Making Urban Quality Negotiable

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Abstract

Heterogeneous groups of stakeholders in urban areas have diverging demands on the infrastructure, the built and the unbuilt environment with regard to socio-economic and ecological aspects. These different notions can lead to conflicts in case of quality targets which require the same spatial area but demand different spatial configurations or facilities. Since not all quality targets can be maximized everywhere, well-informed participative negotiation processes about the socially acceptable quality targets of specific services should be organized. Yet there are no instruments which can make the effects of strategies to achieve various targets on an urban quality targets at different spatial scales transparent and thus negotiable. We demonstrate an online visualization platform coupled with a procedural visualization, which are both based on a dual-step GIS model concerned with such tasks.

1 Introduction

Since 2007 more than half of the world's population live and work in urban areas, and the urban population is still growing steadily (THE WORLD BANK GROUP 2013). In many urban agglomerations this leads to increasing pressure on the remaining open spaces, which often have to serve competing demands (UN HABITAT 2013). Furthermore, these urban land use conflicts are complex because they occur in multiple dimensions (PACIONE 2003). For example, commuters demand efficient transport systems, and families need safe playgrounds within walking distance of their homes. These two exemplary demands concern two different disciplines: transport planning and landscape planning; and are relevant at two different scales: the transport problem concerns regional infrastructures, whereas the need for safe playgrounds can be addressed at district or neighborhood level.

Heterogeneous groups of stakeholders, such as administration departments, investors, property owners, landscape and urban planners, architects, and the local population, may have differing expectations regarding the urban qualities that should be provided. However, the different qualities cannot be maximized everywhere. Therefore, a spatially differentiated balancing of interests by defining the urban quality targets that actually should be achieved is necessary to ensure a socially accepted urban development (MABELIS & MAKSYMIUK 2009). Collaboration is seen as the key to considering all relevant aspects of such land use conflicts and should be supported by goal-oriented application of technical means (STEINITZ 2012; ERVIN 2011). However, the problem remains how to make the

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dependencies between diverging goals transparent and how to show their impacts spatially explicit (GRÊT-REGAMEY et al. 2008). In particular ecological qualities, which suffer from increasing the density of urban development, require more attention in processes of urban strategy development (GRÊT-REGAMEY et al. 2008).

Location, size, and design of urban open spaces influence the provision and quality of the services they can render and which contribute to the urban inhabitants' life quality. In urban areas these so-called ecosystem services are, for instance the regulation of the micro climate or the provision of space for recreation, habitat for plant and animal species, and for enjoying nature (BOLUND & HUNHAMMAR 1999; DE GROOT 2006). On a regional scale the structures required for supplying sufficient public open space and ensuring the connectivity of the habitat network are of interest. On a local scale the services' quality of the open spaces depend, for example, on the provision of adequate facilities for recreation (e.g. play area, benches, shade dispenser, etc.) or for certain plant and animal species (e.g. vegetation types, nesting sites, etc.) (GRÊT-REGAMEY et al. 2013). Therefore, the effects of prioritizing other urban services, such as the provision of housing space, on the performance of those services have to be analyzed across scale.

While there are no universal solutions for successful collaboration processes for spatial development, it is known that factors such as transparent instruments and a shared data base can assist the collaboration effectively (SELLE 2005; STENSEKE 2009). In this context also GIS-based 3D landscape visualization has proved its worth as a communication medium in participatory processes (WISSEN HAYEK 2011). Yet planning practice lacks tools for heterogeneous groups of stakeholders which support the prioritization of different urban quality targets and the evaluation of the spatial consequences on urban patterns on different spatial scales (VAN KAMP et al. 2003; JENKS & JONES 2010).

The goal of this paper is, therefore, to present an approach which combines the thematic complexity, the scale-dependency, and the temporal development of urban landscapes in an online visualization platform, coupled with a 3D visualization and based on a GIS model. A multi-criteria decision analysis model is shown, that is suitable for operationalizing different regional political urban and residential quality targets and trade-off decision making. The modeled results are integrated into a second modelling process that illustrates the local impacts of defining alternative quality target levels with procedural, that is, rule-based 3D visualizations. As a third step, an online platform for collaborative settings is established, which allows to change the weighting of different quality targets interactively and presents resulting urban development options that can fulfill these targets. The combination of the web-interface and the GIS-based trade-off model forms a facilitation tool for well-informed negotiation processes on urban quality targets.

2 Methods

2.1 Multi-criteria decision analysis of quality targets

The objectives of the first modeling approach were (1) to identify different urban quality targets, (2) to define indicators which are relevant for trade-off decision making, (3) to prepare these indicators in spatially explicit maps, and (4) to set up a model which supports multi-criteria trade-off decision making. The output of the modeling process should indicate the optimal selection of potential development areas given in an urban region according to the priorization of the initial urban quality targets. The model was developed for a case study of two adjacent municipalities, Schlieren and Dietikon, to demonstrate the use of the tool for urban strategy development across administrative borders. These municipalities are situated in the Limmattal Region, an urban agglomeration which extends over the area between the cities of Zurich and Baden in Switzerland.

Firstly, political key targets of the Limmattal Region were identified based on the political goals of the considered municipalities: conscious regulation of settlement development; optimizing the accessibility within the settlement area; sufficient supply of public open space for recreation; maximizing the quality of the living environment; increasing ecological quality within the considered area; minimizing emissions of the public and private transport in sensitive areas. In order to operationalize these quality targets, quality criteria and possible indicators were defined which describe the potential of a parcel to supply the individual needs. Table 1 shows examples of this operationalization. For example, the accessibility of a parcel by public transport in the region was mapped by the a combination of the distance to a public transport node and their service rate. The indicator maps show the land use parcels' current state with respect to an identified target. Furthermore, they form the basis for representing and analyzing the dependencies, goal conflicts, and synergies between heterogeneous demands on an urban area.

Table 1: Examples of the operationalization of needs with possible criteria and spatially explicit indicators.

Needs	Criteria	Indicator
Economic viability	Accessibility	Distance to public transport
Basic supply	Centrality	Distance to city centers
Enjoying nature	Habitat for plant and animal species	Habitat potential
Regeneration	Available public open space	Supply rate of public open space per inhabitant

For modeling an optimal land use development according to the key targets on a regional level, a multi-criteria decision-analysis (MCDA) approach was chosen, which allows for the integration and prioritization of different targets. The model optimizes the spatial distribution of urban development in order to minimize the goal conflicts using a linear goal-programming algorithm (IGNIZIO 1980). The model was implemented using the open source software "R" (http://www.r-project.org).

Figure 1 illustrates the modeling workflow. Input data to the model are potential development areas (grey). General quality targets have to be defined, such as providing habitation for 4500 new inhabitants and satisfying the needs of the population to a maximum in order to increase their quality of life. These policy targets were operationalized with indicator maps, e.g. centrality, accessibility by public transport, or the ecological habitat potential. The weighting of the policy targets (*Wi*) in the model leads to a map of development areas (red) that are suitable to fulfill the goals set in the beginning.

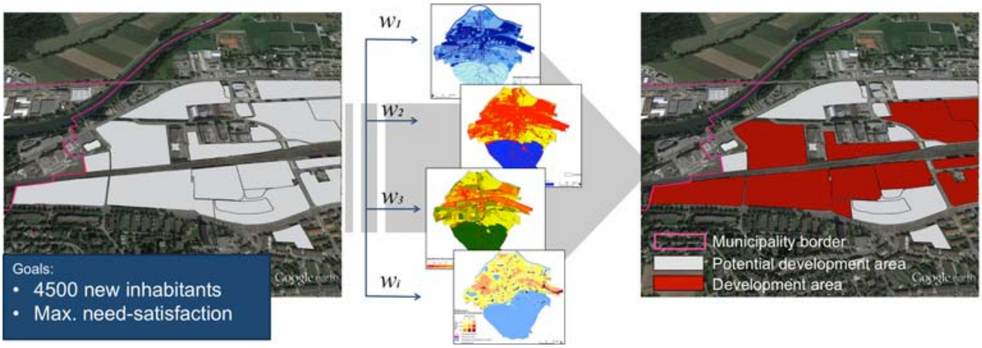


Fig. 1: Modeling workflow of the multi-criteria decision-analysis. The grey parcels represent areas of potential urban development with respect to a number of goals to reach. The goals are determined by a weighted set of targets (illustrated here with four exemplary indicator maps). The model selects the red parcels, resulting from an optimal balance of the target achievements.

2.2 GIS-based procedural 3D modeling

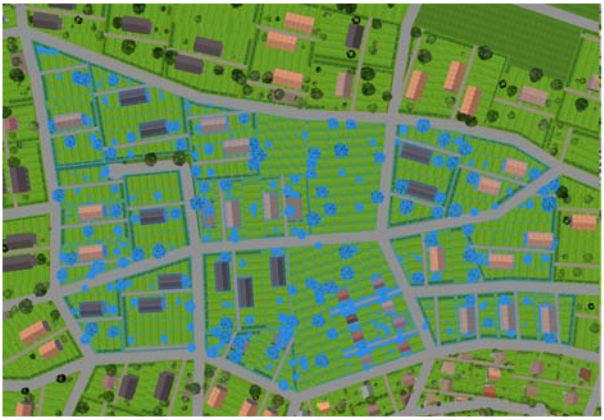
For the local scale a procedural approach was developed to visualize the impacts of the prioritization of the quality targets on the development areas. A procedural 3D model consists of geometric information, such as polygons and volumes, as well as semantic information which describes the form of the geometries with a rule-based code. By executing the code, a 3D visualization of urban form is generated automatically. Modifications of the 3D visualization are merely made by altering the code, which makes it a very efficient and fast visualization technique (HALATSCH et. al. 2008). We used Esri's CityEngine System (http://www.esri.com/software/cityengine) for implementing our procedural 3D visualization.

In order to integrate locally relevant factors, which contribute to life quality of the urban residents, into the procedural model, they had to be linked to physical characteristics of urban patterns. In a first step an urban typology was elaborated comprising a set of eight building types (e.g. single family or multi-family houses) and 15 green space types attached respectively (e.g. private house gardens or semi-private and public green spaces). Then a set of rules was developed defining the environmental elements and the spatial designs, which are typical for the green space types in the case study area (e.g. green spaces of multi-family houses are characterized by sealed access paths to the houses, hedges along the road side, intensive lawns and borders and few, distributed trees and bushes).

This typology permits to link local characteristics of spatial forms and the degree to which the residents' needs and the political targets can possibly be satisfied. For this task, ten basic needs of the residents were deduced from literature and confirmed as significant in a workshop with local stakeholders: recreation; safety; privacy; social interaction; appropriation; affiliation; aesthetics and well-being; enjoying nature; basic supply; economic viability. Enjoying nature depends, among other factors, on the existence of species diversity. A high degree of species diversity requires in turn for example extensive meadows and indigenous vegetation species. These requirements are integrated into the rule-based code.

Through a numeric reporting function of the CityEngine the amount of areas (e.g. lawns) and landscape elements (e.g. trees) with a certain characteristic (e.g. intensive or indigenous) can be accessed and factored into a meaningful indicator, such as the potential diversity of birds on a site (GRÊT-REGAMEY et al. 2013).

Figure 2 gives an example of the procedural model. The land use map with the information on the suggested development areas resulting from the multi-criteria decision analysis are used as input data for the procedural 3D model. The attributes of this ArcGIS shapefile are read out and taken as rule parameters, e.g. for the building type that has to be visualized. In turn the visualization system reports quantitative indicator values which are based on a numeric analysis of areas and items assembled in the 3D view.



Rule Parameters

Name	Source	Value
Min. building length	Rule	20
Max. building length	Rule	28
Min. building height	Rule	9
Max. building height	Rule	15
Min. building distance	User	13

Reporting

Name	Value
Number of trees	168
Total public green space [ha]	2.3
Total private green space [ha]	5.1

Fig. 2: Procedural 3D visualization based on rule parameters and resulting indicators.

2.3 Online visualization platform

Since the tool should support collaborative settings of diverse groups of stakeholders with different backgrounds and (technical) skills, the trade-off decision model should be broadly and easily accessible. Therefore we established an online platform, which allows to change the weighting of different quality targets interactively and presents resulting urban development options that can fulfill these targets.

A customized interface was developed using the GoogleEarth plugin (http://earth.google.com/plugin/) to integrate the virtual globe of GoogleEarth (Figure 3). Basic information, such as street and place names, was taken over from GoogleEarth. It can be switched on and off.

Results of the multi-criteria decision analysis were exported with Esri's ArcGIS from shapefile format to KML (Keyhole Markup Language) format and can thus be draped on the virtual globe in the interface. Further GIS-based information is made available in the same way, e.g. the indicator maps of the individual urban qualities. This permits exploring the current situation and analyzing alternative development options with more complexity.

The users of the platform can weigh the operationalized quality targets. According to their weighting alternative development options are presented. By this means, impacts of certain demands are made spatially explicit, which can foster informed debates.

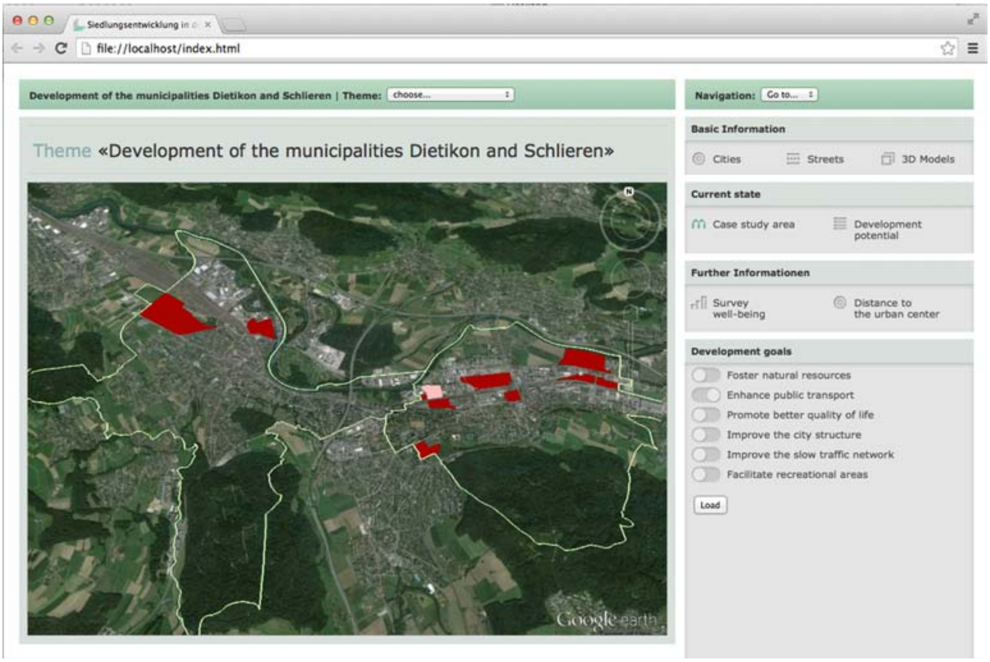


Fig. 3: Interface of the web platform, which can serve for testing interactively alternative weightings of urban quality targets in participatory settings.

3 Results

We presented a feasible method for making the effects of various urban quality targets at different spatial scales transparent and thus negotiable. Coupling a goal-oriented GIS-based model for multi-criteria decision-analysis with a rule-based, procedural 3D model (Figure 4) facilitates an integrated analysis and trade-off decision making of regional policy targets and concrete user demands on parcel level. This can support debates on spatial strategies effectively.

The overall model complexity was kept low to achieve a maximum of transparency coming along with a simple and flexible handling. The short calculation time permits testing and analyzing multiple development options within one session, for example in a stakeholder workshop. Evaluating different priority settings and resulting development alternatives in a group setting can support the discussion about the effects of political strategies on urban spatial structures. Furthermore, the potential of different development options to satisfy needs can be appraised.

The models for calculating the indicator maps of quality criteria were run with existing, official data of the municipalities. In addition, both the multi-criteria analysis model and the procedural model were set up as generic models. Thus the models can be transferred easily to other regions. In addition, further indicators can be added to both models, so that they can be adapted to the relevant regional and local quality targets, respectively.

Fig. 4: Online platform for multi-criteria decision-analysis and 3D visualization of local impacts.

4 Conclusion and Outlook

A sustainable transformation of current urban agglomerations towards more sustainable urban patterns which can fulfill diverse socio-economic and ecological needs is necessary (PACIONE 2003). To this end, the generic, multi-criteria modeling and visualization tool can support open discussions, e.g. on strategies for increasing density of development in the urban area. Thereby effects, such as potential loss of open space for recreation or biodiversity, can be made spatially explicit. This facilitates informed trade-off decision making by negotiating the desired level of urban quality aspects at specific locations.

Feedback of stakeholders from the urban planning departments of the municipalities in our case study area confirm the platform's usability, e.g. for illustrating different positions and their spatial effects in a political or interdisciplinary administerial committee deliberating on future urban development guidelines (e.g. zoning plans or district development plans). As a next step, the effectiveness of the tool should be tested in such workshops. Since the administerial borders of a municipality do not necessarily reflect the functional area of an urban agglomeration, the tool's implementation with a regional perimeter is recommended. It renders the complexity of the multiple dimensions of urban quality and conflicts across scale describable, so that development options become obvious and comparable in a comprehensive manner.

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