

Interactive Procedural 3D Urban Visualization and Evaluation Model for effective trade-off decision-making between built-up and open space

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While urban areas expand, green spaces are disappearing in dense urban areas, coming along with negative effects on the wellbeing of urban people. Particularly services of the urban ecosystem such as access to open space for recreation, appropriation and social interaction, habitat provision for species, water retention or climate regulation are degrading in quality. There is a need for new tools supporting a better integration of environmental aspects into urban development planning, raising the awareness of the urban ecosystem's services, and enabling an effective trade-off decision-making between the amount and distribution of open space and built environment.

We develop an interactive procedural 3D visualisation and evaluation model to facilitate participative processes on urban development taking into account the values of urban ecosystem services (Fig. 1).

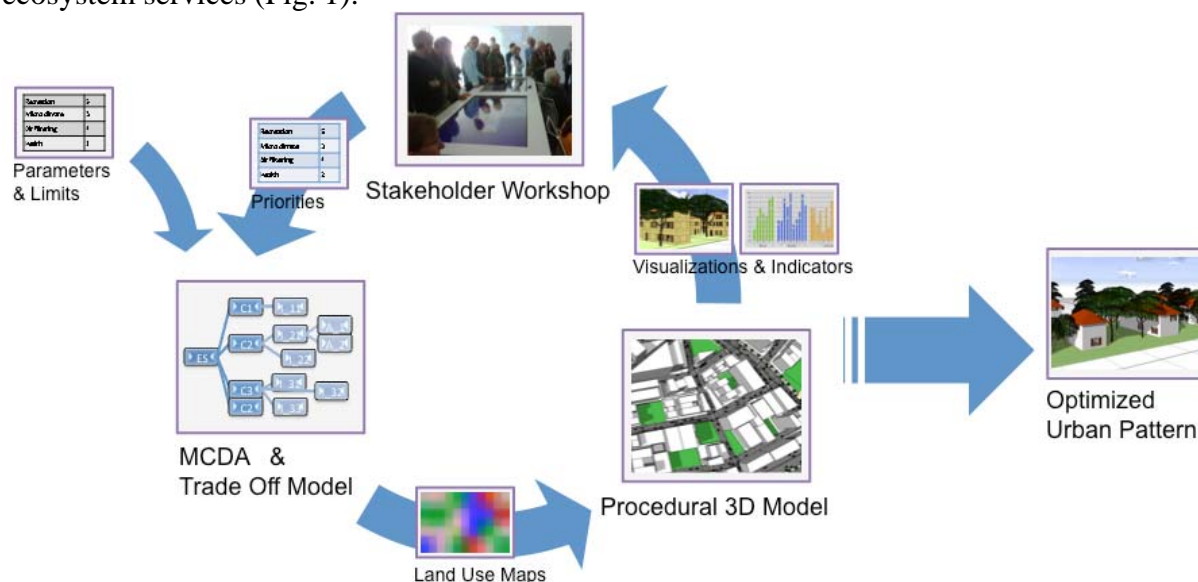


Fig. 1: Overview of the workflow

First, a Multi Criteria Decision Analysis (MCDA) is set up as spatial explicit environmental model calculating maps of new urban patterns. As several stakeholders have difficulties in the comprehension of abstract maps, 3D visualizations of the MCDA's resulting future urban patterns are generated. We apply a procedural modeling approach using CGA shape grammars that are implemented in the CityEngine system (www.procedural.com). The system can quickly visualize urban environments of any size in a three-dimensional view, and thus supports evaluation of alternatives and iterative design workflows. Ecologic aspects are encoded to rule sets structured in shape grammars producing patterns by sequentially applying rules on modeled land use patterns for spatial distribution of features (Fig. 2).



Fig. 2: 3D visualization of urban patterns with the CityEngine system

Then, stakeholders analyze the resulting urban patterns in participative workshops and evaluate the alternative scenarios of urban development both by subjective visual assessment and by objective indicator values such as noise reduction, rainwater drainage or recreation quality.

A trade-off model enables an integration of stakeholders' preferences and priorities with regard to the desired level of urban ecosystem services into the modeling framework. It links the stakeholders' weightings to parameters in the modeling chain calculating and visualizing adapted pattern structures in real-time. Thus, the weightings are directly influencing the amount of specified landscape elements required for providing the service's level aimed at. In this way, stakeholders are able to steer the modelling processes in a conscious manner.

This interactive modeling and 3D visualization process allows iterative analysis of different desires' and decisions' consequences and in this way the generation of optimized urban patterns. Thus, the model provides a valuable information and negotiation basis for architects, planners, investors and further stakeholders in planning the densification of the built environment while ensuring sufficient urban green space there where they are actually needed.