany, 2002; Appleton & Lovett, 2005; Sheppard, 2001). These consequences can seriously damage the participants' support for and involvement in the whole planning process.

The aim of this research was to study professionals' preference for realism of computer-generated 3D visualisations for participatory spatial planning. We assumed that professionals' preference for realism in the visualisation types varied according to different types of use and different levels of participation. In this research, planning supporting professionals such as landscape planners, landscape architects, and GIS experts were studied as one group of participants in a spatial planning process. The research aimed at professionals, because they take the initiative to start up planning processes. Secondly, professionals mainly select the techniques that are used to communicate spatial information about landscape transformations to all participants involved.

2. Materials and Methods

An Internet survey was developed to measure professionals' preferences for realism of visualisations for participatory spatial planning. In this survey, three types of 3D computer-generated visualisations were used with a different degree of realism. Professionals had to value the suitability of these visualisation types for four different types of use such as inventory, analysis, design, and presentation. They also had to choose one visualisation type as highly suitable for each participation level. We used the participation ladder of Edelenbos et. al. (1998), who defined five participation levels that are called informing, consulting, advising, co-producing, and co-deciding. In the survey, these five participation levels were formulated into five case situations (fig. 1). The levels of Edelenbos et al. (1998) are derived from the participation ladder of Dalal-Clayton and Dent (1993). The Dutch National Council for Agricultural Research (NRLO) adapted this ladder for the Dutch planning process, because these participation levels are originally identified for spatial planning processes in developing countries (Twist, ten Heuvelhof & Edelenbos, 1998).

Informing level:
This level is the lowest level of participation. In this level, no specific participants are targeted and communication with involved participants occurs in a one-way flow.

Case situation:
Imagine that you are showing the participants of Meerstad the definitive plans for a future situation. The participants do not have any knowledge about the plans and this is the first time they will see the future situation. Select the image that you think is highly suitable for this situation.

Consulting level:
In this level, participants are used for information gathering. Via interviews and surveys, professionals gather information about problems in the area that need to be solved.

Case situation:
Imagine you want to show the current situation of Meerstad to inhabitants during a meeting. By showing this visualisation you hope to gather information about the current spatial problems in the area. Select the image that you think is highly suitable for this situation.

Advising level:
In the advising level, participants are able to put forward problems in the spatial environment and are able to think and talk with the policy-makers about possible solutions.

Case situation:
Imagine a spatial plan will be created for the area under study. You want to show the area to all participants involved in the spatial planning process. The participants involved are allowed to point out in the visualisation which elements in the landscape they would like to change. Select the image that you think is highly suitable for this situation.

Co-producing level:
Co-producing refers to the ability of different groups of participants to develop together several scenario based alternatives for a future situation.

Case situation:
Imagine you want to develop, together with other participants, a spatial plan for the area under study. By means of the visualisation, you want to develop scenarios for the future situation. Select the image that you think is highly suitable for this situation.

Co-deciding level:
Co-deciding is the highest level of participation. In this level, participants control the development of plans (scenario based) and make decisions while the governing bodies fulfil the role of advisors.

Case situation:
Imagine you want to show two scenarios for the area under study to the participants involved. The participants will chose one of the scenarios for further elaboration. Select the image that you think is highly suitable for this situation.

Fig. 1. Description of the participation levels and the case situations.

Study area

The study area for this research is located at the east side of the city Groningen, the Netherlands (fig. 2). This area is also known as Meerstad, in which several outstanding landscape transformations are planned for the coming years. Meerstad covers an agricultural area of 4000 hectares, and the objective is to develop a new town of 10 000 houses and a lake of 650 hectares for recreational, water buffering and storage purposes. In the three visualisation types, the same location in the Meerstad area was visualised in its current situation (fig. 3).

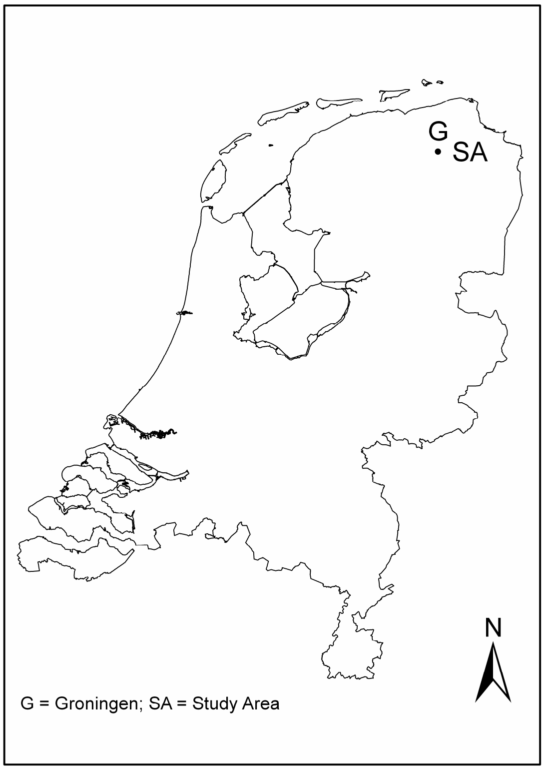

Fig.2. Location of study area in the Netherlands.

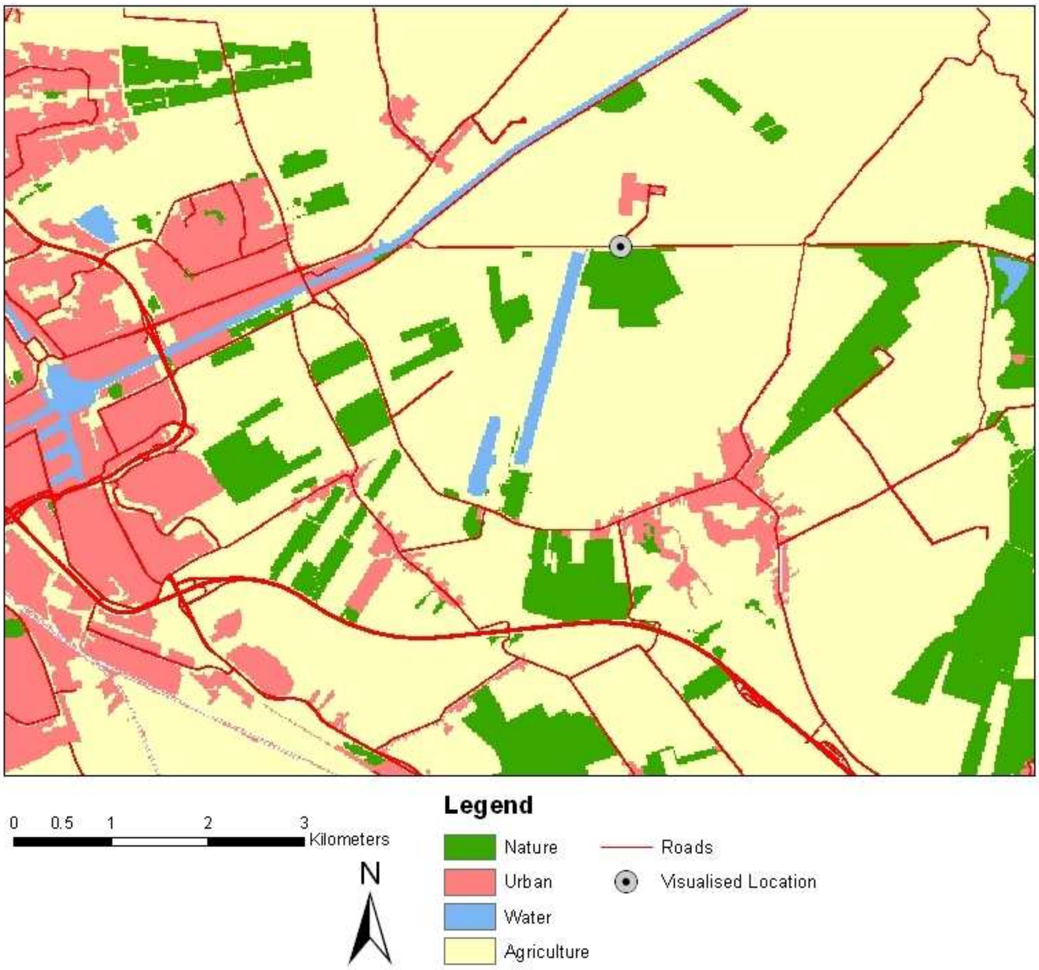

Fig. 3. Current situation of Meerstad (2003) and visualised location.

Data and Visualisations

Dutch National topographic data (scale 1:10.000) of the Dutch Land Registry Office (Kadaster) was used to construct the visualisations. Furthermore, a conceptual landscape design of Meerstad, created by the Government Service for Land and Water Management (DLG), and digital photographs that were taken in the study area were used to visualize the current location in Meerstad. Three visualisation types represented the real world with a varying degree of realism, which was determined by the capabilities of the software used for each visualisation type. The representations were called: abstract, semi-realistic and realistic. All three visualisation types presented the landscape from a fixed point of view, from an eye-level of 1,80 metres, and with the opportunity to spin 360 degrees. The visualised scenes covered an area with a radius of 0,5 kilometre around the selected location in the Meerstad area.

The abstract visualisation type corresponded with the degree of realism of a standard 2D topographic map (fig. 4.). In this visualisation type, the real world was three-dimensionally represented by a 3D scene (Lammeren and Hoogerwerf, 2003). The scene was constructed by extruding simple geometric objects and using elementary colours. The location of solitary trees was not always included in the dataset. For that reason, only clusters of trees were visualised by extruding geometric objects. The scene of the abstract visualisation type was mainly created with the 3D Analyst extension of ArcView (ESRI). Afterwards, the scene was imported into 3D StudioMax (Discreet) via the Virtual Reality Modelling Language (VRML). In 3D StudioMax, several lights (omni-spots) and an animated camera (2400 frames with 30 frames/sec) were added. The same methodology was used to create the semi-realistic visualisation type (fig. 5). In addition to the abstract visualisation type, processed digital photographs (bit-maps) were used to texture the geometric objects and the surface of the topographic data. The third visualisation type showed a photo realistic view on the environment of Meerstad based on panoramic photographs (fig. 6). This visualisation type was constructed by manipulating and stitching digital photographs with PixMaker Pro (PixAround).

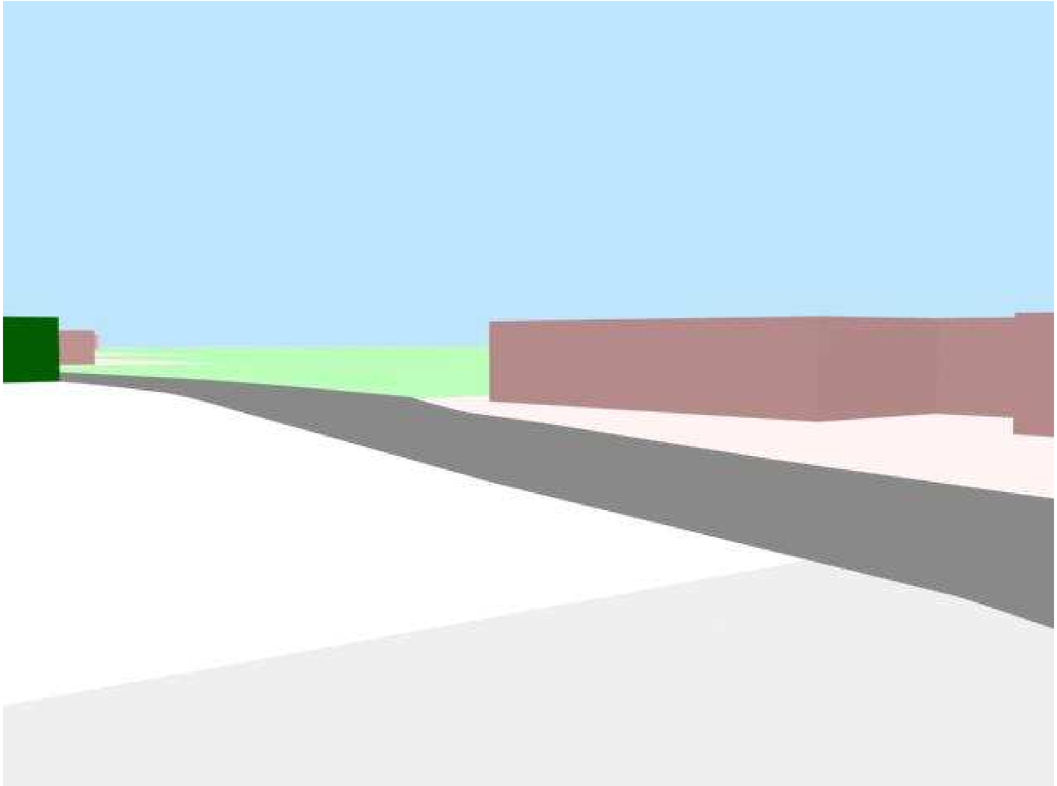

Fig. 4. Abstract visualisation type.

Fig. 5. Semi-realistic visualisation type.

Fig. 6. Realistic visualisation type.

Survey

The survey was made available as a web-application and distributed through the Internet. The Internet was chosen as a medium because of its ability to reach many respondents independent of location and time, its ability to process the replies automatically, and its successful use in previous research projects (Appleton & Lovett, 2003; Bishop, 1997; Bos et al., 1998; Wherrett, 2000). The survey consisted of questions that could be answered independently of each other. The formulation of the questions was based on preceding research on visualisations of Bos et al. (1998) and Kraak (1988). The abstract and semi-realistic visualisation types were presented via a small animation of avi-format while the realistic visualisation type was presented through the panorama viewer Pix Around (PixMaker Pro).

The survey was distributed amongst three partners that were involved in the National project “Panorama Landstad”. Project partners were the Government Service for Land and Water management (DLG), Free University of Amsterdam (VU), and Wageningen University and Research Centre (WUR). Professionals like landscape architects, landscape planners, and GIS experts were approached for this survey. All the respondents worked on local working stations and the results of the survey were submitted to a Microsoft Access database. In total 87 people were contacted to take the survey. The result was an average response of 27,5% people over the different questions of the survey. Some respondents were unable to answer all questions of the survey due to problems with intranet systems, firewalls, and loading and playing the visualisations.

3. Results and Discussion

As each respondent completed the web-based survey, the results were stored in a Microsoft Access database and analysed in Microsoft Excel. The survey response for the different questions varied between 45 and 21 professionals. In the survey, professionals valued the suitability of the visualisation types for different types of use. They also choose one of the three visualisation types as suitable at the five participation levels defined by Edelenbos et al. (1998). The most important results of the questions will now be discussed.

Suitability for types of use

The respondents were asked to value the suitability of the three visualisation types for four types of use. They could value this suitability on a scale from not suitable (1) to highly suitable (5). The question included the use types of inventory, analysis, design, and presentation. These types of use were described as followed: inventory is the identification of problem areas in the area under study; analysis deals with the comparison and interpretation of a current and future situation; design means changing the current situation by scenario-based alternatives; presentation is the information exchange about spatial transformations to participants at each participation level.

Table 1 shows the results of the visualisation types for the four types of use. We analysed the results for these four types of use by comparing the balance between not suitable and highly suitable. For the realistic visualisation type, the results indicated that this visualisation type is highly suitable for all the four types of use. Professionals valued the semi-realistic visualisation type as highly suitable for the design and presentation use. To a lesser extent, this visualisation type was valued as suitable for analysis use. The semi-realistic visualisation type was valued as not suitable for inventory purposes, although the difference between not suitable and highly suitable was small. For the abstract visualisation type, the professionals' value emphasized not suitable for inventory, design and presentation use. This visualisation type seemed to be only suitable for analysis purposes, in order to compare and interpret differences in the landscape between a current and future situation.

Table 1
Suitability of the visual representation forms according to the four types of use
(% of professionals)

		1 (%)	2 (%)	3 (%)	4 (%)	5 (%)
Abstract (*n* =37)						
Inventory		23	47	10	20	0
Analysis		9	25	25	34	7
Design		13	26	23	35	3
Presentation	22	34	22	16	6	
Semi-realistic (*n* =29)						
Inventory		19	19	31	27	4
Analysis		8	27	19	31	15
Design		4	8	35	42	11
Presentation	8	8	23	42	19	
Realistic (*n* =21)						
Inventory		6	6	19	31	38
Analysis		6	7	31	31	25
Design		0	6	37	44	13
Presentation	0	13	0	31	56	

From not suitable (1) to highly suitable (5).

Suitability for participation levels

In the survey, we used the five participation levels of Edelenbos et al. (1998) to formulate five case situations. In Fig. 1 these participation levels are described as well as the corresponding case situations, which were originally in the Dutch language. For each case situation, twenty-two professionals choose one visualisation type as highly suitable (table 2).

Table 2
Suitability of the visual representation forms according to the five levels of participation (% of professionals)

	Informing (%)	Consulting (%)	Advising (%)	Co-producing (%)	Co-deciding (%)
Abstract	0	5	0	25	9
Semi-realistic	58	20	55	55	43
Realistic	42	75	45	20	48

(*n* =22)

The results showed that the differences between the visualisation types were small, especially for the advising and co-deciding level. Most of the professionals choose the semi-realistic visualisation type as highly suitable at nearly all participation levels (table 2). However, the realistic visualisation type was selected by most professionals as highly suitable at the consulting level. The results suggested that the semi-realistic visualisation type is highly suitable at especially the informing and co-producing level. Previous research by Al-Kodmany (1999) found that photo-realistic visualisations (e.g. realistic visualisation type) can be too realistic to inform citizens. Photo-realistic visualisations have disadvantages such as raising undeserved expectations and raising the sense that the proposed changes are already fixed. The semi-realistic visualisation type might be an alternative to avoid these disadvantages while still use the advantage that little interpretation is needed to understand the visualisations. In the realistic visualisation type, the close representation of reality in this visualisation type might be useful in situations where professionals hope to gather information about current spatial problems in the area.

Most of the professionals did not choose the abstract visualisation type as highly suitable at any of the participation levels. However, 25% of the professionals selected this visualisation type at the co-producing level. In addition to the results of this visualisation type for the four use types, the abstract visualisation type might be useful to visualise spatial transformations of the landscape.

Two other points for discussion are the survey sample and the size of the survey sample. The survey sample involved planning supporting professionals such as landscape planners, landscape architects, and GIS-experts. It is likely that other groups of participants such as citizens, pressure groups, and private companies have a different preference for realism of visualisations at the participation levels. Therefore, these results only suggest that planning supporting professionals have a preference for certain visualisation types at the five participation levels. The number of professionals that responded to the survey was limited. Firstly, the number of approached respondents depended on the number of Dutch professionals that were involved in this research project. Secondly, the number of actual survey respondents was influenced by the use of Internet as the medium to distribute the survey. As mentioned before, the Internet caused technical problems with firewalls and intranet systems. Some of the respondents had trouble with loading and playing the visualisations, although the visualisations were of standardized avi-format. The questions in the survey also included large sized visualisations (6.1 mb). These visualisations could not be loaded fast enough for respondents to answer the questions. Therefore, some respondents did not answer all the questions in the survey.

The construction of the three visualisation types varied in effort and resources, which should be taken into consideration while using these visualisations for participatory spatial planning. Besides the availability of geodata, specific knowledge about 3D modelling and photo manipulation software was required to create these visualisation types. Especially the creation of the animations consumed much time. The semi-realistic visualisation type required the most hours of work (e.g. 10 hours/visualisation), because geometric objects need to be textured with bitmaps. The time consuming actions for the realistic visualisation type were the collection of panoramic photographs in the field and stitching these photographs with Pixmaker Pro (e.g. 8

hours/visualisation). The abstract visualisation type was created with less effort compared to the other two visualisation types (e.g. 4 hours/visualisation). Although there is much difference in realism between the three visualisation types, the differences in hours of work are relatively small.

4. Conclusions

This research attempted to study professionals' preference for realism of visualisations for participatory spatial planning. An internet survey was used to carry out this research amongst planning supporting professionals. The survey included three visualisation types that were called abstract, semi-realistic, and realistic. We assumed that professionals' preference for realism of the visualisation types varied according to different types of use and different levels of participation. However, the survey results suggest that especially the semi-realistic visualisation type is highly suitable for each of the four types of use as well as for each of the five participation levels. To a lesser extent, the realistic visualisation type is valued as highly suitable for most of the use types and participation levels. Because the differences in results between these two visualisation types is relatively small, it would be interesting to continue this research with more professionals as well as other participants in the spatial planning process. Future research will be necessary to determine specific guidelines for realism of visualisations for different use types and at different participation levels.

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