

# Urban Planner – ArcGIS extension for land use modelling

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## Abstract

The paper describes model Urban Planner created for land suitability evaluation and detection the most suitable areas for spatial development. The model uses a multi-criteria analysis and respects the principles of sustainable development. The core of the model focuses on the evaluation of land suitability according to input data, its values, and weights.

*Keywords:* ArcGIS, land use, modelling, urban planner, land suitability

## 1 Introduction

There exist many models and applications of GIS in spatial planning [2]. Many authors describe several models and software: What if? [5], LUCIS [3], Geogracom 5W [1], SUDSS [4], UrbanSIM [6]. These models can create highly advanced results, but suitable data in the Czech Republic are missing. This was the main reason to develop new model/extension that would be fully applicable in Czech Republic. In comparison with existing models, Urban Planner is much more applicable as a practical tool for urban planning processes.

## 2 Model description

### 2.1 Land suitability calculation

The core of the model focuses on the evaluation of land suitability according to input data, its values and weights. Land suitability is analysed in three levels (pillars, factors, and layers) for the 6 predefined categories of land use: Housing/Residential, Recreation, Commercial/Public Services, Heavy Industry, Light Industry and Warehousing, Agricultural production.

The total land suitability is calculated according to setting of the weights between the three pillars: ecological, social, economic. Weight can acquire values from 0 to 100. By different weights settings, it is possible to create several scenarios of land suitability.

Figure 1: Scenario variants.

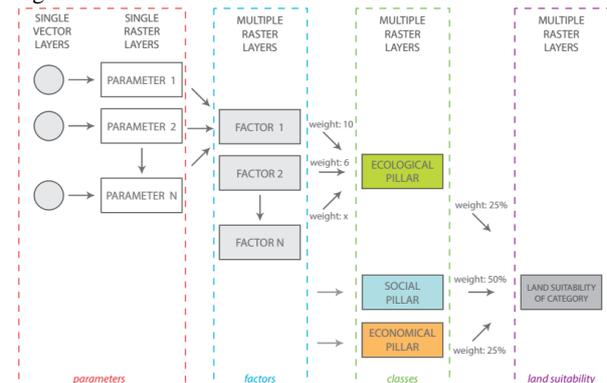
SCENARIO	Ecological	Social	Economical	SCENARIO	Ecological	Social	Economical
Sustainable	33%	33%	33%	Ecological pillar priority	60%	20%	20%
Acceptable	40%	40%	20%	Social pillar priority	20%	60%	20%
Viable	40%	20%	40%	Economical pillar priority	20%	20%	60%
Fair	20%	40%	40%	Custom	? %	? %	? %

Source: Authors

Each of the three pillars consists of factors. Factors are divided into three groups - positive, negative and limits. As in the case of pillars, the combination of factors is based on weighted overlay method.

The most detailed level of settings are parameters that are described as properties of factors. They are represented by specific layers and their attributes. Factors' weights can be set up in the range of scales 0-10.

Figure 2: Land Use calculation.



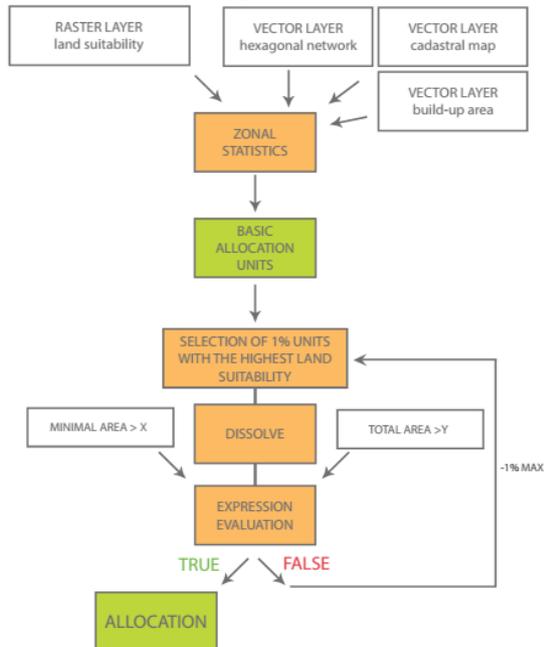
Source: Authors

### 2.2 Optimal land use calculation

The second part of the methodology is designed to identify areas suitable for optimal allocation (optimal land use). Due to spatial variability of land suitability is recommended to use more regular units (hexagonal grid).

The whole area is covered with vector hexagonal network; the built-up areas are eliminated. By using zonal statistics, the average value of the land suitability is calculated for every hexagonal unit. One percent of units with the highest value of land suitability are selected and combined into contiguous areas. If the conditions of minimum and total allocated area are fulfilled, the calculation is done. If the conditions are not fulfilled, the process of units selections is repeated (2 % of units with the highest value of land suitability are selected).

Figure 3: Identification of optimal land use.



Source: Authors

### 2.3 ArcGIS extension interface

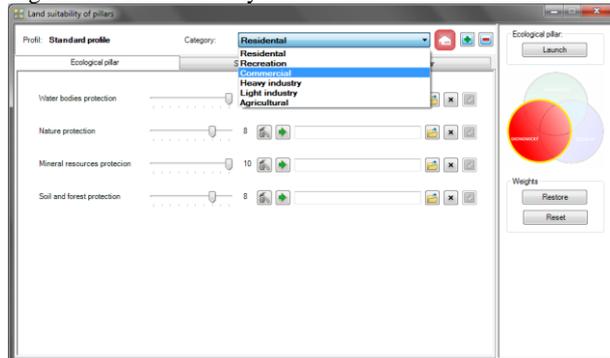
Urban Planner is released as ArcGIS for Desktop plugin (Add-In). The main extension toolbar is divided into four main sections (Land Suitability, Land Use, Data Manager and Settings). Land suitability component offers two sub-sections: Pillar Suitability and Land Suitability. Land Use component also contains two sub-sections: Suitability Transfer and Allocation, which must also be run sequentially. Land suitability analysis consists of two sub-parts. First of all is necessary to calculate land suitability of pillars (environmental, economic and social).

Figure 4: Urban Planner Toolbar.



Source: Authors

Figure 5: Land Suitability Calculation.

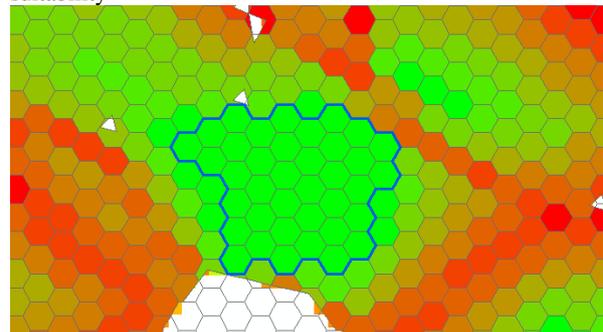


Source: Authors

For each pillar is necessary to choose, what factors will enter into the calculation and what will be their weights. Factors can be deleted or added, and there is no requirement concerning number of factors in each pillar. Each pillar must be run separately. After the calculation of all three pillars, the total land suitability has to be calculated.

The second component Land use allows to search (allocate) areas suitable for development on the basis of the previous total land suitability calculation. Land suitability is converted to the selected polygonal units. For each vector unit, the average value of land suitability is calculated. Unit size should be selected larger than the pixel size. The last tool allows finding (allocate) areas with the highest value of land suitability for selected category of land use.

Figure 6: Total allocated area with highest values of land suitability

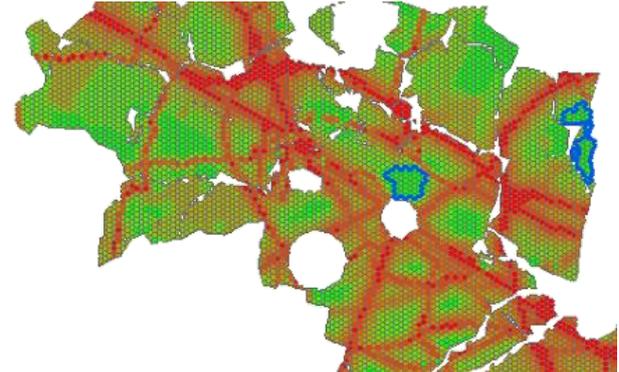


Source: Authors

### 2.4 Model outputs

The outputs of the components Land Suitability Analysis are mainly raster layer showing the potential of individual factors, the potential of the three pillars and the total land suitability for selected category of land use. The final analysis (calculation of the total land suitability) can be calculated in several variants (scenarios), which can be compared and evaluated. The outputs of the second component (Land Use) are primarily vector layers that show the total suitability shown in the polygon layer (the basic allocation unit) and the final areas suitable for allocation.

Figure 7: Basic settlement units with land suitability values with final areas suitable for allocation.



Source: Authors

### 3 Conclusion

This paper describes the extension “Urban Planner”, which is the first software product of its type in the Czech Republic. In comparison with existing models, Urban Planner is much more applicable not only as a new methodological approach but also as a practical tool for urban planning processes. The functionality of Urban Planner was tested in three town regions - Hranicko Region, Olomouc Region, and Prague region. The extension was developed with strong cooperation with Olomouc local government officials.

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