Virtual worlds – real decisions: Recent research in landscape modelling and visualisation and the potential of computer-based tools for planning

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Prominent construction projects, such as the planned "Sawiris luxury resort" by Orascom Hotels & Development (OHD), Cairo (Egypt) in Andermatt, Switzerland, or the idea of a hotel and apartment tower at Schatzalp, Davos, Switzerland, demonstrate how rapidly Alpine landscapes may undergo major changes (Box 1). Decisions on whether or not such changes are supported by policy makers should be based on the best information available and in agreement with the local population to ensure long-term sustainable development. Synthesis V of the Swiss National Research Programme 48 ("Landscape and Habitats of the Alps"; NRP48) investigates the potential and limitations of computer-based tools to support such decisions in the area of landscape planning with particular respect to Alpine landscapes.

Changes of the traditional Alpine landscape

Traditional Alpine landscapes are considered one of the major cultural heritages of Switzerland. Landscape is an important resource for national and international tourism. These landscapes have evolved over centuries of cultivation. Nowadays, slow processes, such as changing cultivation patterns or gradual land abandonment, as well as high-impact interventions, namely extended construction projects or infrastructure development, contribute to the rapid alteration of Alpine landscapes.

Computer-based tools in landscape planning: Models and visualisation tools

To enable decision makers in landscape planning to consider the long-term effect of interventions, they require the best information available. Computer-based tools are able to serve the complexity of the decisions to take, and offer appropriate techniques to visualise and communicate relevant information.

Models are abstract and well-defined depictions of the real word that help us to better understand complex systems (i.e. nature and society) and to predict their reaction as a response to external changes. The primary aim of models is to improve our understanding and knowledge of the process of interest. Models do not necessarily have to be computer-based, but they often appear as software applications for well-defined purposes.

Visualisation tools help to communicate complex information in a comprehensive manner. Apart from well-processed graphs, such as diagrams, tables or maps, photorealistic or in general picture based depiction has become common in landscape planning. Similar to modelling, visualisation does not have to be computer-based, but increasing availability of digital information and advancing visualisation technology have made computer-based visualisation a powerful and attractive tool.

Recent research progresses in landscape modelling and visualisation

Within the NRP48, several projects focused on landscape modelling and visualisation. A closer look at these contributions shows a slight bias towards methodological and technical approaches with, for instance, the integration of multiple disciplinary methodologies or multiple software environments. This is typical for research on landscape modelling and indicates that many methodological and technical problems are still unsolved.

Examples from research

The following examples serve to highlight the potential of state-of-the-art research, but also the problems in developing operational tools of high complexity.

Example 1: Agricultural change and tourism attractiveness

One eminent question that arises within the discussion on landscape conservation in the Alps tackles the consequences of agricultural change for Alpine tourism regions. To address this question, it appears logical to combine the highly complementary NRP48 modelling projects, briefly introduced in Box 2.

So, *SULAPS* could hypothetically simulate the reaction on changing agricultural policies at the level of individual farms and output spatially explicit land-use changes as well as changes in agricultural productivity. *ALPSCAPE* would then approximate the economic effects of changing agricultural production on economy and resource management. Further, *IPODLAS* would simulate forest growth and structure on abandoned land using empirically derived growth curves. Then *ALPSIM* would focus on changing hiking patterns, recreational behaviour, tourist satisfaction, and the number of days spent at the holiday destination as a response to landscape alteration. The changing number of days spent at the destinations could finally be fed back to the economic model of *ALPSCAPE* to estimate the impact on the economy.

Although this looks like an ideal coupling of models on landscape change, the technical and methodological difficulties at the interfaces between these various models are remarkable. Basic problems are (1) the limited exchangeability of data (content, scale, extent, purpose, validity range, etc.) among the different models, (2) implicit assumptions often closely connected to the modelling techniques and algorithms, including temporal and spatial scales of validity and (3) the increase in uncertainties which add up with the number of models that are consecutively used.

Example 2: Animation of hiker's behaviour in the vicinity of the proposed Schatzalp Tower

In the second example, the *ALPSIM* model (Box 2) was transferred to the municipality of Davos, Canton Grisons, to assess the effect of the proposed Schatzalp Tower (Box 1) on hikers' behaviour. Based on the primary input data on topography, land cover, and the tower itself, the *ALPSIM* model ran simulations and produced an animation as a key visualisation product (Figure 1). Although no special adjustments, e.g. in agents' behaviour, or extra data surveys were accomplished, the preparation of the input data, the simulation runs and the production of the animation totalled up to about 37 days of labour. This example demonstrates that the model can technically be transferred to a different setting, but also that the effort involved, and closely liked to it the user-friendliness are still major problems. If such models should establish as easy-to-use tools in planning, the availability of the required input data needs to be ensured, and convenience in operational application including the transfer to other regions would still have to improve profoundly.

Modelling and visualisation as tools in landscape planning

Although the above examples show the difficulties in developing operational tools from state-of-the-art research, modelling and visualisation can already now be a valuable method in planning and decision-making processes. In the area of modelling, we find already computer-based tools available. One example is *RiskPlan* of the Swiss Federal Office for the Environment and the Swiss Federal Office for Civil Protection, a strongly simplified risk analysis that provides first-order support for decision-making in risk and natural hazard management. Another example, partly developed within the NRP48, is the protection forest model, a simple tool to optimise the protection function of mountain forests against rockfall by Peter Brang (Swiss Federal Institute for Forest, Snow and Landscape Research WSL). These applications can be characterised as niche products addressing very specific and well-defined tasks.

In the area of landscape planning, however, the complexity of decisions does often not allow for an easy transfer of models. Once multiple functions or aspects of the landscape are to be combined, e.g. land-use, economy, biodiversity and recreation potential, models have hardly been used in practical planning. Instead of applying a ready-to-use tool, modelling can be used as a sophisticated method to analyse existing or newly surveyed data in such cases. For instance, the extrapolation of an observed trend might not fully reflect the expected development, and a model may give better estimates on future development and may as well result in a better understanding of the underlying dynamics. Especially in these complex situations, so-called "use cases" can help to better communicate the requirements of planners by announcing their needs in great detail and by breaking them down into little single tasks requested from the computer applications (see Further readings).

Visualisation has been used for centuries, for instance, in architecture, and is slowly playing a more important role also in landscape planning. Especially when visual qualities of the landscape are a key focus of the planning process, illustrations are needed, as planners and decision-makers must be able to see and to demonstrate to others how a development might change the appearance of the landscape. From drawings, 3D cardboard models to photomontages, the latest development in visualisation technique are fully computer-generated views of the planned intervention. The number and the usage of highly sophisticated and fully operational visualisation tools have increased quickly over the past decades.

This technique allows changing the viewpoint in an arbitrary way revealing new perspectives. A simple computer visualisation could so, for instance, effectively demonstrate that the intended centre of the Swiss National Park would cover the line of sight to the historical chateau in Zernez, Grisons, Switzerland (Figure 2), which had neither become obvious from the 3D cardboard model nor from the in-situ scaffold. As a result the new centre had to be realised at a different location, leaving the surroundings of the historical building complex untouched. Computer generated visualisation also reduces drastically the time needed to create images of alternative scenarios, once the required input data is available and the system set up. Finally, it allows transferring the numerical output of models directly in a photorealistic representation. The combination of single views into a photorealistic animation becomes possible, if the model simulates a temporal development (e.g. *ALPSIM*, Box 2).

Developing better tools for planning

Modelling and visualisation in landscape research and in planning practice do not have much in common these days. But with regard to the ongoing alteration of the Alpine landscape, the planners and decision-makers should profit of the potential of state-of-the-art modelling and visualisation.

While computer-based visualisation is increasingly used in planning processes, the use of models is still rare. The outputs of the research community represent mostly prototype models for specific case studies. They are too complex to be easily transferable and often too time and labour intensive in their application. To overcome the development of such prototypes and to establish tools for the planning practice, the models would need to focus on similarities in questions regularly arising in planning. They would need to encounter a degree of detail that is required to add to the problem, and at the same time still allow the transfer to different regions. And then, the operability and user-friendliness of these models need to be improve for operational use.

Still, when looking at the course that landscape visualisation has taken over the last 20 years, one can speculate that also landscape modelling will make it into the planning mainstream eventually. For the fundamental decisions that are to be taken for the Alps in the near future, this would certainly improve the knowledge base.

Further readings

Walz, A., Gloor, Chr., Allgöwer, B., Bebi, P., Fischlin, A., Lange, E. & K. Nagel, in press. Virtuelle Welten – Reale Entscheide? Die Alpen im Modellbaukasten. Thematische Synthese V des NFP48 „Landschaften und Lebensräume der Alpen", vdf-Verlag, Zürich.

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Box 1: Two newspaper excerpts on large construction projects in the Swiss Alps

Sawiris luxury resort, Andermatt, Switzerland: „Egyptian tycoon plans alpine oasis. One of the Middle East's biggest hotel groups is on course to transform Andermatt into a luxury resort, complete with a golf course and a pool with its own sandy beach. ...“ (Imogen Foulkes**,** BBC News, April 9 2007, http://news.bbc.co.uk)

Schatzalp Tower, Davos, Switzerland: “After the vote of the Davos people at the October 10 2004, the local government decided upon alterations in local spatial planning in order to facilitate the construction of the 105-m high Tower at the Schatzalp. …” (Translated from P. App: Die Schatzalp – vom Zauberberg zum Zauberturm. Speech at the Summer University Davos 2007, August 24 2007)

Box 2: Short description of four selected NRP48 projects in the area of modelling and visualisation

ALPSCAPE: Simulation of future scenarios of regional development by linking three simulation models (economy, resource fluxes, land use) and a valuation tool. Focus: Integration of multi-disciplinary modelling approaches.

ALPSIM: Simulation of hikers’ behaviour as a response to landscape change and interaction with other hikers. Focus: Agent based modelling, visualisation, animation.

IPODLAS: Linking spatial (GIS), temporal modelling environments, and real-time visualisation tools for ecological modelling. Focus: Integration of software environments.

SULAPS: Simulation of regional scenario of mountain agriculture by linking optimisation modelling at the farm-level with spatially explicit land use. Focus: Impact of optimisation of multiple “agents” in response to changing external conditions.

FIGURE CAPTIONS

FIGURE 1: Visualisation of the Schatzalp Tower, Davos, Grisons, Switzerland, within its Alpine setting.

FIGURE 2: Visualisation example of the planned visitor centre of the Swiss National Park at Zernez, Grisons, Switzerland. First row: 3D model of the responsible architect, middle row: Scaffold of the intended building, last row: computer-based simulation of the building (Courtesy of Pro Chaste da Zernez).