Environment and Planning B: Planning and Design 2011, volume 38, pages 921 – 939

doi:10.1068/b36113

Which is the appropriate 3D visualization type for participatory landscape planning workshops? A portfolio of their effectiveness

Ulrike Wissen Hayek
Institute for Spatial and Landscape Planning, Planning of Landscape and Urban Systems, ETH Zurich, CH-8093 Zurich; e-mail: wissen@nsl.ethz.ch
Received 8 September 2009; in revised form 8 February 2011

Abstract. Communication and information are central aspects in participatory spatial planning. This study analyzes the effectiveness of current 3D landscape visualizations in communicating the required spatial information. The focus was on measuring 3D visualizations' effectiveness in participatory planning processes according to the level of various supporting functions for, for example, information processing or achieving the objectives of different planning phases. The effectiveness of abstract and realistic 3D visualization types was tested in case studies using qualitative social – empirical research methods. In order to provide a systematic overview of the results, a portfolio analysis was carried out. The benefit of the visualization types for different planning tasks and their quality of representing the required planning content were evaluated. The results show that the different strengths of both abstract and realistic 3D visualization types are required in participatory workshops. They are especially efficient at motivating stakeholders and enlarging the information base. However, until now they have proved to be less suitable for the development of new ideas and decision making. In particular, the realistic visualization type was ranked as very attractive for the purpose of evaluation, but the representation of the required spatial information needed enhancement. On the basis of the portfolio, focusing further research on optimizing the 3D visualization types for analysis and evaluation tasks is suggested.

1 Introduction

GIS-based 3D landscape visualizations have shown great potential as valuable communication tools. One aspect that has not been explored is how to prepare and apply these new tools effectively in real planning processes (Al-Kodmany, 2001; Orland et al, 2001; Wergles and Muhar, 2009).

Although rapidly developing computer technology allows the production of increasingly sophisticated and realistic 3D visualizations, the technical possibilities currently exceed the knowledge of their correct application. The application of 3D visualizations influences the workflow of planning processes and affects participants' perception as well as their decision making. Therefore, standardized methods and guidelines for producing and applying 3D landscape visualizations in participatory planning workshops are needed to ensure unbiased, high-quality landscape planning processes (Appleton and Lovett, 2003; 2005; Ervin, 2001; Orland et al, 2001; Sheppard, 2001; 2005).

3D visualizations can fulfil various functions in participatory planning workshops. These can be divided into three main groups: functions to support (1) individual information processing, (2) participant discussions, and (3) achieving the objectives of information transfer in different phases of the planning process (Dransch, 2007; Wissen et al, 2008). Information processing requires, for example, functions such as motivating and focusing the attention of the viewer to help him or her to extract the relevant information, contextualizing the information and providing links between reality and the viewer's concept of an issue (Wissen et al, 2008). In the discussion process social functions of the media that support social behavior and actions are important (Dransch, 2007). Functions that support stakeholders in fulfilling the various planning tasks are, for example, aiding in collecting, exploring, and analyzing problem-relevant information as well as designing, evaluating, comparing, and choosing possible solutions (Andrienko et al, 2007). Visualizations have to meet societal and professional needs to be of real added value (Sheppard, 2005). Yet a clear connection between the planning tasks and the data made available in 3D, as well as the function of the 3D visualizations in the planning process, is missing. It is important to consider their specific functions in the application context. In particular, the human dimension, that is, how the tools support perception and communication, should be taken into account (Dransch, 2007; Lewis and Sheppard, 2006; MacFarlane et al, 2005; Nicholson-Cole, 2005). There is a need to find out how well the visualization tools already fulfil their required functions.

Many recent studies on 3D visualizations have analyzed the different aspects of these tools in order to optimize them for stakeholders participation, by, for example, comparing different display methods (Dockerty et al, 2005; Wergles and Muhar, 2009), optimizing approaches to realistic landscape visualization (Ghadirian and Bishop, 2008; Williams et al, 2007), and using interactivity and immersion in participatory planning (Salter et al, 2009). However, for their suitable application in actual planning processes, in the near future, it is essential not only to find out when the tools might be best employed (Salter et al, 2009), but also how effective they are already are. Determining which tasks need optimization will allow an appropriate allocation of research resources and a focus on in-depth research, for example, in experiments.

The goal in this study was to determine the effectiveness of 3D visualizations for communicating spatial information in participatory landscape planning workshops. The effectiveness was measured in terms of the functions that 3D visualizations should fulfil in participatory planning processes. The qualities of the different visualization types in actual workshops with a qualitative case-study analysis were analyzed. In addition, the qualitative case-study results are arranged systematically in a portfolio analysis that gives an overview of the effectiveness of the visualization types in different planning tasks. Finally, recommendations are made for future research and the development of new visualization tools.

2 Methods

An explorative case-study analysis was conducted in order to test the effectiveness of abstract and realistic 3D visualization types in real planning processes. An explorative case-study analysis was chosen because little is known about the effectiveness of 3D visualization types in real planning processes (Flick, 2003). The analysis was carried out within the framework of the EU project VisuLands (project duration: 2003–05) (http://lrg.ethz.ch/visulands/fs_visulands.html), which aimed at developing new visualization instruments for public participation in the management of landscape change.

2.1 Case-study area

The Entlebuch UNESCO Biosphere Reserve (http://www.biosphaere.ch) comprises the main valley between Lucerne and Berne in central Switzerland with an area of 395 km^2 and an altitude that ranges from 590 m to 2350 m above sea level. Its cultural landscape is of international significance because it contains important habitats for plants and animals, for example, karst areas, forests, and unique moorlands. Approximately 17 000 inhabitants live in the prealpine region, which is shaped mainly by agriculture and forestry. Agriculture and tourism each employ about a third of the working population.

As a UNESCO Biosphere Reserve, Entlebuch serves as a model region where sustainable development concepts are elaborated in participatory planning processes. Particularly notable are Entlebuch's established and sophisticated participation structures, including collaborative planning forums on topics such as business and industry, tourism, agriculture, energy, wood, and education. Participation in these forums is characterized by shared power, group learning, transparency, and a consensus-oriented style of communication (Schroth et al, 2006; Wissen et al, 2008).

2.2 Workshop setting and data collection

Five workshops with 73 people were organized within the two-year period by the management of the Biosphere Reserve. Each was led by a facilitator and lasted approximately three hours. They followed a standard workflow with different phases (Schmid, 2004): orientation phase (introduction), working phase (collecting, choosing, editing, planning), and finishing phase (conclusion). Details about the participants are given in table 1.

Table 1. Workshops supported by 3D visualizations.

Tourism	Agriculture	Forestry
Planning topic Concept for sustainable tourism	Agricultural development concept for alpine farms	Forest development plan
Participants Workshop 1 (2004):	Workshop 2 (2004):	Workshop 4 (2004):
11 experts (tourism; owner of cable car company)	14 experts (farmers) 4 representatives of public office 3 scientists (agricultural experts)	10 stakeholders (experts (forest owners, wood processors, hunters), representatives of public office, interested public)
	Workshop 3 (2005):	Workshop 5 (2005):
	8 experts (farmers); 2 scientists (agric. experts)	21 experts (forest owners, wood processor, hunters, tourism)

The topics of the workshops were determined by existing, ongoing planning processes in the field of tourism, agriculture, and forestry. The content and timing of the visualization application were arranged beforehand with the facilitator conducting the workshop. A schedule was set up for each workshop comprising the overall goal of the workshop, a description of the single tasks in the different workshop phases, the time available for each task, the chosen method for elaboration, the required media, and the responsible person.

Two main 3D visualization types, shown in figure 1, were applied in the workshops. The visualization types used can be distinguished by their level of realism, ranging from abstract, rather symbolic representation (eg, a simple volume for a house) to realistic representations of the landscape with specific textures and geometries (Bishop and Lange, 2005; Danahy, 1997). Both types offered different perspectives that ranged from an overview to close local views. The application of the abstract and realistic visualization types was carefully integrated in the workshops' workflow.

A mix of qualitative methods was used for data collection comprising in-depth interviews with key actors, group discussions with the workshop participants, and an observation of the workshop that followed structured observation guidelines. Data analysis of observation and discussion protocols and transcribed interview tapes were

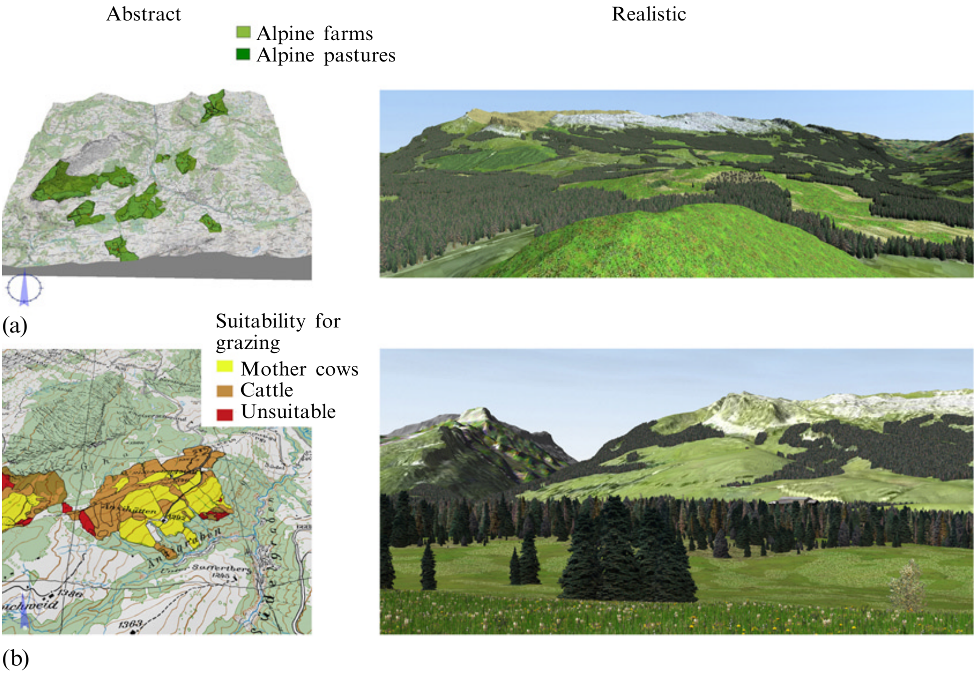

Figure 1. [In color online.] Examples of abstract and realistic 3D visualization types in overview (a) and close-up perspective (b). (Abstract 3D visualizations by Olaf G Schroth, 2004.)

carried out using a combined method of grounded theory and qualitative content analysis (Mayring, 2003; Strauss, 1998). Two researchers analyzed the data and built codes, which were later compared. This triangulation of different data sources, researchers, and methods should allow higher theoretical generalization of the research results because conclusions can be based on different levels (Flick, 2004).

2.3 Identification of the functions of 3D visualizations

The determination of the required functions of 3D visualizations was assessed in three steps. First, the application context of the 3D visualization types were analyzed. Secondly, a literature review in the field of cognitive and didactic sciences was conducted and the functions were organized according to the identified application fields (table 2). Thirdly, the visualization types' functions were complemented with case-study results.

First, the planning phases of a landscape planning process were determined, that is, the application contexts of the 3D visualization types. Each phase aims at achieving a specific goal and fulfilling this task might be supported by 3D visualizations. Table 3 gives an overview of the main phases of landscape planning processes. Andrienko et al (2007) note that in practice there is not strict separation of all the phases and suggest that the tools should support the process as a whole. Nevertheless, it is important to understand which visualization type supports which planning task. This can provide a basis for developing effective tools that allow easy transition between the tasks. Therefore, functions supporting the processing of planning tasks were defined in the different phases.

Secondly, a literature review was conducted. Communication and information are central elements in these processes, particularly in participatory planning (Healey, 2003). Orland et al (2001) call for the integration of principles of communication theory to enhance the effectiveness of the visualization tools. Therefore, a focus was placed on reviewing research results in the field of cognitive and didactic sciences, particularly image reception, cognition, and functions of images as a learning tool.

Table 2. Functions of 3D visualizations according to three application fields with different levels of relevance.

Function according to application fields	Level of relevance
Functions supporting the achievement of objectives through information transfer in different phases of the planning process	
Information and motivation (goal)	Planning
Communication of relevant planning information (collection; analysis)	
Collection of information/enhancement of the information basis (collection)	
Development of ideas (design)	
Evaluation (evaluation; choice)	
Decision making (decision)	
Functions supporting information processing (Dransch, 2007, pages 80 – 81)	
Motivation (arouse user's interest and attention)	Individual person
Demonstration (help a user to get a suitable 'picture' of a phenomenon)	
Setting in context (help a user to set information into a greater context)	
Construction (help a user to create complex mental models such as construction of pictorial and propositional knowledge about information units and their relationships)	
Functions supporting discussions (derived from case-study analysis)	
Positive effects on:	Interpersonal communication
Working atmosphere	
Style of the discussion	
Direction of the discussion (eg, introducing new aspects)	
Exchange of information	

Table 3. Main planning phases of landscape planning processes (Andrienko et al, 2007; Lange and Hehl-Lange, 2006; modified).

Collection	Analysis	Design	Evaluation	Choice	Decision
Data collection	Analysis of the problem situation	Building possible solution options	Evaluating options	Choosing the best alternative	Decide on action

A comprehensive overview of possible functions of 3D visualizations supporting the individual person's information processing given by Dransch (2007) and Wissen (2009) is summarized in table 2.

Thirdly, functions supporting interpersonal communication (ie, the discussion within the group) were derived from case-study data analysis. The visualization types' effectiveness was assessed according to the functions in these three fields.

2.4 Portfolio analysis

A portfolio analysis was constructed to bring the extensive qualitative results into a compact, tangible form. This should provide an overview of the current effectiveness of the visualization types and form a useful basis for discovering further important research aspects. Thus, recommendations for an efficient application, as well as for a strategic choice, regarding further development of 3D visualization types in participatory planning workshops could be derived.

Portfolio models originate from the finance sector and were developed for balancing risk in the field of asset management (Cooper et al, 2001). In modified form, they have become one of the most important management instruments for strategic planning, particularly for making strategic choices or resource allocation on projects in the field of research and development (R&D) industries. These approaches are suitable for making decisions under uncertain conditions, dynamic opportunities, multiple goals, and strategic considerations. In order to obtain good portfolio results, it is important to apply formal, explicit, efficient (ie, not too time-consuming) and user-friendly methods such as (Cooper et al, 1999):

- Financial methods. Ranking projects according to financial value to the company.
- Strategy methods. More intuitively allocating money or resources for different types of projects on the basis of a decided strategy.
- Bubble diagrams. Plotting projects on two dimensions of interest on an $x-y$ portfolio map.
- Scoring models. Ranking projects by a number of criteria on scales, then adding up the ratings to give a project score, which becomes the criterion used to select a project or rank decisions.
- Checklists. Evaluating projects on the basis of a list of yes/no decisions.

Scoring models and strategic approaches are found to result in robust portfolios. Bubble diagrams are valuable for portfolio balancing or strategic alignments and they illustrate the results comprehensively. It is recommended to use combined or hybrid approaches for analysis, rankings, and selection of R&D projects from a portfolio in order to use the strengths of both (Cooper et al, 1999; Linton et al, 2002).

Here a combined method was applied, using a scoring model (Scholles, 2001) with a mapping approach based on the original portfolio model (Cooper et al, 2001; Vollmuth, 2008). First, two dimensions were evaluated: an independent dimension, namely, the attractiveness of the visualization types as information tools in planning tasks throughout the planning process, and a second one which can be influenced by the researcher; namely, the quality of the abstract and realistic designs. Secondly, these dimensions were mapped in a 2D portfolio matrix for better communication.

The result of the scoring model is a ranking of the visualization types' effectiveness to achieve determined goals (Jacoby and Kistenmacher, 1998; Linton et al, 2002). We measured relative efficiencies of the 3D visualization types against the various functions they should provide in order to support the different tasks in the planning process. The evaluation criteria given in table 4 represent (1) goals to be fulfilled by the design (dimension of quality); that is, the abstract or realistic visualizations, and (2) the required functions of the visualization types as an information tool for planning tasks throughout the planning process (dimension of attractiveness). Individual criteria were determined for each planning task because these require different functions of the visualization types. Thus, each visualization type's effectiveness was expressed with regard to the individual planning tasks.

Not all functions contribute to the overall use of the visualization types in the same manner; this is expressed by a weighting factor (Scholles, 2001). The weighting is based on the experiences of the researchers obtained in the five planning workshops and the qualitative case-study analysis based on ten observation protocols, four group discussions with the participants, and ten individual interviews with the facilitators and single participants. All weights add up to 100, that is, 100% of the total value to support a certain task (Scholles, 2001).

The qualitative case-study results were aggregated according to the identified functions for each planning task and the effectiveness of the respective visualization type was rated on each criterion by a $1-5$ ordinal scale ($1 =$ very low effectiveness; $5 =$ very high effectiveness). The total score is the mean value of the weighted and aggregated values for all criteria (Scholles, 2001, page 233):

$$N = \sum_{j=n}^{m} = g_j n_j ,$$

where

N is the total score,
m is the number of criteria,
n is the effect of the visualization type on the criterion's character,
g is the weighting factor.

Table 4. Evaluation criteria for measuring the 3D visualization types' effectiveness on functions they fulfil in the planning process.

Tasks in the planning process	Aims to be achieved through the representation of the information (dimension of quality)	Aims of information transfer in the planning process (dimension of attractiveness)
Information and motivation	arouse interest and attention create a motivated and creative atmosphere direct attention to specific aspects	activate examination of shown facts inspire the discussion of shown facts trigger identification with shown landscape areas
Communication of relevant information	activate preknowledge illustrate impact of (long-term) developments on the view of the landscape concise demonstration of characteristic states or developments demonstrate large-scale, structural states or changes on landscape level illustrative presentation of abstract, theoretical facts	support immersion in landscape structures raise awareness about slow, long-term landscape processes and associated problems comprehension of interrelated landscape factors provide transparency for the planning/visualization process demonstrate planning levels
Collecting information	provide a basis for checking the validity of shown data provide a basis for rough spatial analyses	concrete and spatially explicit discussion check the contents' validity collect wishes, problems, opinions, or aspects make implicit knowledge explicit revise shown contents/planning data according to the local situation detect further relevant aspects; give impulse for further analyses rough analyses; discovering interrelationships
Development of ideas	demonstrate a problem clearly introduce new aspects at the beginning of a discussion phase demonstrate cause–effect chains as impulse for developing ideas	development of alternative solutions support the collection of new, individual ideas
Evaluation	integrate diagrams for assessment in a more general context integrate indicators for an appraisal of the quality of spatial conditions presentation of summaries at the end of a workshop (protocol)	check theoretical assumptions of landscape scenarios discussion and common weighting of evaluation criteria discover different perspectives (demands, individual values)
Decision making	picture the spatial extent of a certain problem clearly	concentration on decision making (concepts)

The total score yields the coordinate values of the two dimensions, the attractiveness and the quality. The detailed results are given in appendices A and B. These were plotted against each other in a bubble diagram format (see figure 3 later). The x-axis shows the degree of quality of the visualization type's design, whereas the y-axis gives its degree of attractiveness for application in a certain planning situation; the higher the total score, the higher the effectiveness of the visualization type.

3 Results

3.1 Scoring model

The qualitative results of the case-study analysis are presented in condensed form according to the revealed supporting functions of the 3D visualization types [see Wissen, 2009 (pages 123 – 185) for a detailed documentation of the qualitative results]. Subsequently, the respective type's characteristics are ranked in scoring cards, shown in appendices A and B.

3.1.1 *Information and motivation*

Abstract as well as realistic visualizations were very well suited for inspiring discussions on particular topics. Realistic visualizations were particularly suitable for triggering identification with the landscape area shown. Reactions to realistic visualizations of an abandonment scenario on alpine pastures were, for example, "This is where I grew up", or "It is my work to do something against the abandonment." Understandably, this emotional effect was relatively low when using abstract visualizations.

3.1.2 *Communication of relevant planning information for analysis*

Abstract visualizations were very useful to show large-scale structural states and developments at the landscape level and to present results of spatial analyses. For statistical data, they provided the landscape context and localized and contextualized the viewpoints of realistic 3D visualizations in the landscape. By showing the GIS database, they made the planning process or, as an add-on for realistic 3D visualizations, the visualization process more transparent. The use of 3D visualizations in overview and close-up perspectives can point out different planning levels. However, there are indications that rather complex designs of abstract visualizations showing multiple parameters or extensive legends are counterproductive when applied in workshops with a lay audience comprised of people who are not used to analyzing spatial patterns based on abstract data. Stakeholders in different workshops were not able to comprehend the content of the visualization, for example, saying "Sometimes there was too much information in one image" referring to an abstract 3D visualization of various tourism facilities available in the area (points and areas of interest, hiking trails, accommodation, and restaurants). Another example is the comment: "Particularly when there were three or four things displayed next to each other, such as tables, images, and legends, orientation was difficult." These participants did not follow the discussion actively and asked for more time to understand the contents.

Realistic visualizations illustrate the impact of a development on the vegetation or the view of the landscape and thus raise awareness about slow, long-term landscape processes and their associated problems. One of the stakeholders mentioned, "We know our area very well and know what will be happening if one or the other management schemes on the alpine pastures is applied", while another responded "However, from time to time you need pictures to recall what it actually looks like." Problems such as possible shifts in the species composition of fens leading to the loss of rare but very attractive vegetation types were discussed.

3.1.3 *Collection of information*

When abstract 3D visualizations were used, workshop participants called for comments on the source and quality of the data in order to check their validity. On the basis of the details shown, a discussion or exploration of the topic took place by, for example, expressing opinions and local knowledge on the drivers of change and their effects. Abstract visualizations were helpful for determining further relevant information as well as for collecting wishes, problems, opinions, and aspects to be considered in the planning process. Results of an economic and ecological analysis of alpine farms were presented in the form of abstract 3D visualizations in a workshop on elaborating a concept of future management systems on the farms. A farmer mentioned that "This approach was relatively good." Another farmer pointed out that the decline in grazing pressure on fens was the problem and not the grazing management on wet pastures. This was followed by an exchange of practical experience of grazing by different types of cattle. From this discussion, the participants suggested concrete measures such as enlargement of the farms in the valley, building free-stall barns on the alpine farms, or a better cooperation between alpine farms in order to avoid a decline in grazing pressure. Individual notions and concerns of this type are valuable for the development of appropriate solutions.

Moreover, abstract visualizations could support the correlation of multiple factors and rough analyses. For example, while looking at the uneven distribution of overnight stays in winter compared with other seasons combined with the visualization of the spatial distribution of holiday houses and hotels, workshop participants who were analyzing the potential for tourism development identified an open potential for summer tourism and a lack of hotel space in the case-study area. In one of the agricultural workshops, abstract visualizations were useful to combine relevant factors for assessing the characteristic conditions of the pastures. The facilitator commented that "In contrast to using 2D maps, one could aggregate the factors much better, for example, the morphology of the terrain, the vegetation, and management intensity." Thus, the abstract visualizations assisted participants in discovering spatial relationships, and this released an impulse for further in-depth analyses.

Participants also checked and commented on the contents presented in realistic visualizations, but by using their experience and concept of the landscape and spatial developments. The stakeholders in the agricultural workshops, for example, revealed different opinions on the possible future development of the vegetation. The farmers mentioned that deciduous trees would germinate in the first succession stages, whereas the foresters were of the opinion that spruce would occur area wide. Furthermore, they discussed the likely change in the species composition of the fens and wet pastures in their area in cases of undergrazing. This allowed their implicit knowledge (local knowledge, practical experience, perceptions) to be made explicit. Implicit knowledge is useful for differentiating the shown contents with regard to the local situation and to render them more precise. In one workshop, important aspects were raised that otherwise would not have been discussed. In this case, management errors on alpine pastures and the resulting effects were given as an explanation for visualized vegetation developments.

3.1.4 *Development of ideas*

When the problem was clearly demonstrated in abstract visualizations, the participants were activated to suggest possible solutions. Visualizations highlighting one aspect, for example, future levels of sufficient snow conditions for skiing in fifty years time under different climate-change scenarios, assisted in the understanding of the main message. In this case, it triggered stakeholders' suggestions for diversification of tourism opportunities in the summer season (Schroth et al, 2011). Participants considered realistic visualizations useful due to the illustration of the causes and effects of a particular development, which gave an impulse for developing ideas. In one case, the visualizations of possible effects of overgrazing on alpine pastures triggered a discussion of the general problem of the occurrence of rush species on the pastures. A deeper analysis was suggested as the basis for developing solutions. However, in brainstorming sessions neither visualization type supported the creation of new, individual ideas. For example, in the tourism workshop where abstract visualizations were used, participants developed rather conventional ideas for enhancing summer tourism, such as wellness and conference centers, fun parks, or hostelry along the hiking paths. In the agricultural workshops, in which realistic visualizations of abandonment and large-scale grazing management on the alpine pastures were shown, no ideas for alternative agricultural management schemes were generated in the brainstorming session. From his experiences in this workshop, the facilitator stated that, "For me, the 3D visualizations are not necessarily required in the brainstorming phase; they are even rather destructive in effect. In brainstorming sessions, the thoughts must be uttered uncensored. They must not be channeled through visualizations. In brainstorming, limiting factors and regularities should be avoided. These kill the imagination." In his opinion, the visualizations should be used in the subsequent discussion phases that assess alternative solutions.

3.1.5 *Evaluation*

Abstract visualizations assisted in the forming of opinions. The entire group of participants discussed and ranked the relevance of criteria for evaluation. In large groups, abstract visualizations were suitable for rough evaluations since the details were not accessible to everyone because only one presentation screen in the front of the room was used. With regard to carrying out detailed analyses and evaluations, the facilitator of the agricultural workshops considered the abstract visualizations to be more suitable for application in small groups of four to five people. In his opinion, organizing a discursive and detailed evaluation process in a large group appears to be too demanding.

When realistic visualizations were applied evaluation took place on two levels. First, the visualizations served as intuitive proof of theoretical assumptions, which were based on the landscape development presented. Thus, for example, practical experience was integrated into the evaluation. Secondly, an appraisal was carried out of the vegetation's habitat quality at different stages or the quality of pastures for grazing according to the assumed fodder quality. The integration of visual indicators, for example, key plant species of vegetation types or management influences on the vegetation (figure 2), proved to support the participants in evaluating such facts (Wissen et al, 2008).

Figure 2. [In color online.] Realistic visualization type showing the possible impact of a management change on the habitat and fodder quality through the use of indicator species (*Veratrum album* and *Ranunculus aconitifolius*).

Through viewing realistic visualizations, different stakeholders developed diverging perspectives, such as theory versus practice or nature protection versus agricultural management. In both small and large groups, multiple demands and individual values regarding the view of the landscape were raised effectively by the use of realistic visualizations. These comments ranged from the need for prohibiting abandonment of the landscape, because of the identification with the view of the current landscape, to the effort required to restore an open landscape or the maintenance of rare and protected vegetation types.

3.1.6 *Decision making*
An added value of the use of abstract visualizations in decision making is the participants' clear focus on the spatial extent of a certain problem. In the case-study workshop, this effect accelerated decision making on developing a forest development concept. An overlay of alternative but partly overlapping spatial functions of the forest as defined by the interests of different stakeholder groups, such as hunting, nature protection, and winter sports, made the actual areas of conflict spatially explicit. As a solution, the stakeholder group decided that only the decision makers responsible for the small number of identified subareas should meet and review the extent of areas with conflicting demands. However, of the workshops analyzed, only one reached the phase of decision making and realistic visualizations were not used in this case. Therefore, conclusions cannot be reached about the quality of the realistic visualizations for this task.

3.2 Portfolio of the effectiveness of 3D visualization types

In the portfolio diagram (figure 3) the determined values (table 5) for the dimension of 'quality' were plotted against the values for the dimension 'attractiveness'. The different tasks in the planning process were coded by color scales. Showing the results for both visualization types in one diagram allows direct comparison of their respective effectiveness. Additionally, their potential for enhancing the participatory planning process was evaluated for the different tasks using a three-tiered ordinal scale (1 = low, 2 = medium, 3 = high). In the portfolio diagram, the ranking of the potential is indicated by the size of the square or circle.

The big circle and square in the upper right-hand corner of the portfolio diagram for the task 'information and motivation' show the very high quality of representation of the relevant information in both realistic and abstract visualizations. In addition,

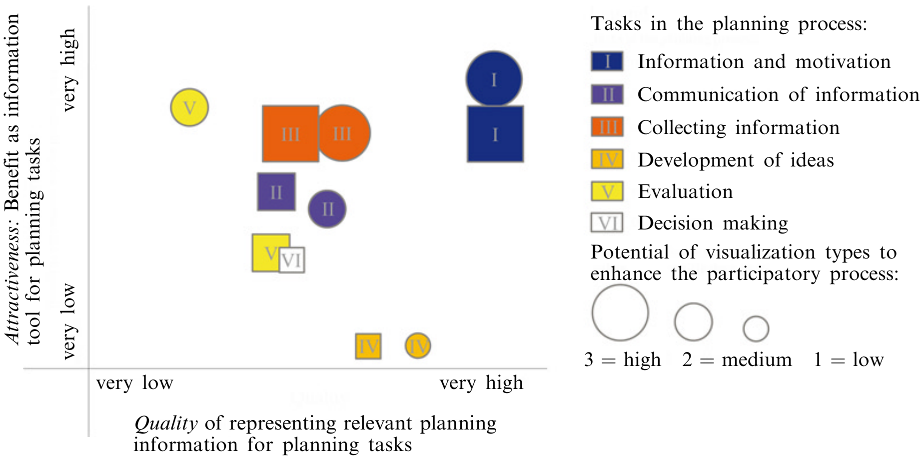

Figure 3. [In color online.] Portfolio of the effectiveness of 3D abstract (square) and realistic (circle) visualization types for supporting different tasks in the planning process.

Table 5. Overview of the aggregated evaluation of the quality and attractiveness of the 3D visualization types. Ranking of the potential for enhancing the participatory planning process due to the application of an abstract (A) or realistic (R) visualization type for the respective task.

Tasks in the planning process	Information and motivation		Communication of planning information		Collecting information		Development of ideas		Evaluation		Decision making
	A	R	A	R	A	R	A	R	A	R	A
Quality											
Value of coordinate on the x-axis	5	5	2.85	3.35	3	3.5	3.75	4.25	2.8	2	3
Attractiveness											
Value of coordinate on the y-axis	4.25	5	3.45	3.2	4.25	4.25	1.3	1.3	2.6	4.6	2.5
Potential											
Enhance participatory planning process	3	3	2	2	3	3	1	1	2	2	1

both types are very attractive for application in the planning process; that is, they proved to be very useful for the task of motivating people and focusing their attention on certain facts. The slightly higher attractiveness of the realistic visualization type can be attributed to its characteristics of triggering identification with the landscape areas shown. Both visualization types are already very beneficial for this task and it does not seem necessary to optimize them. If stakeholders are already familiar with the new tools, however, they might be less effective. In order to maintain this value of the visualizations, their contents should be interesting for the participants and related to the local situation (Nicholson-Cole, 2005).

Another aspect drawn from figure 3 is that although both 3D visualization types had very low attractiveness for developing ideas, they show a high quality in representing the planning information for this task. While both visualization types introduced new aspects to a discussion, this did not lead to many original solutions.

The quality of representation of the planning information shows moderate values with respect to supporting the other tasks. It was found that, when applied with lay audiences, abstract visualizations should provide the required information in a concise manner; that is, in a rather aggregated form. The visualization of already correlated parameters can probably support a collaboration exploration and analysis more efficiently in the generally very limited time available in a workshop. For the evaluation of certain conditions or possible solutions by a lay audience, approaches should be developed which show indicator values (such as habitat quality), but avoid complex legends as these have been shown to be a hindrance to the overall orientation in the visualization. Easily understandable color schemes (eg, from dark to light colors) might be a useful starting point (Wissen et al, 2005).

For evaluation purposes the noticeably higher attractiveness of realistic 3D visualizations compared with that of abstract ones leads back to their emotional effect. Thus, different perceptions, requirements, and individual values can be discovered that are very valuable for more comprehensive evaluations.

Considering the potential of the different types of 3D visualization for enhancing the participatory planning process, the diagram shows that the highest potential is when they are applied in order to motivate and enhance the information base. They were attributed least potential when used for developing ideas or for decision making. However, there is a good potential for optimizing participatory planning if these tools are used for analysis and evaluation.

4 Discussion

Looking at the portfolio, what stands out is that most of the differences between abstract and realistic visualization are quite small and certainly less than those between different stages of the planning process. First, this underlines that, although the 3D visualization types have different characteristics, their quality in representing relevant information and their attractiveness as information tools are quite equal. However, rather than being able to substitute one type for the other, this means that the strengths and weaknesses of both types have to be taken into account when planning their application in participative planning workshops in order to provide the required information.

Secondly, the application of the 3D visualization types seems to have rather unequal added value for different planning stages with regard to both the quality of representing information as well as the attractiveness. Furthermore, there is a broad tendency for the rating scores and potentials (symbol sizes) to become lower or smaller through the planning process. While the prepared 3D visualizations were rather useful in the early planning stages to support the aims regarding representation of the information and information transfer, in the later stages they were not. From the practical experience in the workshops, a reason for this finding may be that it is more difficult to prepare and apply 3D visualizations for supporting the development of ideas or evaluation purposes than it is for motivating and collecting relevant information. Generally, it can be accepted that 3D visualizations are very effective for the latter purposes. However, both the characteristics of the 3D visualizations, the complexity of the task, and the workshop set-up have an influence on the effectiveness of the visualization tools. Thus, further research is required to analyze the specific requirements and framework conditions of the later planning stages in order to refine approaches for the preparation and application of 3D visualizations that might be more supportive.

The results reveal that the 3D visualization types have different communicative strengths, both of which are required throughout the planning process. The differences in the effects of various 3D visualization types on the participants and on the style of the discussion are of special significance. The presentation of abstract visualizations leads mostly to discursive discussions, which can be used to detect wishes, problems, opinions, and topics for further elaboration. Thus, individual views and concerns, which are very valuable for the development of planning solutions, can be addressed. In contrast, the realistic 3D visualizations evoke very intuitive reactions and trigger a high identification with the area shown. This has also been found by other research groups: for example, Salter et al (2005) and Appleton and Lovett (2005). These reactions are useful for collecting local knowledge, particularly practical experience and perceptions. They make implicit knowledge explicit so that groups with divergent styles of thinking (driven by theory versus experience) can find a common basis for collaboration. Overall, the use of 3D visualizations leads to more spatially explicit discussions. However, before 3D visualizations are applied, the type of information that is to be collected should be considered carefully. These findings support the idea of renaming the visualization types. Sheppard and Cizek (2009) use the expressions ‘experiential’ and ‘conceptual’ visualizations instead of ‘realistic’ and ‘abstract’.

These terms stress the visualization types' different effects: the experiential ones affecting perception and the conceptual ones leading to rational discussions.

3D visualizations are best employed in the phase of motivating people, raising their awareness, and drawing their attention to a specific topic. Moreover, they have a high added value in collecting further information as they support information flow in all directions. This supports the opportunity to cooperatively evolve towards a consensus and to find potential new concepts that are more comprehensive. The information derived from local knowledge represents a gain for all participants, and extends well beyond the content of the 3D visualizations. Therefore, targeted application of 3D visualizations for enhancing the information basis potentially increases the quality of planning processes.

The portfolio also shows the most important area for further research. For evaluation purposes, the realistic 3D visualization type shows high attractiveness but not very effective design. The high attractiveness can be attributed to its emotional effect allowing an intuitive testing of the theoretical assumptions that scenarios of landscape change are based on. Furthermore, different opinions, requirements, and individual values, which enlarge the criteria catalogue used for evaluation, can be discovered through its use. Abstract visualizations did not show these effects, but provided a good discussion base for weighting the importance of the criteria presented. Setting up a common criteria catalogue and the weighting of criteria are very important tasks for participatory decision processes (Wissen and Grêt-Regamey, 2009). Further investigation and development of both visualization types should focus on the optimization of their use in the evaluation phase. This has also been concluded by other researchers, who stress the importance of this research direction (Andrienko et al, 2007).

It has to be noted that 3D visualizations are not useful in all phases of the workshop moderation. For example, during a brainstorming session for developing new ideas, the visualizations did not show the intended effect of stimulating the quick production of various proposals. Ideas are generated through novel combinations of existing knowledge (Stroebe et al, 2010). Stroebe et al (2010) have found that preliminary priming procedures that induce active thinking about a relevant subtopic of a certain problem can increase the accessibility of particular knowledge. This can lead to ideas that are more original and of higher quality than without priming or with irrelevant priming.

Why then, for example, did the priming of the farmers with realistic visualizations demonstrating the effects of large-scale grazing management on the view of the landscape not lead to proposals for alternative management schemes? Since realistic 3D visualizations can direct the viewer's focus within an image (Appleton and Lovett, 2005; Wergles and Muhar, 2009), they should be rather useful as a priming medium. However, perhaps the visualized information, rather than the visualization type, could have been unsuitable as priming. First, large-scale grazing management was refused by the farmers as being an infeasible solution for their area. Secondly, it was found that information similar to the problem has less impact on idea generation than more distantly related information (Tseng et al, 2008). Thus, rather than an existing solution, distantly related concepts should be presented. For these reasons, on the basis of the study results, it cannot as yet be concluded that realistic 3D visualizations have no use in brainstorming sessions. This is also true for the decision-making phase as this phase was reached only once in the workshops.

The generalizations of the qualitative case-study results in the portfolio analysis have to be interpreted carefully as the data in the case studies were collected in real planning workshops. The advantage of such an approach is that due to the visualizations' application in real planning situations, it was possible to gather responses founded on practical experience instead of the hypothetical answers that can be gained in an experiment. As a disadvantage, the fact has to be mentioned that only short group discussions were possible during the workshop because the participants had very restricted time frames. These limitations are also discussed by other groups conducting research in real planning (eg, Salter et al, 2009). Nevertheless, repeated testing of the visualization types in workshops and the triangulation with observation data lead to a reasonable data basis, which allows a rough evaluation of effectiveness as carried out in our study.

The portfolio of the new communication instruments can help prove the quality of the 3D visualizations and discover important fields for further development. A diagram provides a concise basis for communicating the extensive qualitative results of the social–empirical analysis. However, the scoring of the visualization types was carried out by just one researcher. In particular, the weighting of the different criteria has a great influence on the value of the effectiveness. As a first overview and discussion basis for the main research direction, the resulting portfolio is useful. It should be enhanced by including more case-study results and a larger group of researchers in the evaluation and weighting of the criteria.

5 Conclusions

The specific qualities of 3D visualization types regarding their functions for certain tasks in participatory planning workshops have been revealed. The most suitable areas for their application were motivation, communication of information for analysis, the gathering of new information, and evaluation. It is not clear yet whether the 3D visualizations support the development of ideas or decisionmaking in a workshop. However, one should deliberate carefully upon their use in brainstorming sessions because they have a potential to support, but also to constrain, these processes. Current findings from social psychology should be used to guide informed preparation and application of these potential priming tools. In addition, the findings of this study can help to plan the application of these new communication tools in a useful manner and to avoid basic errors that may hinder the planning process. Lovett et al (2010) conclude that 3D visualization types may perform complementary functions. Here the conclusion is that from the range of the studies conducted, particularly for communicating and collecting relevant information as well as for evaluation, their combined application should be considered in order to make use of their complementary nature. Furthermore, the portfolio analysis highlights important research fields. Rather than concentrating on the preparation and application of 3D visualization tools for motivation and collecting of information, research is needed to determine which characteristics 3D visualization tools have to provide and which workshop settings are suitable when it comes to the development of ideas, evaluation, and decision making. Particular focus should be placed on enhancing the quality of 3D visualization in representing the relevant information to support comprehensive exploration and analysis of alternative designs or possible land-use scenarios for evaluation purposes. The integration of indicators into both visualization types, as shown in, for example, Wissen et al (2008), Wissen Hayek et al (2010), or Salter et al (2009), is crucial for making them more efficient for this task.

Acknowledgements. This work is part of the project VisuLands—Visualisation Tools for Public Participation in the Management of Landscape Change, which is funded by the European Union Fifth Framework Programme, Quality of Life and Management of Living Resources, and the Swiss State Secretariat for Education and Research. I thank two reviewers for their careful comments on the manuscript. Special thanks go to the Canton of Lucerne for providing digital data from their geographical information system and to the public of the Entlebuch UNESCO Biosphere Reserve for testing the 3D visualisation tools in their local planning processes.

References

Al-Kodmany K, 2001, "Visualization tools and methods for participatory planning and design" *Journal of Urban Technology* **8** 1 – 37

Andrienko G, Andrienko N, Jankowski P, Keim D, Kraak M-J, MacEachren A, Wrobel S, 2007, "Geovisual analytics for spatial decision support: setting the research agenda" *International Journal of Geographical Information Science* **2** 839 – 857

Appleton K, Lovett A, 2003, "GIS-based visualisation of rural landscapes: defining 'sufficient' realism for environmental decision-making" *Landscape and Urban Planning* **65** 117 – 131

Appleton K, Lovett A, 2005, "GIS-based visualisation of development proposals: reactions from planning and related professionals" *Computers, Environment and Urban Systems* **29** 321 – 339

Bishop I, Lange E, 2005, "Visualization classified", in *Visualization in Landscape and Environmental Planning. Technology and Applications* Eds I Bishop, E Lange (Taylor and Francis, London) pp 23 – 34

Cooper R, Scott J E, Kleinschmidt E J, 1999, "New product portfolio management: practices and performance" *Journal of Product Innovation Management* **16** 333 – 351

Cooper R, Scott E, Kleinschmidt E, 2001, "Portfolio management for new product development: results of an industry practices study" *R&D Management* **31** 361 – 380

Danahy J W, 1997, "Visualization data needs in urban planning and design", in *Automatic Extraction of Man-made Objects from Aerial and Space Images (II)* Eds A Gruen, E P Baltsavias, O Henricsson (Birkhäuser, Basel) pp 357 – 366

Dockerty T, Lovett A, Sünnenberg G, Appleton K, Parry M, 2005, "Visualising the potential impacts of climate change on rural landscapes" *Computers, Environment and Urban Systems* **29** 297 – 320

Dransch D, 2007, "Designing suitable cartographic multimedia presentations", in *Multimedia Cartography* Eds W Cartwright, M P Peterson, G Gartner (Springer, Berlin) pp 75 – 87

Ervin S M, 2001, "Digital landscape modelling and visualization: a research agenda" *Landscape and Urban Planning* **54** 49 – 62

Flick U, 2003, "Design und Prozess qualitativer Forschung", in *Qualitative Forschung — Ein Handbuch* Eds U Flick, E von Kardoff, I Steinke (Rowohlt, Reinbeck bei Hamburg) pp 252 – 265

Flick U, 2004 *Triangulation — Eine Einführung* (VS Verlag für Sozialwissenschaften, Wiesbaden)

Ghadirian P, Bishop I D, 2008, "Integration of augmented reality and GIS: a new approach to realistic landscape visualization" *Landscape and Urban Planning* **86** 226 – 232

Healey P, 2003, "The communicative turn in planning theory and its implications for spatial strategy formation", in *Readings in Planning Theory* Eds S Campbell, S Fainstein (Blackwell, Oxford) pp 1237 – 1255

Jacoby C, Kistenmacher H, 1998, "Bewertungs- und Entscheidungsmethoden", in *Methoden und Instrumente räumlicher Planung: Handbuch* Ed. Akademie für Raumforschung und Landesplanung (VSB-Verlagsservice, Braunschweig) pp 146 – 168

Lange E, Hehl-Lange S, 2006, "Integrating 3D visualisation in landscape design and environmental planning" *GAIA: Ecological Perspectives for Science and Society* **15** 195 – 199

Lewis J L, Sheppard S R J, 2006, "Culture and communication: can landscape visualization improve forest management consultation with indigenous communities?" *Landscape and Urban Planning* **77** 291 – 313

Linton J D, Walsh S T, Morabito J, 2002, "Analysis, ranking and selection of R&D projects in a portfolio" *R&D Management* **32** 139 – 148

Lovett A, Carvalho Ribeiro S, Van Berkel D, Verburg P, Firmino A, 2010, "Representing and communicating rural futures through 3D landscape visualizations — experiences from the RUFUS project", in *Peer Reviewed Proceedings of Digital Landscape Architecture 2010 at Anhalt University of Applied Sciences* Eds E Buhmann, M Pietsch, E Kretzler (Wichmann, Berlin) pp 261 – 268

MacFarlane R, Stagg H, Turner K, Lievesley M, 2005, "Peering through the smoke? Tensions in landscape visualisation" *Computers, Environment and Urban Systems* **29** 341 – 359

Mayring P, 2003, "Qualitative Inhaltsanalyse", in *Qualitative Forschung: Ein Handbuch* Eds U Flick, E von Kardoff, I Steinke (Rowohlt, Reinbeck bein Hamburg) pp 468 – 475

Nicholson-Cole S A, 2005, "Representing climate change futures: a critique on the use of images for visual communication" *Computers, Environment and Urban Systems* **29** 255 – 273

Orland B, Budthimedhee K, Uusitalo J, 2001, "Considering virtual worlds as representations of landscape realities and as tools for landscape planning" *Landscape and Urban Planning* **54** 139 – 148

Salter J, Sheppard S R J, Cavens D, Meitner M, 2005, "Planning, communicating, designing and decision making for large scale landscapes", in *Visualization in Landscape and Environmental Planning. Technology and Applications* Eds I Bishop, E Lange (Taylor and Francis, London) pp 120 – 124

Salter J D, Campbell C, Journeay M, Sheppard S R J, 2009, "The digital workshop: exploring the use of interactive and immersive visualisation tools in participatory planning" *Journal of Environmental Management* **90** 2090 – 2101

Schmid A, 2004 *UNESCO Biosphäre Entlebuch: Modell für eine nachhaltige Regionalentwicklung? Konzept Zielerreichungskontrolle* (Biosphärenmanagement UNESCO Biosphäre Entlebuch, Schüpfheim, Switzerland)

Scholles F, 2001, "Die Nutzwertanalyse und ihre Weiterentwicklung", in *Handbuch Theorien + Methoden der Raum- und Umweltplanung* Eds D Fürst, F Scholles (Dortmunder Vertrieb für Bau- und Planungsliteratur, Dortmund) pp 231 – 247

Schroth O, Wissen U, Schmid W A, 2006, "Developing new images of rurality—interactive 3D visualizations for participative landscape planning workshops in the Entlebuch UNESCO Biosphere Reserve" *disP* **166**(3) 26 – 34

Schroth O, Wissen Hayek U, Lange E, Sheppard S, Schmid W A, 2011, "A multiple-case study of landscape visualizations as a tool in transdisciplinary planning workshops" *Landscape Journal* **30** 53 – 71

Sheppard S R J, 2001, "Guidance for crystal ball gazers: developing a code of ethics for landscape visualization" *Landscape and Urban Planning* **54** 183 – 199

Sheppard S R J, 2005, "Validity, reliability and ethics in visualization", in *Visualization in Landscape and Environmental Planning. Technology and Applications* Eds I Bishop, E Lange (Taylor and Francis, London) pp 79 – 97

Sheppard S R J, Cizek P, 2009, "The ethics of Google Earth: crossing thresholds from spatial data to landscape visualisation" *Journal of Environmental Management* **90** 2102 – 2117

Strauss A L, 1998 *Grundlagen qualitativer Sozialforschung: Datenanalyse und Theoriebildung in der empirischen und soziologischen Forschung* (Wilhelm Fink Verlag, Munich)

Stroebe W, Nijstad B A, Rietzschel E F, 2010, "Beyond productivity loss in brainstorming groups: the evolution of a question" *Advances in Experimental Social Psychology* **43** 157 – 203

Tseng I, Moss J, Cagan J, Kotovsky K, 2008, "The role of timing and analogical similarity in the stimulation of idea generation in design" *Design Studies* **29** 203 – 221

Vollmuth H J, 2008 *Controlling Instrumente von A – Z* (Haufe, Freiburg)

Wergles N, Muhar A, 2009, "The role of computer visualization in the communication of urban design—a comparison of viewer responses to visualizations versus on-site visits" *Landscape and Urban Planning* **91** 171 – 182

Williams K J H, Ford R M, Bishop I D, Loiterton D, Hickey J, 2007, "Realism and selectivity in data-driven visualisations: a process for developing viewer-oriented landscape surrogates" *Landscape and Urban Planning* **81** 213 – 224

Wissen U, 2009 *Virtuelle Landschaften zur partizipativen Planung—Optimierung von 3D Landschaftsvisualisierungen zur Informationsvermittlung* (vdf Verlag, Zürich)

Wissen U, Grêt-Regamey A, 2009, "Identifying the regional potential for renewable energy systems using ecosystem services and landscape visualizations", in *Proceedings of the European IALE Conference 2009, European Landscapes in Transformation: Challenges for Landscape Ecology and Management* available at http://www.irl.ethz.ch/plus/people/uwissen/IALE_wissen_gret-regamey.pdf

Wissen U, Lange E, Schmid W A, 2005, "User friendly design of indicators in 3D visualisations for public assessment of landscape functions and processes", in *Proceedings of the Conference Our Shared Landscape 2005* Eds E Lange, D Miller (ETH, Zurich) pp 170 – 171

Wissen U, Schroth O, Lange E, Schmid W A, 2008, "Approaches to integrating indicators into 3D landscape visualisations and their benefits for participative planning situations" *Journal of Environmental Management* **89** 184 – 196

Wissen Hayek U, Halatsch J, Kunze A, Schmitt G, Grêt-Regamey A, 2010, "Integrating natural resource indicators into procedural visualisation for sustainable urban green space design", in *Peer Reviewed Proceedings of Digital Landscape Architecture 2010 at Anhalt University of Applied Sciences* Eds E Buhmann, M Pietsch, E Kretzler (Wichmann, Berlin) pp 339 – 347

Appendix A

Table A1. Quality of the abstract (A) and realistic (R) visualization types in representing relevant planning information for planning tasks throughout the planning process.

Aims to be reached with the representation of the information	Weight	Tasks in the planning process											
		information and motivation		communication of relevant planning information		collecting information		development of ideas		evaluation		decision making	
		n_A	n_R	n_A	n_R	n_A	n_R	n_A	n_R	n_A	n_R	n_A	n_R
Arouse interest and attention	25	5	5										
Create a motivated and creative atmosphere	25	5	5										
Direct attention to specific aspects	50	5	5										
Activate preknowledge	10			3	5								
Illustrate impact of (long-term) developments on the view of the landscape	30			1	5								
Concise demonstration of characteristic states or developments	15			1	4								
Demonstrate large-scale, structural states or changes on landscape level	30			5	3								
Illustrative presentation of abstract, theoretical facts	15			4	1								
Provide a basis for checking the validity of shown data	50					1	5						
Provide a basis for rough spatial analyses	50					5	2						
Demonstrate the problem clearly	25							4	3				
Introduce new aspects at the beginning of a discussion phase	50							5	5				
Demonstrate cause–effect chains as impulse for developing ideas	25							1	4				
Integrate diagrams for assessments in a more general context	30									3	1		
Integrate indicators for an appraisal of the quality of spatial conditions	50									3	3		
Presentation of summaries at the end of a workshop (protocol)	20									2	1		
Picture the spatial extent of a certain problem clearly	100											3	-
Total value/value of coordinate on the *x*-axis	(*N*)	5	5	2.85	3.35	3	3.5	3.75	4.25	2.8	2	3	-

Appendix B

Table B1. Benefit of the abstract (A) and realistic (R) visualization types as an information tool for planning tasks throughout the planning process.

Aims of the information transfer in the planning process	Weight	Tasks in the planning process											
		information and motivation		communication of relevant planning information		collecting information		development of ideas		evaluation		decision making	
		n_A	n_R	n_A	n_R	n_A	n_R	n_A	n_R	n_A	n_R	n_A	n_R
Activate examination of shown factors	25	5	5										
Inspire the discussion on shown facts	50	5	5										
Trigger identification with shown landscape areas	25	2	5										
Support immersion in landscape structures	20			4	2								
Raise awareness about long-term landscape processes and associated problems	30			1	5								
Comprehension of interrelated landscape factors	30			4	2								
Provide transparency for the planning/visualization process	15			5	2								
Demonstrate planning levels	5			4	3								
Concrete and spatially explicit discussion	5					5	5						
Check the contents validity	5					5	2						
Collect wishes, problems, opinions, or aspects	30					5	5						
Make implicit knowledge explicit	30					1	5						
Review contents shown/planning data according to the local situation	10					2	5						
Detect further relevant aspects; give impulse for further analyses	10					5	2						
Rough analyses; discovery of interrelationships	10					4	2						
Development of solution options	50							2	2				
Support the collection of new, individual ideas	50							1	1				
Check theoretical assumptions of landscape scenarios	20									1	5		
Discussion and common weighting of evaluation criteria	40									4	4		
Discover different perspectives (demands, individual values)	40									2	5		
Concentration on decision making (concepts)	100											4	-
Total value/value of coordinate on the *y*-axis	(N)	4.25	5	3.45	3.2	4.25	4.25	1.3	1.3	2.6	4.6	2.5	-