1 Introduction

During the so-called ‘dot-com boom’, the term interactivity was over-burdened with expectations, although its actual meaning remained rather vague. Nevertheless, strong arguments support the ability of interactive features to considerably enhance the effectiveness of real-time visualizations especially in planning participation. However, there is a lack of empirical evidence of their potential benefits, and with the growing relevance of integrated landscape visualization systems today, the need for research and guidance on the design and the use of interactive visualizations in collaborative environments is ever increasing (SHEPPARD 2001).

The basic hypothesis of this paper, which relates to a PhD thesis, is that a high level of participation in the planning process requires a sophisticated level of interactivity from computer-based visualization tools. Based on a working definition of interactivity in the context of planning, workshop meetings with the use of interactive 3D visualizations were analysed, and useful applications as well as limitations of interactive features were discussed.

2 From Information to Participation

Based on approaches for problem solution from systems engineering in general (HABERFELLNER 2002) and planning theory in particular, it can be said that any planning process contains the following three phases:

- Analysis of the situation
- Goal definition
- Assessment of alternative solutions

In a cooperative planning approach, these basic elements of the planning process are subject to the exchange of collective information, discussion and decision-making by all relevant stakeholders. Between these phases, feedback loops may take place and the degree of participation may differ with regard to the task at hand as well.

2.1 Levels of Participation

ARNSTEIN (1971), the first to determine and differentiate different levels of participation in a collaborative process, concluded that real participation involves the cooperative sharing of power, i.e. in the form of partnership, delegated power, and citizen control. She described a ‘ladder of citizen participation’, where informing, consultation, and placation
are taken as ‘degrees of tokenism’, which means that people take part in the planning process, but without any real decision power. On the lower side of the scale, attempts at manipulation or therapy are not regarded as participation at all.

For the case studies in this research, it is assumed that high levels of participation, i.e. cooperation and collaborative decision making, are given. Provided such optimal conditions exist, it is the key assumption of this paper that visualizations require a certain degree of interactivity in order to fulfil beneficial functions in a participatory process.

2.2 Functions of Visualization in Participation

MaCEAhREN et al. describe visualization as “an act of cognition, a human ability to develop mental representations that allow us to identify patterns and create or impose order” (1992) or, in other words, a visualization is the representation of complex issues by visual means as a tool for exploration and communication. This paper particularly refers to landscape visualizations, i.e. the computer-generated representation of landscapes on the basis of real-world geodata.

WeIDENMANN (1995) has distinguished four functions of media with regard to the purpose of communication, which have been transferred to the visualization of spatial data by DrAnsCh (2000):

- Motivation
- Demonstration of an idea or phenomenon
- Creating mental models of spatial elements and their relations
- Putting information in (a spatial) context

2.3 Defining Interaction and Interactivity

DANAHY (2001) argues that the perception of landscapes from still images is inherently biased because still images only address parts of the human visual system. Therefore, he sees great potentials in current real-time rendering techniques which incorporate dynamics in landscape visualizations as well. Similarly, ErVIN (2001) distinguishes three types of dynamics in the landscape in his research agenda for digital landscape modelling and visualization: movement of the landscape, movement through the landscape, and interaction with the landscape.

At this point, it seems necessary to clarify the term interaction. What exactly does it mean? A literature review shows that a generally accepted definition of interaction is almost impossible, because the term is widely used, and its meaning varies for each discipline. Originally, the term interaction was derived from the Latin “inter – between” and “agree – acting”, and it has been used in sociology to describe how people influence each other. A key attribute of human interaction is that the participants share a common objective for their action. The term has been adopted by Human-Computer-Interaction (HCI), a rather new field of computer science, where interactions describe the actions between human user and computer. Related disciplines, i.e. geovisualization and media studies, have combined these approaches in a basic definition that describes interactions in 3D landscape visualization. In this context, interaction is defined as
The derived term interactivity refers to the capacity of a computer system to provide interactive features. There is a range of interactive features, e.g., movement, navigation, selection, explanation, manipulation, etc., that may be assigned to various planning tasks. In this context, a typology or ranking of the various features is helpful, although this depends on specific criteria. A preliminary classification with regard to the technical sophistication of interactions was introduced by Peterson (1995) and Crampton (2001). First, they stated the possibility to interact with the data representation in order to change the ‘look’ of the data, e.g., by changing the lighting and other settings. This is a rather low level of interaction that normally takes place on a global level and will not be examined further in this text. Particularly in landscape visualization, three more sophisticated levels of interactions may be distinguished:

1) Movement through the landscape
   Moving through the landscape or toggling through time, the user technically sees a series of views of a terrain that give the appearance of movement (animation).

2) Interaction with the landscape or rather the underlying data
   For this type of interaction, the focus is on the data. Selecting, filtering, and manipulating the data base of the landscape model are inherently interactive features.

3) Contextualizing interaction
   Contextualizing interaction can be realized by linking visual elements of the 3D model to related non-visual information fields.

Although such a topology may help in identifying the technical opportunities of interactive landscape visualizations, an assessment of their benefits for planning purposes requires a classification with regard to their function in the planning process (Fuhrmann 2001). Therefore, the question how interactive functions contribute to the basic participation tasks of situation analysis, target definition, and solution discussion was examined in an explorative case study.

3 Case Study: Applying Interactive Features of Landscape Visualizations in Moderated Workshops

The application of interactive landscape visualizations as tools for participation was tested in the Entlebuch UNESCO Biosphere Reserve (http://www.biosphaere.ch). The Entlebuch Biosphere Reserve was chosen as a case study site, because it was the first Biosphere Reserve to evolve from a ‘bottom-up’ process. That means the application to the UNESCO came from the local community, and it was adopted in a referendum in 2000 with 90% support. Since then, many projects on the sustainable development of the region have been initiated and the Biosphere management is supporting this process by facilitating panels and workshops on tourism, agriculture, energy, local economy, forestry, and other topics.
3.1 Setting: Moderated Workshops
In the Entlebuch Biosphere Reserve, interactive visualization tools were tested in seven comparable workshops. The planning tasks included addressing scenarios for tourism and agriculture and the forest management plan of Entlebuch. Participants were local stakeholders, including farmers, forest owners, members of the local tourism board, hunters, and external experts. Because the topics are related to each other, broad participation was sought, e.g. the tourist managers also took part in the discussion of the forest management plan, which includes zones for tourism. The level of participation was generally high, aiming at collaboration and group decision making, with workshops as the key instruments of participation. The workshops were facilitated by a moderator and attended by a navigator who operated the visualizations according to the wishes of the workshop participants or the moderator. It became evident that in a workshop setting, previous coordination between moderator and navigator is necessary for the successful integration of the visualizations. The visualizations ran on a desktop PC using the LandXplorer Studio software by 3D Geo GmbH (http://www.landex.de) and were projected onto a screen.

Fig.1: Application of 3D visualizations in a moderated workshop on the development of tourism in the Entlebuch UNESCO Biosphere Reserve

3.2 Qualitative Approach
Data on the impact of the visualizations during the workshops was gathered using qualitative measures, i.e. observations, group discussions, and in-depth interviews with the moderators and key stakeholders. The data was analysed in a qualitative content analysis, based on different methods of data collection (methodological triangulation). Preliminary results from this study were then introduced in the following part by giving application examples for different participation tasks and discussing user response.

3.3 Potential Benefits for the Situation Analysis
Planning Task: Strategies for Tourism in Sörenberg
Most visitors come to Sörenberg (1165 to 2350 meters above sea level) to take part in winter sports, so safe snow conditions are a key driving force. In addition, the
infrastructure needs to be adjusted to match existing demand. The discussion started with a summary of existing infrastructure in tourism and visualizations were used to show the distribution of winter facilities in comparison to hiking and biking routes for summer tourism.

**Interaction with the Data Representation, Contextualising Information and Database**

Ski slopes, lifts, and hiking paths were projected step by step on a 3d model of the area and then presented from different perspectives. It became clear that all ski facilities are very much concentrated in the area south of Sörenberg, whereas summer facilities are dispersed across the region.

Protocols indicate that the iterative construction of the model and the application of different views (**interactive representation**) helped in orientation and in assessing the current situation. In any case, it should be noted that interactions are time-consuming processes, because all participants have to orient themselves, follow each action, and give feedback if required.

A 3D animation, linked to a diagram, was used to illustrate the changes of traffic numbers per day over the year. The participants requested this specific information, although they generally recommended the integration of more non-visual information.

However, this **contextualising interaction** was not immediately possible because the necessary data was not available during the workshop. In other words, the possibility to set 3D visualisations into a non-visual context depends on the availability of complementary data.

The moderator asked for visualizations of a scenario from climate research, which was done by colouring the elevation model. On basis of a study by FÖHN (1990), a future level of probable safe snow conditions of 1500m in 50 years was chosen, and this level as well as all the areas below it were coloured green after consultation with the moderator (fig.4).

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**Fig.2:** Visualization of forecasts on safe snow conditions by colouring the 3D model, representation of skiing facilities in black vector lines (©Geodata: GIS-Koordinationsstelle, Kanton Luzern)
Although the numbers had been well known before, the visualization caused some discomposure and astonishment, until people recapitulated that “the green will be without snow”. After this demonstration, the focus of the discussion shifted from the enhancement of winter sports to alternatives in hiking, educational and agricultural tourism. From the meeting minutes, it may be suggested that the elevation analysis was the turning point and the moderator confirmed that it had a very strong impact on participation. Nevertheless, it should be noted that one participant felt uncomfortable working with the 3D images and stated that they were manipulative, because they had such a strong impact. This will be an issue for future research; whether the interactive implementation of the analysis provides any benefit in transparency and confidence building or if it is perceived with similar or even more distrust than prepared still images.

### 3.3 Potential Benefits for the Goal Definition

#### Planning Task: Forest Management Plan

The Biosphere management and the local Forestry Commission organised a series of workshops together on the cooperative development of the forest management plan in autumn and winter 2004/05. During this series of workshops, 3D visualizations were not requested at every stage, but the demand depended on the discussion topic and even more on the moderator and his or her style of moderation.

#### Interaction with the Data

After local stakeholders had identified the topics that were relevant to them, all interest groups, i.e. hunters, members of the tourist board, forestry commission, had the opportunity to map their interests on paper printouts of the ordnance map. The VisuLands team digitized these maps with the interests of the stakeholders and overlapped them in a 3D block model (fig.3). Finally, the interest groups met again and discussed conflicts of interest with regard to the 3D visualization.

**Fig.3**: Visualization of conflicts in interest by the interactive overlap of two thematic maps: wildlife areas (left) and additional summer-/winter-tourism (right) on the basis of a 3D block model overlaid with topographic map (©Geodata: GIS-Koordinationsstelle, Kanton Luzern)

Feedback indicated that the interactive 3D visualizations supported the communication of the spatial situation by putting information from previous workshops into a different
context. Furthermore, the moderator emphasized that the visualizations were of great benefit for the discussion and that they helped him to set up a task force with members from all interest groups.

It can be concluded that the interactive visualization of areas of conflict supported the discussion in the large panel and helped the participants reach a consensus. However, it seems that the technique was not flexible enough to facilitate the work of small working groups, who chose paper maps to sketch and discuss their areas of interest.

3.4 Potential Benefits for the Assessment of Alternative Solutions

Although the workshops have not yet entered a phase where alternative scenarios are being discussed, participants have already expressed their expectations on how the visualizations may benefit the forthcoming decision making process.

Movement through the landscape and Contextualizing Information

During the situation analysis and goal definition, the realtime functionality of the model was mainly used by the navigator to quickly navigate between points of interest. This should be done carefully, because any abrupt movements cause a disruption and people could be distracted from the discussion. However, the ability of users to move through the landscape themselves might be more important for the assessment of alternative scenarios. Nordic skiers, for example, wished to view how the future forest will look when moving along the ski slopes. By means of temporal animations, a forest manager said that he would be very interested in the animation of future forest growth. In the workshops on agriculture, switching between alternative land use scenarios had already been introduced, showing that this ‘toggling’ interaction aids in the perception of differences. These observations imply that the use of movement requires careful consideration and that its use is recommended only in specific situations.

Various stakeholders emphasized the importance of adding contextual information to the 3D visualizations, e.g. diagrams and statistics, in the decision making phase. It will be the subject of forthcoming research steps to evaluate to what extent such a contextual link benefits a balanced planning proposal assessment.

4 Conclusions & Outlook

The case study has shown where interactive features contribute to the use of 3D landscape visualizations as participatory instruments in planning workshops. In the situation analysis, an interactive, iterative construction of the situation helps to demonstrate spatial phenomena and create a mental model of their relations. By conducting analysis operations on the data itself, it is possible to highlight any driving forces that are related to topography in realtime during a workshop. Finally, the spatial model can be complemented by adding non-visual information in the form of diagrams and figures, depending on the available data. During the process of goal definition, the interactive presentation and overlapping of maps to show different stakeholder interests in their spatial context may contribute to consensus building. Furthermore, all participants emphasize that contextualizing
interactions are valuable contributions to the assessment and decision making process. Overall, the possibility to move through the landscape provides the navigator with some of the flexibility that is necessary to react to participatory processes, which are open-end by definition. However, it should still be clarified whether multiple perspectives are able to overcome manipulation accusations or whether they are regarded as being manipulative, too. At least, it seems clear that participant confidence in the visualizations also depends on the data quality and the moderation process.

In general, any interaction requires the attention of the audience, and the navigator needs to be aware of how the discussion process may take advantage of this additional attention. Therefore, coordination with the moderator and a careful consideration of how the interactive features are presented, are crucial. Otherwise, it must be considered that interactions take time and in many participation processes, time is a rare good. In the worst case, an inadequate use of interactions might even distract the discussion process.

Altogether, it is concluded that 3D landscape visualizations applied as tools for participatory workshops in planning do benefit from interactive features. In contrast, still images often fail to provide the degree of flexibility and the contextualization required in participation processes. Hence, interactive visualizations are mighty tools, although they have to be used with careful consideration or, as one of the moderators said, it is a “very selective tool”.

Future research for this project will focus on the assessment of alternative scenarios with the help of interactive 3D features, other participatory settings, and the role of immersive visualization systems in collaborative settings. Immersive visualization systems might be realised by joining several screens to a panoramic facility and they may support the viewer in conceiving the spatial character of a location (Danahy 2001).

Furthermore, it is suggested that the design of the participation process should get more attention with regard to the use of interactive visualization tools, e.g. how do moderator, panel and navigator cooperate? Finally, a successful application of interactive 3D visualization tools must incorporate both aspects: the design of the tools and the design of the application process.

5 References


