Does real-time visualization support local stakeholders in developing landscape visions?

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Abstract. Research on visualization during participatory planning workshops is widespread, but there are hardly any studies comparing workshops with and without visualization. We conducted four workshops with local stakeholders to develop landscape visions for the year 2030. In three workshops we used different techniques to support the visioning process with real-time visualization: drawings by hand, a town planning computer-aided design software, and a combination of GIS, Google Earth, and SketchUp with Cinema 4D. In the fourth workshop the participants developed their visions without any visualization. In all cases the participants evaluated the workshops expost by means of a standardized questionnaire. The comparative analysis of the data revealed that visualization supports the participants consistently but only moderately in imagining future landscape conditions. In particular, visualization provided a better common basis for communication, whereas it only marginally inspired the viewers to develop new ideas. The main trade-off of using visualizations that we found was that the participants assessed their influence on the discussion as too strong as they focused the discussion on visual aspects. Among the visualization techniques tested, drawings by hand appeared to be particularly useful for creating long-term (more than fifteen years) landscape visions. Future research on the use of visualization during workshops should concentrate on the perceptions and requirements of the viewers.

Keywords: visualization, planning processes, perception, computer-aided design, built environment

1. Introduction
Humans perceive landscapes first and foremost in a visual way (Ribeiro et al, 2013). Consequently, any changes in a place’s landscape scenery will affect its touristic and residential quality (Buchecker, 2009; Hunziker et al, 2008) and should be taken into account in spatial planning projects. Local stakeholders have, therefore, been increasingly involved in landscape planning processes. Practical experience has, however, shown that it is very difficult for both residents and tourists to imagine future changes in a given landscape and to anticipate possible impacts on their well-being (Buchecker et al, 2003; Soliva and Hunziker, 2009). For this reason visualization is being used increasingly in landscape planning, as it is thought to support the viewer in imagining future landscape conditions, particularly lay people who may not be familiar with maps and other two-dimensional planning documents, and help them to understand complex planning issues more intuitively. Recently, a variety of visualization techniques have been developed and implemented in participatory planning processes. Photorealistic visualizations, artistic renderings, and three-dimensional (3D) simulations on the basis of geographical information systems (GIS), and computer-aided
design (CAD) software have become rather popular among landscape planners and they continue to be improved (Bentrup and Wells, 2005; Bishop and Lange, 2005; Lewis, 2012; Sander and Manson, 2007). Currently, the emphasis is on visualization tools that allow images to be created and changed immediately according to the viewers’ wishes so the users can quickly obtain a visual impression of the potential consequences of their planning decisions.

There is a substantial body of literature on the way participatory processes can foster sustainable landscape development (Buchecker et al, 2010; Garmendia and Stagl, 2010; Höppner et al, 2005; Menzel and Buchecker, 2012; Volker, 1997). Some preliminary studies have also explored the effects of visualizations during landscape planning workshops with local stakeholders (eg, Al-Kodmany, 1999; Lewis, 2012; Lewis et al, 2012; Pettit et al, 2011; Salter et al, 2009; Schroth et al, 2011; Wissen Hayek, 2011; ). It is, however, not evident to what extent different forms of visualization can support local stakeholders in discussions on long-term landscape developments.

Most studies on the effects of visualizations have focused on 3D visualizations with GIS and CAD. Salter et al (2009) conducted an explorative case study with real-time 3D visualizations at two workshops. They combined GIS, CAD, and a digital terrain model to visualise potential densification of residential areas on Bowen Island in the suburbs of Vancouver (Canada). Schroth et al (2011) used the method of cross-case synthesis to analyse three workshops on possible future landscape development in a pre-alpine region in Switzerland, and Wissen Hayek (2011) analysed five workshops on landscape development in another region in Switzerland. The workshops differed not only in the topics discussed (tourism, agriculture, or forestry), but also in the levels of realism and interactivity of the visualizations. Both Swiss studies emphasized the positive effect of visualizations on people’s motivation to participate in a planning workshop. They also found visualization useful to give information about the problem to be discussed and to make the participants more familiar with the problem context. Further, they pointed out that visualization provides a common basis for communication and thus supports consensus building among workshop participants.

More recent studies have evaluated different visualization tools in terms of the users’ quality requirements. Lewis (2012) investigated the effects of artistic renderings in terms of how realistic and credible the viewers considered the images to be, and which kind of rendering they preferred. He created different renderings for specific features in an urban park (eg, park entrance, restaurant, and art gallery) and presented the pictures to members of the park’s masterplan task force and students of environmental science. The informants viewed and assessed the images on a computer screen in single sessions. Similarly, Pettit et al (2011) ascertained the requirements of different user groups in terms of the design of 3D visualizations representing different future landscape conditions. They used different visualization software packages available online and presented the images to professional planners (as examples of current users) and to students (as examples of future users) during semistructured or online interviews, respectively. These studies recommend photorealistic representations because their content is assumed to be understood the best and they look the most objective. The viewers reported that they did not feel manipulated or disturbed while making their decisions.

In most cases, visualization is used to evaluate given alternatives in the context of advanced planning projects, and not to substantiate new ideas or visions that the participants develop immediately during the workshops. So far, only a few researchers have studied the performance of visualizations for specific planning purposes. Al-Kodmany (1999) applied different visualization techniques in a participatory neighbourhood planning process in the city of Chicago, and investigated their suitability for different planning phases. While the studies considered above exclusively employed digital visualization techniques, he included
not only GIS maps and computer photomanipulations, but also sketches made by an artist. Abstract GIS and draft-like drawings by hand turned out to be best suited for brainstorming and visioning phases, whereas photomanipulations and photorealistic 3D visualizations appeared to work better in the more concrete projecting and planning phases. It is still, however, unclear if real-time visualization supports the actual decision-making process by motivating the participants to be creative and to develop new ideas mutually. Further research on users’ perceptions of visualizations is needed (Lewis et al, 2012). Systematic, quasi-experimental evaluations of the effects of visualizations are rare because most research on real-time visualization has been case-study research on workshops in real-world situations, where real stakeholders discuss real planning problems in their regions. In these studies, the researchers have very few opportunities to influence the goals and processes of the workshops. In addition, they are usually unable to repeat their experiments under similar conditions: that is, with similar stakeholder groups and similar planning questions. In particular, research comparing workshops with and without visualization seems to be lacking.

Our study addresses these gaps by systematically evaluating the contributions of different visualization techniques, including the variant of no visualization, to stimulate discussion on future landscape developments among local stakeholders. In particular, we aimed to answer the following research questions: (1) Does real-time visualization support the participants in imagining future landscape conditions? (2) Does real-time visualization stimulate the participants to develop new ideas? (3) Does real-time visualization provide a common basis for communication? (4) Is real-time visualization only a fun factor? (5) Are the individual visualization techniques perceived differently by the participants? Our study differs from most previous research in three ways: (i) it focuses on participants’ visions and new ideas instead of their assessment of previously given planning alternatives; (ii) it integrates a control group who did not experience real-time visualization; and (iii) it compared different visualization approaches.

2 Materials and methods
2.1 Research design
Our case study is part of the comprehensive transdisciplinary research program Room for People and Nature (http://www.wsl.ch/raumanspruch), which aims to develop scenarios of future landscape development in four different periurban regions near the metropolitan region of Zurich (Switzerland). As it is part of a scientific research program, our study was independent of any political processes such as the revision of zoning plans. Thus, we had more leeway in designing the workshops. Nevertheless, the participants still benefited from the workshops because they had the opportunity to discuss an issue that they considered to be highly relevant but neglected in the daily business of local politics.

In each of the four case-study regions, we conducted a workshop with local stakeholders to develop a common vision about the future development of their particular region. The workshop topics were about quality of life and rather long-term visions concerning potential situations in 2030: that is, seventeen years into the future. Thus, the discussions focused mostly on socioeconomic and environmental aspects, and spatial accuracy was less important than it would be in actual spatial planning workshops. The principal question addressed in our workshops was: “What will your region look like in the year 2030 if it features an extraordinarily high quality of life?” Our intention was to make the participants express their actual wishes about the future landscape development regardless of any political constraints. Therefore, we did not include local zoning plans or similar official documents in the visualizations or discussions. However, we did consider some statements in informal documents about long-term regional development concepts and mission statements in preparing the visualization and moderation of the workshops. Both the stakeholder groups and the workshop structures
were very similar in all four regions. Three workshops used real-time visualization, and one was carried out without visualization. At the workshops with visualization, we applied three different visualization techniques in order to assess their potential to support the stakeholders in developing visions of future landscape states. All four workshops took place between April and June 2013.

### 2.2 Case study regions

Our case study regions were: the Linth plain region in Canton St Gallen; the municipality of Glarus Nord in Canton Glarus; the Seetal region in Canton Lucerne; and the Obere Freiamt in Canton Aargau. These are four typical periurban regions in Switzerland, all in the vicinity of the city-region of Zurich, which is the largest conurbation in Switzerland, and all less than one hour by car or public transport from the centre of Zurich. The Seetal and the Obere Freiamt are also within 20 minutes of the urban centres of Lucerne and Zug. This easy accessibility makes these regions attractive living areas for residents who commute to the larger cities, with the additional attraction of being in the countryside with rural landscape scenery and sunny and quiet residential areas. They all still dispose of free building lots, particularly for single-family houses. From 2000 to 2012, the four regions experienced population increases of 9% (Glarus Nord), 11% (Seetal), 16% (Oberes Freiamt), and 18% (Linth plain), because they still offer much more affordable housing than the conurbations of the big cities. The municipal councils in the case-study regions expect similar population growth up to 2030. They view this development ambivalently. On the one hand, resulting new taxpayers and particularly young families make the villages more lively and dynamic. On the other hand, the landscape may be affected by even more sprawl than has occurred in the recent past.

### 2.3 Workshop participants

Our goal was to find approximately 10 participants for each workshop. We kept the groups rather small so that they could work together on one picture at the same time, but large enough to represent a wide spectrum of interests. We looked for people very familiar with the everyday life in the particular region and strongly involved in its future development. We contacted the planning authorities of each canton, our funding partners, to suggest people we could invite to our workshops.

We ended up with eight to fourteen participants at the workshops. Most of them live in the respective region and many are involved in local politics. The workshop participants consisted of members of the municipal council, representatives of the municipal and Cantonal authorities, and members of local nongovernmental organization, such as nature and landscape protection associations or ornithological associations. The participants’ background knowledge ranged from farming, nature protection, landscape design, spatial planning, and place branding, to local politics. The individual workshop participants had very specific interests in matters such as agriculture, nature protection, and the regional economy and we aimed to reconcile these different interests in one common vision of the future landscape.

### 2.4 Workshop structure

All four workshops had principally the same structure. In the first ice-breaking step, the participants introduced themselves with their names, their connections to the region (eg. resident in the region, on the municipal council), and named their favourite place in the region. In the second step, each participant wrote on index cards the three most important strengths and weaknesses of the region considering quality of life. They then presented these individually and the moderator pinned and grouped the cards on a pinboard. In the third step the participants elaborated their visions for the region’s future development. We chose an open discussion for the workshops with visualization and group discussions for the workshop
without visualization. In all four cases we asked the participants to say what they thought the region would look like in 2030, if its weaknesses would have been overcome and its strengths made even stronger. In three workshops we moderated the discussion using real-time visualization. We asked the participants if the pictures shown corresponded to their visions, and what they wanted to have changed. The pictures were changed immediately, at least in a draft version. Each change was recorded either as a separate file on the computer or as a digital photograph. In this way, we documented how the discussion progressed.

The control workshop was without visualization. As there was no tangible picture for the fourteen participants to focus on in their discussions, they developed their visions for the future in small groups of three to four. We asked them to write on index cards what should change in the future and what should remain the same. They were also asked to express what the region could look like in the future after a positive evolution. In the following plenary session the group speakers presented the results of their group discussions and we recorded key words, particularly about what can make the positive trends visible, on a flipchart.

The workshop team consisted of the workshop leader, the moderator, one operator for each visualization technique, and a photographer taking pictures of the workshop procedures. With the drawings by hand (see also section 2.5) an additional photographer took photographs of the drawings at different stages to document the changes discussed. The workshop leader supported the moderator by recording keywords in the discussions on a flipchart and by giving advice on the visualizations. In the workshop without visualization, there was no visualization operator. Each team member participated in at least one workshop. The workshop leader and the moderator were the same in all four workshops.

2.5 Visualization techniques

We chose two perspectives for the visualizations: ‘bird’s-eye-view’ perspectives from well-known viewpoints to obtain overview images over large parts of the case-study regions, and ‘street-view’ perspectives for pictures of typical, well-known places in the regions. Since the workshops were not actual planning workshops but focused on quality of life, the visualizations did not need to be georeferenced pictures but rather they conveyed the atmosphere of a particular place. This was very important for the street-view pictures, which is why they often showed everyday scenes containing people. We chose different visualization techniques that might be used in planning workshops, including computer-aided georeferenced 3D visualization techniques, GIS, Google Earth, and a specific town-planning CAD software. In contrast, we also used artistic visualizations, such as Cinema 4D renderings in photographs and drawings by hand. The advantage of the georeferenced visualization techniques is that the resulting pictures can provide an immediate basis for drafting concrete spatial plans such as zoning plans. This may make the workshop participants more aware that they are actually talking about a real-world problem requiring decisions than the other artistic approaches used. Conversely, the drawings by hand and the Cinema 4D renderings may be better for reflecting the uncertainty of future visions about potential landscape development.

For Glarus Nord we produced the bird’s–eye-view pictures with a combination of the GIS software ArcGIS, GoogleEarth, and SketchUp (http://www.sketchup.com). The basis of the street-view pictures was photographs, to which we added further objects using the CAD software Cinema 4D (http://www.maxon.net). While Google Earth and the photographs showed realistic images of the current landscape, the features inserted using SketchUp and Cinema 4D (buildings, crop fields, vehicles, or people) were rather abstract. With this contrast we intended to stress that the workshop was about visions and potential developments, and not about tangible details of current projects. Prior to the workshop, the operators had prepared not only the images of the initial situation but also different layers of possible landscape changes. This helped to save time when adjusting the screen layout during the workshop. The
operators could, however, still modify the pictures by adding or removing single buildings. The preliminary results of the discussions were saved as screenshots. After the workshop, the operators developed the images in more detail, particularly the renderings from the bird’s-eye perspective.

In Lucerne’s Seetal, a scientific illustrator drew pictures of potential future landscape states according to the inputs of the workshop participants. She used pastel chalks, which she applied with various paintbrushes. In this way, she could easily paint over certain objects or erase them. She used a sketching technique that allowed her to draw very quickly, drawing silhouettes only, leaving out details, or drawing only the main characteristics of certain features. Before the workshop she painted the initial pictures from photographs. She was also able to test how best to display possible landscape changes in a pilot run at our research institute, and to develop more routine in the drawing technique. During the workshop in the case study region, a second operator took photographs of the preliminary results of the discussion. We also had the possibility of projecting the photographs onto a screen.

In the Linth plain we used the UrbanRoiDesigner (URD), which is a CAD software developed specifically for town planning (http://www.urbanroidesigner.com). Prior to the workshop, the operator produced a georeferenced terrain model of the region, which could be viewed either from a bird’s-eye or street-view perspective at any user-defined place. In addition, the operator had prepared stencils of possible landscape changes. In contrast to the digital visualization techniques used in Glarus Nord (GIS, Google Earth, SketchUp, photographs, and Cinema 4D), the URD landscape model showed a very rough picture of the natural environment, but buildings were displayed in much more detail. This was due partly to the fact that URD is a town-planning software. Moreover, URD’s screen layout was much quicker at generating the landscape picture the smaller the amount of information given. During the workshop, the images were modified immediately. The participants told the operator how they wished the landscape to be designed and the operator implemented their ideas in the pictures. The preliminary results of the discussions were again saved as screenshots.

Examples of the visualizations are presented in figure 1.

2.6 Workshop evaluation

After the workshops we asked the participants at the workshop without visualization to fill in a questionnaire with eight standardized questions about the workshop, and at the workshops with visualization to fill in a questionnaire with twelve questions. All questions were written as statements and the participants had to indicate their agreement on a five-point scale (5 = fully agree,…,1 = fully disagree). In all four workshops, we presented the same statements: how well the visualizations, or the workshop design generally, had supported the participants in imagining future landscape states, how well they had served as a common basis for communication, and how well they had helped the group to develop new ideas. The last question in all four workshops asked the participants how much fun they had during the workshop. The questionnaires for the workshops with visualization contained four additional questions about how well the participants could understand the contents of the images. In the questionnaire for the workshop without visualizations, we asked them participants if it mattered that there were no visualizations. As the number of participants was rather small, we refrained from conducting a detailed statistical analysis of the results and focused on the distribution of the answers as shown in bar charts in section 3 and in the medians for the responses.

We also assessed the workshops qualitatively. The photographers of the workshop process had the additional task of observing the participants’ reactions to the visualizations and their behaviour in the group work at the workshop without any visualization. After the final workshop, the whole research team met to exchange their impressions of the workshops. No video records were made in order to ensure privacy protection.
3 Results
3.1 Summary of the questionnaire results

Figures 2 and 3 present the distributions of the ratings for each statement in the questionnaire. We grouped the statements according to the research questions presented in the introduction. After each workshop, all participants returned their questionnaires. As not everybody completed all statements, the number of answers to the single statements was between 7 and 13. The distributions of the ratings differed for the statements and for the different workshops (figures 2 and 3).

3.2 Imagining future landscape conditions

Three statements in the questionnaire considered the first research question: (1) Does real-time visualization support the participants in imagining future landscape conditions? Only the workshop with the drawings by hand achieved high ratings for all statements in question 1 [see figure 2(a) – (c)], with narrow distributions around the highest scores, showing that the participants agreed fully (score 5) or rather (score 4) with all three statements. This indicates that the visualizations had helped them better understand the problem discussed, and helped them more than the workshop without visualization. This suggests that visualization in the form of hand sketches really supported the participants in imagining future landscape states. Responses to the same statements on the digital visualization techniques indicate these were less helpful in supporting participants in imagining future landscape states. When the participants at the workshops with visualization were asked directly, they all agreed that the visualizations were helpful for developing spatial scenarios [figure 2(c)]. However, after the
Figure 2 [In colour online.] Distribution of the answers to the questionnaire. Numerals (1) to (4) correspond to the research questions explored in the statements in the questionnaire: (a) (I) Does real-time visualization support the participants in imagining future landscape conditions? (b) (2) Does real-time visualization stimulate the participants to develop new ideas? (c) (3) Does real-time visualization provide a common basis for communication? (d) (4) Is real-time visualization only a fun factor? X-axis: 5 = fully agree; 4 = rather agree; 3 = partly agree; 2 = rather disagree; 1 = fully disagree. The colours of the bars indicate the different visualization techniques: blue = GIS, SketchUp, Cinema 4D; violet = drawings by hand; green = URD (CAD); red = no visualization.
workshop without visualization, the participants differed in how much they reported missing the presence of visualizations during the workshop.

3.3 Inspiring new ideas
Our second research question (2) explored whether real-time visualization helped the participants to develop new ideas. Statements were included to determine (1) how much the visualization used supported the participants in decision making [figure 2(d)], and (2) how much it enhanced their creativity [figure 2(e)]. The distributions in figure 2(d) suggest that, surprisingly, the participants at the workshop without visualization felt better supported in making up their minds than those at the workshops with visualization. The median for this workshop is 4, whereas for all workshops with visualization it is 3. Considering figure 2(e), the participants’ ratings of the workshop without visualization are much more concentrated (on the neutral value) than the ones from the other workshops. The opinions from the workshops with visualization show extremely even distributions, irrespective of the visualization techniques. This means that the participants’ opinions differed greatly, so whether real-time visualization has a stimulating effect seems to depend on the individual preferences of the participants.

3.4 Common basis for communication
The third research question (3) raises the issue of whether real-time visualizations provide a common basis for communication? As the distributions in figure 2(f) suggest, at least in terms of the drawings by hand (median = 4.5) and the combination of GIS, CAD, and Cinema 4D (median = 4), the visualization did seem to provide a common basis for discussion.
However, the participants’ ratings of the workshop without visualization also indicate that the participants rather agreed with the statement. Hence, visualization is not a prerequisite for establishing a common basis for communication at participatory workshops. Considering figure 2(g), the distributions of the ratings are particularly interesting. The participants at the workshop with the URD software reported feeling most influenced in their discussion by the visualization. There the participants were directly involved in the image creation and may have felt limited by the software. As one participant said after the workshop: “I think in this case the visualization even impeded the participants in developing visionary ideas.” The participants at the workshop with the drawings by hand were also involved in creating the pictures, and their ratings in figure 2(g) were divided. Half felt too strongly influenced by the visualization, while the others did not. Participants at the workshop with GIS, CAD and Cinema 4D, where most pictures had been prepared in advance, reported feeling less influenced in their discussions, as did those at the workshop without any visualization. To conclude, in our case study, visualization revealed not only having advantages but also drawbacks for guiding the discussion at a participatory workshop, depending on the main purpose of the workshop.

3.5 Fun factor
Is real-time visualization only a fun factor? Our fourth research question (4) referred to the frequently made conclusion that visualization enhances participants’ motivation to become involved in landscape-planning decisions (eg, Al-Kodmany, 1999; Wissen Hayek, 2011). From the ratings in figure 2(h), we cannot conclude that participants at the workshops with visualization had more fun than those at the workshop without visualization. During the preparation for the workshops, the participants were equally spontaneous in accepting our invitation to attend regardless of whether there was or was not visualization. Our participants might have signed up, because they wanted to get involved in the future development of their regions anyway. Hence, the motivation to attend a workshop does not depend on the fact that there will or will not be visualization. Moreover, real-time visualization does not necessarily improve the atmosphere at a workshop.

3.6 Perception of visualizations
Our last research question (5) explored whether the different visualization techniques are perceived differently using four statements in figures 3(a) – 3(d). The distributions of the participants’ ratings are given in figure 3. The drawings by hand achieved the best ratings throughout. The participants reported understanding the information presented in these visualizations most easily [figure 3(a)] and also found they had the best degree of detail and level of abstraction of information [figure 3(b) – 3(d)]. The URD pictures appeared to be least understandable since they were rated as not sufficiently tangible, too abstract, and too little detailed. The combination images produced with GIS, CAD, and Cinema 4D appeared to be rather easily understood but participants rated their detailed qualities similarly to those in the URD pictures, that is, not tangible enough, too abstract, and not detailed enough. The drawings by hand were richer in detail than the digital visualizations, but their information was actually very fuzzy and many details, such as storks in a fen or a child’s push chair, were only marked with tokens. As the participants had to develop visions of the landscape more than fifteen years in the future, the rather fuzzy drawings by hand may have been best suited for this task, which, in itself, includes a high degree of uncertainty.

3.7 Lessons learned from observations
After the last workshop, the members of the research team shared their impressions of the workshops in a separate meeting. Most felt that the pictures had focused the discussions on the specific locations or subjects they represented. At the workshops with real-time visualization
the discussions concentrated on visual aspects, whereas at the workshop without visualization the discussions emphasized social and cultural topics. Considering creativity, visualization may even have hindered the participants in developing innovative and visionary ideas. Not only did the researchers observing the workshops come to this conclusion, but also one participant at the workshop with the URD visualization, who also criticised the visualization tool (see also subsection 3.4). In contrast, we observed that the participants at the workshop without visualization expressed rather innovative thoughts in the group discussions, but for some reason failed to present these ideas in the plenary discussion afterwards.

The visualizations supported the discussions to different extents. Particularly in the workshop with drawings by hand, participants repeatedly left their seats to explain what they meant by pointing at the pictures to indicate how they could be developed further. The workshop using drawings by hand was most successful in developing a shared picture of future landscape states. The digital visualizations also motivated the participants to comment on the pictures and state their wishes and ideas for change. However, during the screen layout of the revised pictures, the discussions tended to move on to other topics (irrespective of the pictures) much more than in the hand sketch workshop. The reason for this may be that the visualization interventions can be followed much better with drawings by hand than with CAD. The moments with frozen screens seemed to irritate the workshop participants. The screen froze several times during the visualization with the URD software because the images were produced directly according to the participants’ instructions. The moments of untraceable image processing were fewer for the visualizations with the combination of GIS, CAD, and Cinema 4D because a variety of possible scenes had been produced in advance in specific layers.

4 Discussion
We wanted to determine the contribution of different visualization techniques to developing long-term landscape visions in small stakeholder workshops. Our study differs from other studies of real-time visualization in that the focus was on visioning and on comparing the workshops with and those without visualization, and the different visualization techniques. Our research design was useful for exploring the limitations of visualization during participatory workshops, and for highlighting the advantages of manual visualization techniques.

First, our findings show that real-time visualization may be helpful, but is not a necessary prerequisite for a successful landscape planning workshop. At first glance, our results support the findings of other authors that visualization during workshops helps participants to imagine the potential development of their home regions (e.g. Salter et al, 2009; Schroth et al, 2011; Wissen Hayek, 2011). However, when compared with the results of our workshop without visualization this effect appears to be rather moderate, especially as in the workshop without visualization the participants said they did not miss it. In addition, visualization appears to focus the discussion very much on visible aspects only, and participants tended to ignore social and other nonvisible topics. Therefore, issues involving such aspects may overstretch the capabilities of visualization.

Our findings do not, in spite of the enhanced research design, support clearly the claim that real-time visualization helps participants to develop ideas and visions. The respective effect of group work in the workshop without visualization was rather similar to the effect of the visualizations in the workshops. Wissen Hayek (2011) also queries whether visualization can inspire the generation of new ideas. This requirement may also go beyond the potential of visualization.

Real-time visualization was found to influence the discussions on landscape visions by either supporting or manipulating them. Our results support the view that visualization can
provide a common basis for communication. This, however, only holds true if the participants are able to follow the screen layout; otherwise the discussion runs the risk of digressing from the subject illustrated. Furthermore, it has to be noted that the participants may also feel restricted in their creativity due to the limitations of the visualization techniques, or because the visualization focuses the discussion on visible aspects. This may explain why half the participants in the hand-sketch workshop felt too strongly influenced by the visualization, although they could follow the screen layout very easily. Only in the workshop without visualization did the participants discuss social and cultural topics (see also subsection 3.7). Thus, our results support both types of studies: those that recommend visualization as a way to provide a common basis for discussion (e.g., Schroth et al., 2011; Wissen Hayek, 2011), and those that warn that visualization may restrict discussion (e.g., Lewis et al., 2012; Salter et al., 2009).

Our main finding in terms of visualization techniques was that drawings by hand were very useful for creating visions and scenarios. More sophisticated digital 3D visualization techniques are not necessary for this purpose. The URD software was developed for architecture and town planning and is not very suitable for modelling landscapes in its current stage of development. The other digital 3D visualization techniques have similar limitations. Al-Kodmany (1999) also recommends sketches and drawings by hand for the visioning phase of a workshop. Thus, it is important for workshop moderators to choose carefully the visualization technique best suited to the problem to be discussed. The visualization technique must be able to present the issues in a sufficiently tangible and detailed way. At the same time, the picture’s degree of accuracy or fuzziness must be appropriate for the planning phase. Therefore, we recommend that research should not focus on technical improvements only, but should also consider using manual visualization techniques during the different planning stages. This is in agreement with the conclusions of Al-Kodmany (1999), Salter et al. (2009), and Lewis et al. (2012). Studies recommending the development of more photorealistic 3D visualization (e.g., Bishop and Lange, 2005; Lewis, 2012; Pettit et al., 2011; Wissen Hayek, 2011) may refer to applications for short-term and advanced planning projects.

5 Conclusions
Our findings show that real-time visualization can be advantageous for the participatory development of landscape visions. However, we recommend paying attention to whether visualization is actually suitable for representing the topic of the workshop. Visualization proved to be most useful where visual aspects are decisive but is not indispensable for generating visions about the future quality of life in a region. Moreover, visualization is not essential for stimulating new ideas at a workshop, as we found at our workshop without visualization.

The particular strength of real-time visualization is in providing a common basis for the discussion. On the other hand, if the pictures are created according to their wishes, participants may feel overly influenced in their discussion. Therefore, we recommend choosing carefully the technique that corresponds best to the planning phase and the accuracy or fuzziness of the problem to be discussed. Sophisticated 3D simulations are by no means always necessary. Drawings by hand may be very suitable for fuzzy visioning or brainstorming. In addition, this technique can make a workshop very lively because the drawing process is easily traceable and familiar to everybody. In particular, where local authorities do not have powerful financial and IT resources, drawings by hand offer attractive options to implement real-time visualization in planning workshops.

We, like many other researchers, also recommend continuing research on visualization during participatory workshops. The emphasis of this research should, however, be more
on participants’ perceptions of the visualizations and their requirements, rather than on
developing technical simulation tools.

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