Optimizing the Visualization of 3D-Information for Participative Planning of Landscape Development Concepts

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1 Introduction

The integrative planning of landscape development concepts with the balancing of ecological, economic and social aspects requires the cooperation of various stakeholders. Thereby, the exchange of knowledge is crucial to enable all participants to an objective assessment of planning alternatives (SELLE, 1997). As maps and texts turn out to be hard to understand for lay people, there is an increasing use of 3D-visualizations to show concepts in a clearer way (LANGE ET AL., 2003a). To ensure a useful design of these visualizations as information and communication tools in participatory settings, it is strongly recommended to include scientific results on human perception (LANGE, 2001) and cognition (KLIMSA, 2002) as well as didactic principles (DEMUTH & FÜNKNER, 2000).

This paper describes research undertaken in a Ph.D. thesis concentrating on editing information relevant for the participative planning of landscape development concepts by means of 3D visualizations. A better comprehension and estimation of consequences of activities and their effect on landscape change over a long period of time by lay people is aimed for. Results from psychological and pedagogical research are used to identify requirements for a user friendly design of 3D visualizations as regards information communication. The focus is laid on the image functions and the needed degree of realism and complexity in the visualizations, with the aim of minimising the effort of content understanding. The stronger inclusion of the human factor in the development of the 3D visualizations as a tool for 'shared learning' should provide for principles with regard to design aspects and lead to a component for a standardized 3D landscape visualization method.

2 Characteristics of Information

Information is knowledge shaped in a definite way to convey or adopt messages, as well as the result of the conveyance and adoption. Crucial characteristic of the knowledge to be transferred is that it serves for a specified use, it contains significant aspects of an issue, and it is composed and bound to a communication medium ruled by conventions (BOLLMANN, 2001).

This definition leads to different dimensions with influence on the production of 3D visualizations as a communication medium for participative landscape planning:

- The use / function of the 3D visualization in a specified planning situation.

- The aspects of an issue relevant for the planning to be shown with the 3D visualization.
- The conventions for the production of the 3D visualization.

Also, indications for the chronology of the visualization process can be derived from this definition. First of all, the planning process and the implementation of the visualizations define the functional character of 3D visualizations. The information needed in the specific planning situation is decisive for the content to be visualized. Both require for a certain design of the visualization so that this can be decided on when these factors are known.

In the following chapter, the functions of images regarding communication and learning of knowledge with results from psychology and pedagogy are specified. In addition, design aspects assisting these functions are mentioned.

3 Functions of 3D Visualizations for Knowledge Communication

Images can have various functions. Studies assessing the efficiency of learning with images underline the following functions as important for human information processing (LEWALTER, 1997, WEIDENMANN, 2002):

- ***Motivating*** the beholder by activating his interest and curiosity.
- ***Situating*** the content in a larger context and providing for relations to the real world.
- ***Demonstrating*** a significant aspect.
- ***Supporting the construction of complex mental models*** or providing for an addition to an existing mental model.

These aspects are also important in phases when information has to be communicated in a participative planning context, e.g. in moderated workshops (SEIFERT, 2002).

In the beginning of a workshop the audience has to be interested for the topic. Images are very suitable for this task as they can provoke something because of their direct emotional effect. Motivation can be reached with images that have an appellative function calling for an action. So called push images or images acting as a stimulant that are giving an impulse fulfil this function. “Push” is a term used in advertising and techniques used in this branch of business are suitable to produce images with appellative function (DOELKER, 1999), e.g. provocative, attractive or shocking images and headlines as well as animated images that cause a subconscious automatic reaction (DRANSCH, 1997). Certainly, it has to be deliberated carefully about the choice of the technique regarding the aim of the workshop, especially if ‘shocking images’ should be used.

Images providing for a scenario, in the sense of a certain setting or scenery, help to integrate detailed information in a larger context. Scenarios can activate the imagination of the situation from everyday life experiences due to effecting the emotions (WEIDENMANN, 2002). These situating images can be spatial or textual. They give a hint to the real situation or a real event in space and time (DOELKER, 1999). A (photo)realistic design of visualizations is most effective but can cause a search for errors which affects the process of getting involved. Therefore, it is suggested to reduce the content to characteristic elements illustrating the situation (DRANSCH, 1997).

In contrast, scientific visualizations are produced with the intention rather to uncover relationships of visual or non-visual functions than to represent reality. The visualization of spatial-functional landscape relationships, e.g. the impact of agricultural management over time on the landscape functions as economic, ecological, and social area, can be a very complex issue (LANGE & WISSEN, 2004). With 3D visualizations, the data can be reduced to a compact format that is simultaneously presented to the human eye. Using the abilities of human perception, the time to take up the information can be optimised (HEINTZ & HUBER, 2001).

In this context, so called demonstrational images are useful for showing and explaining landscape functions. Research on visual perception has proved that solely presenting the required information can maximise the speed of perception (EASTERBY & ZWAGER, 1984) Abstract contents can be shown more comprehensible by stressing significant characteristics and omitting irrelevant features. These are the main techniques used to draw the attention of the beholder on the important and characteristic elements (DOELKER, 1999; WEIDENMANN, 2002). One problem is that the accuracy of data may suffer due to the reduction of complexity and false interpretation is possible (EASTERBY & ZWAGER, 1984).

Simulating images e.g., future scenarios can be seen as coaching for a lack in imagination. The benefit of these images with regard to landscape development is that experience can be anticipated. This means that it could be learned from errors without conducting them. This is a rather crucial function as decisions that can cause harmful and not reversible environmental impact must not be made (DOELKER, 1999). The advantage of 3D visualizations compared to maps or texts is that the function of these images is not solely to explain certain issues, but to include and address the emotional aspect of the experience, too. Beyond this, the better imagination of different dimensions of a landscape development can be the basis for individual ideas of alternatives (LANGE ET AL., 2004). Like this the visualizations can contribute to the construction of complex knowledge structures (mental models) and activate their further enhancement. Images assisting in the comprehension of complex sections of reality by providing visual information on the elements and their interrelationships have to deal with the problem of complexity as well (WEIDENMANN, 2002).

In summary, it can be said that the design of 3D visualizations with the use of didactical principles requires for the arrangement of the information content based on the function the visualization should have in the communication process. STROTHOTTE (1998:19) states that "information visualization deals with how to depict an extract of an information space, how to visually communicate important features of data". The recommendations found regarding the design of images supporting the itemised functions, are rather general and refer to various aspects. Nevertheless, in pedagogic studies it was determined that a medium degree of reality and complexity of images had a positive effect on the learning performance (LEWALTER, 1997), and thus the comprehension of the issues. In the following chapter, the terms “realism” and “complexity” are defined as to their meaning for information visualization in the context of landscape planning.

4 Realism and Complexity in 3D Landscape Visualizations

Landscape visualizations are a more or less abstracted imitation of the complex reality (LANGE, 2001). Reality can be understood as the sum of the existing and the actually given, and thus it is concrete. The opposite of “concrete” is “abstract”, in the general sense, by separating the essential from the randomly existing (BROCKHAUS, 1997). Regarding the prior described image functions, information visualization requires for different degrees of abstraction. These have to match the content to be transferred by containing the most important information needed for a specific purpose.

In geological, biological and environmental sciences the expression “complex” stands for spatial or systematic structures that appear as functional entities or holisms. These can be differentiated by partial complexes standing for a part of the whole system. For example vegetation, soil form and water balance are key characteristics in landscape ecology expressing complicated relationships, and representing a part of the geo-ecological system respectively (LESER, 1997). In 3D landscape visualizations the differentiation of the complex spatio-functional relationships of the real landscape are an important task to make these interactions more comprehensible as they are almost only partly considered in landscape planning processes (LANGE ET AL., 2004) Visualizing smaller entities of the whole system indicating the extent of specific functional relations or their spatial dimension for a particular issue are challenging but have proven to be doable (HEHL-LANGE, 2001). A comprehensive evaluation of landscape development concepts requires the combination of these indicators which is again a task of complexity for their visualization.

How these principles found can be used, is analysed amongst other items in the frame of the EU-project ‘VisuLands’. 3D landscape visualizations are applied to current planning tasks of participative landscape planning processes in the Entlebuch UNESCO Biosphere Reserve (UBE), Switzerland. With social science techniques the responses of the users are evaluated (LANGE ET AL., 2003b).

The 3D visualizations given in the next chapter show examples for relevant issues and demonstrate possible applications of the principles found regarding image functions and degree of abstraction and complexity.

5 Examples for 3D Visualizations and Their Functions in a Participative Planning Context

In Fig. 1, a scenario on forest growth on the alpine farms in the UBE is shown. It was used in the initial workshop on the participative elaboration of the Forest Development Plan in the UBE and had principally the function to motivate the participants to give their own opinion on the shown topic. The 3D visualizations depict the provocative hypothesis by the facilitators of the workshop that the forest growth affects valuable habitats and leads to a monotonous view of the landscape.

The visualizations were produced with a medium level of realism and a rather low level of complexity. For the representation of the agricultural land use classes, textures are used that allow for a very coarse classification in different pastures and thus habitats. All forest is made up of billboards of firs (Picea abies). The whole process of forest growth on alpine pastures due to management changes and the affect on landscape ecosystems is rather complex and the functional relationships are manifold. Making it less complex, the functional relationships were differentiated and only the aspect of the changes in the land use and the correlating changes in the visual landscape were demonstrated.

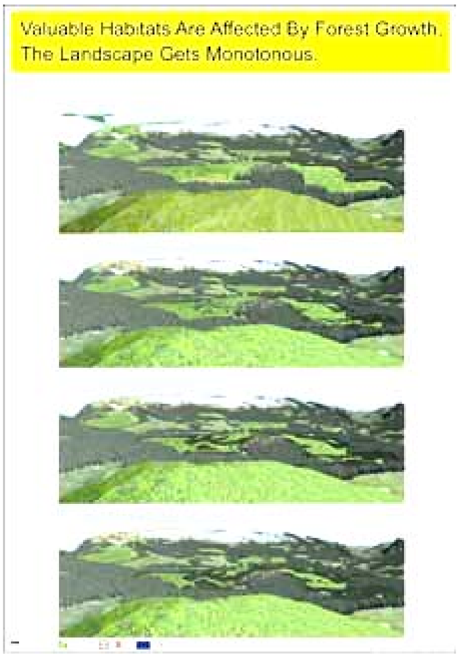

Fig. 1: Examples of 3D visualizations presenting a scenario of forest growth on alpine farms in the Entlebuch UNESCO Biosphere Reserve used in a communicative planning context as a stimulant. (Visualizations ©VisuLands 2004; Geodata © Cantone Luzern, GIS-Coordination office).

In the actual workshop, the participants reacted actively on the hypotheses presented on the posters. However, the reaction could not be assigned clearly to the visualizations as the text had stimulating effect as well.

For a better location of the presented situation the images were linked to a 3D visualization providing for the overview on the area. This 3D model is characterised by an abstract representation of the landscape with a topographic map draped on the relief. Few labels name the landmarks important for the orientation. The degree of complexity is rather low, too. The polygons show the position of the pastures visualized in the more realistic visualization. A line from the abstract model to the more realistic one indicates the view point of the latter.

Feedback on the abstract overview model give first hints that it allows for a better orientation than 2D maps. However, one has to be careful with the change of the perspective in this model during the presentation as beholders get lost very quickly.

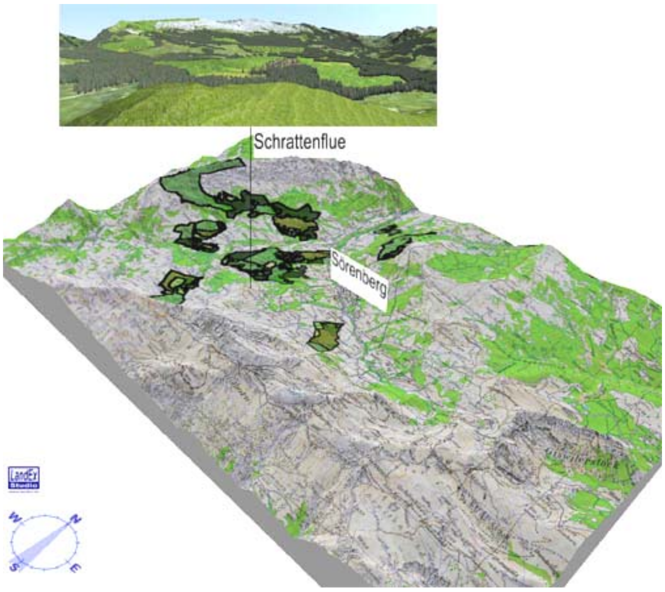

Fig. 2: Situating the single more realistic view in a larger spatial context by the link to a more abstract 3D visualization providing for the overview on the area. (Visualizations ©VisuLands 2004; Geodata © Cantone Luzern, GIS-Coordination office).

The 3D visualizations of the development of a small area demonstrate the impact of changes in the grazing system on the alpine pastures in the study area over time. Here the focus is laid on the development of the visual landscape quality and on the shift in the presence of species at vegetation level. The degree of realism is the highest compared to the visualizations shown in the other figures. But even though single species on the pastures are represented, there is an abstraction of the actual vegetation to indicator species of the mapped vegetation types. Participants of a workshop in the UBE regarded these visualizations as useful to explain crucial landscape processes to people not familiar with the area.

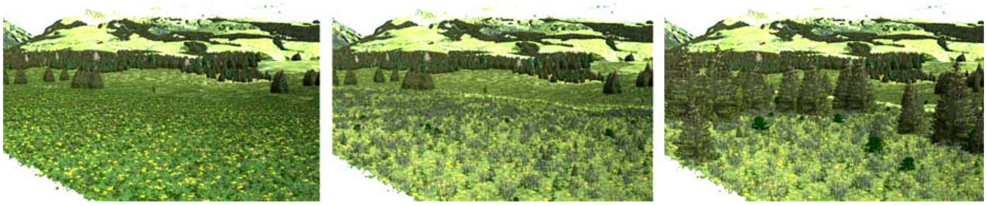

Fig. 3: 3D visualizations demonstrating the impact of a shift in the grazing system over time (from left to right: today, within 5 years, within 30 years). (Visualizations ©VisuLands 2004; Geodata © Cantone Luzern, GIS-Coordination office).

These are only a few examples of the design and application of 3D visualizations with different functions assisting in the comprehension of landscape planning issues. Results from empirical testing in planning practice reveal their potentials for effective information communication. Nonetheless, for the definition of explicit design guidelines the findings are too weak as yet.

6 Conclusions & Outlook

Visual communication is of interest for various disciplines but while the practical side of visual communication design is very well established, the theoretical part - analysing the production, the product and its impact - lacks literature (MÜLLER, 2003). In addition, only general advices for a user friendly design of images can be found. As the degree of realism and complexity is of importance for both, the human process of managing the received information, and the technical process of structuring and designing the content presented in the visualizations, these aspects will be further analysed. In the next step, the 3D visualizations will be tested in an experiment to get an answer on the degree of realism and complexity appropriate to support the functions of images that are assisting lay people in the comprehension of information relevant for the planning process.

The development of design principles is not only of interest for an effective information transport. A lower degree of realism and complexity of production comes with lower time consuming design effort and rendering time. This aspect is crucial with regard to the economic efficiency of the images in the landscape planning practice.

It should be kept in mind that with the increased use of 3D visualizations in landscape planning, expectations for their added value for participative planning processes are high. Therefore, it is more important than ever to work on a guideline for the production of these images to avoid weak or ineffective design that restricts the communication of information or lead to false interpretations. Optimizing the representation of content in 3D visualizations regarding the functions of the images in the communication process can help to avoid mistakes before they are put into practice.

7 Acknowledgements

This work is part of the project «VisuLands– Visualization Tools for Public Participation in the Management of Landscape Change», funded by the European Union 5th Framework Programme, Quality of Life and Management of Living Resources, and the Swiss State Secretary for Education and Research (SER). Special thanks apply to the Canton Lucerne for providing the digital data of 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.

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