INDICATOR-BASED ENVIRONMENTAL ASSESSMENT OF SPATIAL PLANNING WITH THE USE OF COMMUNITYVIZ

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Abstract

Rapid land use transformation caused by human activity make it necessary to create indicator-based assessment to measure those changes. Assessment should be established in a form of mechanism which is possible to implement on any area. One of main issues which should be measured is environmental group. Considerations made in this paper examine the possibility to use for this purpose tool called CommunityViz. Research was taken on a local spatial plan and spatial polices for communes, prepared for area from Wroclaw Larger Urban Zone. Calculation include demographical, environmental and vehicle-journey factors. Research has shown that the application Scenario360 can support environmental impact assessment.

Keywords: environmental changes, indicator-based assessment, CommunityViz, Scenario360

INTRODUCTION

This paper presents an attempt to use the geoinformation system – CommunityViz for forecasting environmental burdens caused by spatial planning and development. Research area was a local spatial plan and spatial polices for communes from Wroclaw Large Urban Zone. This paper presents the principles of spatial calculations, based on parametric assumptions on the local level and use of the decision support system for environmental issues. CommunityViz system makes it possible to define the elements in system-assessment by the user, and the ability to modify the calculation assumptions.

INDICATOR-BASED ASSESSMENT

The need of monitoring changes in the environment, as a complementary component of a comprehensive assessment of local development, has been discussed for many years. "Report on the status and conditions of work-tangent planners in municipalities at the end of 2007," prepared by Institute of Geography and Spatial Organization from Polish Academy of Sciences pointed to the escalating intense of the spatial conflicts caused by urbanization process. It concerns mainly on natural, residential, tourism and communication functions.

The report highlighted the fact that local governments are not able to forecast or monitor these conflicts effectively. The lack of consistent and a comprehensive system of monitoring the investment processes and space transformation at the local level was found. It is a serious obstacle in the assessment of actual risks arising from land development. Moreover, one of the main conclusions defined in the scientific discussion on the phenomenon of urbanization, is urgent necessity to develop techniques which allow precise and clear as possible assess the scale of the phenomenon of urban sprawl. This is considered by the experts of the European Union as a "priority task of the Member States of the Union" (Kozlowski 2006). European Parliament resolution of 8 June 2011 on "Beyond GDP – The Need for New Measures of Progress" emphasizes the needs of the measurement of change and development, not only in economic and social terms, but also in environmental and planning. It is proposed to complement the GDP including the environmental load index, illustrating aspects such as climate change and energy use, nature and biodiversity, air pollution and health impacts, water use and water pollution or waste generation and resource use.

In order to investigate the possibility of measuring indicators with the use of geoinformation systems, analysis focused on the current state of knowledge and reliable indicators selected. As noted Czochanski (2010) indicators used in monitoring, should be simple (one-dimensional), relational and synthesizing (showing wider background of phenomena and relationships with other elements) and context (showing the

relationships between different areas or variants of phenomena). Based on the analysis of the final report "Criteria development of ecoabsorbency in spatial planning" (Fogel et al. 2004), and public statistical data, three groups of measures were defined: demographic factors (A), resources-use indicators (B) and automobile traffic indicators (C).

Geoinformation systems which support decision making can be based on two different types of graphics. These are vector or raster graphics. The choice of graphics dictates including spatial coverage of the analyzed area. Raster graphic is used more often for larger areas and geoinformation are more generalized. Examples of operations on raster data is to study the soil changes made in the evaluation process of the environmental effects caused by urban sprawl on the example of the Warsaw agglomeration. In this case, the terrain resolution pixel used in the study was 1 kilometer (Gutry - Korycka 2005). These systems are based on the idea of cellular automata, and are designed primarily for making changes in the spatial projection. Vector graphics, compared to raster, makes it possible to faithfully reflect the topology of the area. Given the size of the selected area of study, in these trials have been used with vector graphic.

System used for forecasting and assessing the environmental effects in this article is CommunityViz. It is an extension of the basic functionality of ArcGIS Desktop. The two main components are CommunityViz Scenario360 and Scenario3D. For research the first component was used. It was designed as a tool to assist decision-making by stakeholders in the planning process. It allows the prediction of future traits that define the area and the factors that affect the local community. It can be used to carry out experiments with hypothetical scenarios, perform parametric evaluations, modify spatial calculation assumptions, present visual effects of the proposed action, make decisions based on comprehensive information and connect your work with three-dimensional visualization variants. U.S. experience shows that the system CommunityViz with skilful use and cooperative society can be an effective tool to support decision-making (Walker and Daniels 2011). CommunityViz case study from Boston named “Supporting Youth in Designing Sustainable Neighborhoods” have shown that complexity of this software is really low. It can be successfully used for helping social participation even during work with laymen, people who are not specialists (http://placeways.com/communityviz/gallery/casestudies/pdf/).

The intention of the authors is an attempt to use the system CommunityViz in predicting and assessing environmental influence of spatial planning changes on the example of local spatial plan from Wroclaw LUZ. The essential thing is proper interpretation of principles for the formulation of indicators, public parameterized data distributor for advice on the local level, and results visualization of spatial calculations.

METHODOLOGY AND RESEARCH AREA

Research was taken on local spatial plan from Siechnice area and spatial polices for Czernica, Kobierzyce and Kostomloty communes located in the suburbia of Wroclaw. It was a basis for forecasting future environmental effects of development polices and plans. Information about changes in population, consumption of natural resources, energy and waste production was presented in variants. It was generated as well as information about the approximate load of the road network by setting an indicative number of cars and daily trips. To define these indicators and determine their value system CommunityViz was used.

The article presents the possibilities of use of the application as a tool to support investment decision-making process related to land development. In order to determine the assumptions used in the calculations of space was used, inter alia, the provisions of the Study of Conditions and Directions of Development of the Siechnice commune from 2010 and statistical data from the Central Statistical Office (GUS).

RESEARCH RESULTS

First part of research is focused on the development of the elements of the environmental effects of the provisions of the local spatial plan for the section Siechnice – Center (Fig. 1).

Fig. 1. Local spatial plan for part of the area: Siechnice – Center (source: www.siechnice.gmina.pl)

To calculate values in CommunityViz, system was provided with geoinformation describing the topological characteristics of the terrain and objectives defined by the operator of the program. Because the system used in the study is a framework to ArcGIS, it was benefited in the electronic format tailored to the vector spatial data. Assumptions values were set freely and they are modifiable in the CommunityViz interface. Data assumptions should come from external databases (available in parametric form) or they should come from operator's expertise (Fig. 2).

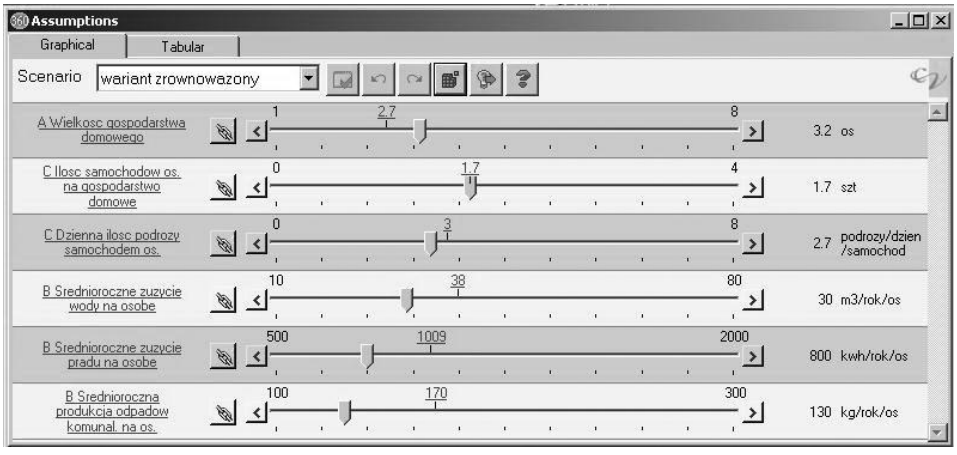

Fig. 2. The appearance of the interface – changes in the values of the assumptions (source: own study with the use of CommunityViz)

CommunityViz may calculate values of any indicators to predict future changes found from the local plan, if it is supported with data prepared in this form. During the study it was defined seven indicators describing the demographic changes, natural resources and energy consumption, waste production and increase the indicative amount of cars and the number of their daily trips. Values can be obtained in the form of tabular and graphics.

A major advantage of the system is possibility to create variants and analyze results from each scenario. For this purpose, in addition to the basic variant, were generate an additional two scenarios. To demonstrate the technical feasibility calculations based on very different assumptions and presentation of the span-values results two other variants were created: a sustainable variant and a variant of consumption growth. The values of the assumptions used in the calculations in various scenarios are shown in the table (tab. 1). Results of the calculations can be presented in tabular form (tab. 2) and in graphical form (will be present in a second part of this research).

Table 1. Values of assumptions in scenarios

Assumption	Basic scenario	Sustainable scenario	Consumption growth scenario	Units
A Quantity of households	2.7	3.2	2.7	people
B Average year waste production	170	130	200	kg/year/person
B Average year energy consumption	1,009	800	1,300	kWh/year/person
B Average year water consumption	38	30	50	m3/year/person
C Daily trips per citizen	3.0	2.7	4.0	trips/day/car
C Number of cars per household	1.7	1.7	2.0	cars

Source: own study with the use of statistical data from GUS and CommunityViz

Table 2. Values of indicators in scenarios

Indicators	Basic scenario	Sustainable scenario	High consumption scenario	Units
A1 Number of households	103	103	103	households
A2 Number of citizens	278	330	278	people
B1 Average year water consumption	10,578	9,898	13,919	m^3/year
B2 Average year energy consumption	280,877	263,938	361,883	kWh/year
B3 Average year waste production	47,323	42,890	55,674	kg/year
C1 Number of cars	175	175	206	cars
C2 Number of daily trips by car	309	278	412	trips/day

Source: own study with the use of CommunityViz

Assumptions about the environmental issues, which are primarily focused in this discussion, adopted in the variants are based on data from the Central Statistical Office resources. They show that the average water consumption per person in the community Siechnice in recent years hovers around 38 m³. The annual production of commune waste per capita by Siechnice averages 170.5 kg. Due to the lack of available data about consumption of electricity at the commune level, the value was used for group of communes from Wroclaw LUZ. It is 1,008.6 kWh.

Second part of this research are focused on spatial polices for selected communes. To this calculations only one indicator was chosen to examine possibility of those calculations for larger area. Communes which were chosen in different directions of development were analyzed. Different assumptions for each commune come

from GUS data. Calculations were taken on Kobierzyce which had highest rate of water use, Czernica with average level and Kostomloty where use of water was the lowest. The bottom map shows area of Wroclaw and surrounding communes (fig. 3). To the west of Wroclaw is located Kostomloty, to the south Kobierzyce and to the right of it is Czernica. Central city is strapped and selected communes are marked darker grey colour.

Fig. 3. The map of Wroclaw Larger Urban Zone (source: Local spatial policy documents)

Only residential development was analyzed. It follows that those three communes vary in way of development. Significant part of Kostomloty was intended for agricultural production, marked light gray (fig. 4. A). The different situation is in Kobierzyce where the northern part adjacent to Wroclaw predominates industry – checkered (fig. 4. B). Czernica is intended mostly for residential development, marked dark gray (fig. 4. C). It is typical example of ‘bedroom of the city’. In water use calculations only housing areas were taken into consideration, that is why communes which intended areas for over uses may be underestimated, like Kobierzyce where predominates industry.

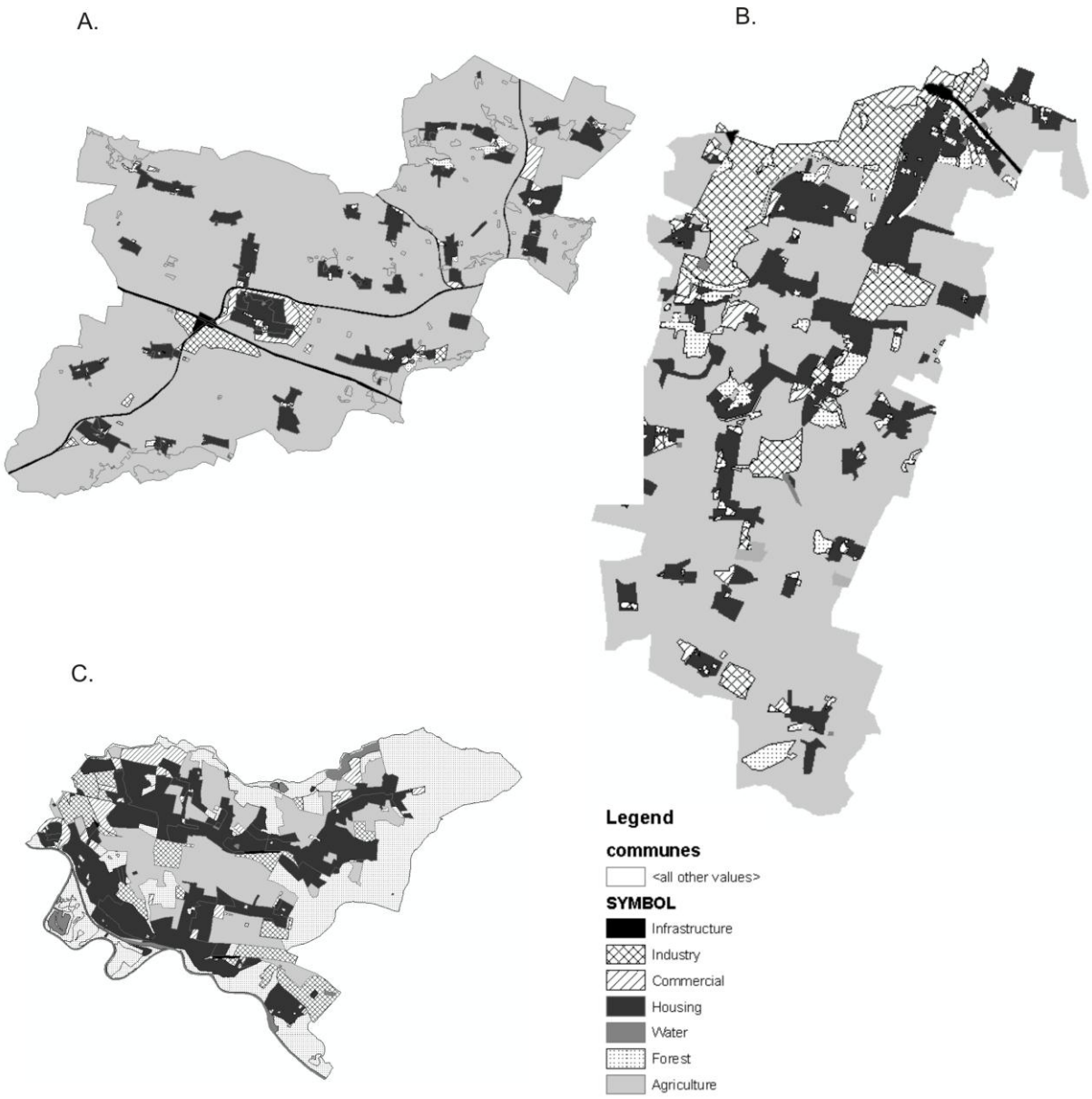

Fig. 4. Development of Kostomloty (A), Kobierzyce (B) and Czernica (C) (source: Local spatial policy documents)

The table below (tab. 3) shows assumptions which were used to the further calculations. Density of households and their quantity is stable for all communes. Data allows calculate what the annual water use per inhabitant is in chosen communes.

Table 3. Values of assumptions

Assumption	Local spatial policy	Units
Households per ha	15	households/ha
Quantity of household	3	people/ household
Czenica – average use of water per citizen per year	38	m³/year
Kobierzyce - average use of water per citizen per year	44	m³/year
Kostomloty- average use of water per citizen per year	26	m³/year

source: own work with use of CommunityViz

Results are visible in table below (tab. 4) and it follows from it that commune which has the highest water use, that is almost 5 million m³ per year is Kobierzyce. Kostomloty – the only commune which retained rural character, has the lowest water consumption.

Table. 4. Values of calculated indicators

Indicator	Local spatial policy	Units
Czernica – number of citizens	107,937	people
Czernica- predictable water demand per year	4,101,602	m³/year
Kobierzyce- number of citizens	113,603	people
Kobierzyce - predictable water demand per year	4,998,517	m³/year
Kostomloty- number of citizens	60,144	people
Kostomloty- predictable water demand per year	1,563,737	m³/year

source: own work with use of CommunityViz

Below are data in form of bar chart (fig. 5) which concern population in chosen communes and use of water per year. It shows relation between water use and number of inhabitants in selected communes. Worth noting is that although Kobierzyce has nearly two times more inhabitants than Kostomloty, water use in this commune is more than three times higher what shows that Kostomloty is environmental friendly commune. Despite of similar amount of citizens between Kobierzyce and Czernica, difference in water consumption is much more visible.

Those calculations are not added to table of attributes, that is why cartograms are not able to generate by this function. Charts are the only option to visualize those values, when this mechanism is used. Cartograms would be possible to create by making the calculations on dynamic layers, which is not a part matter of this paper.

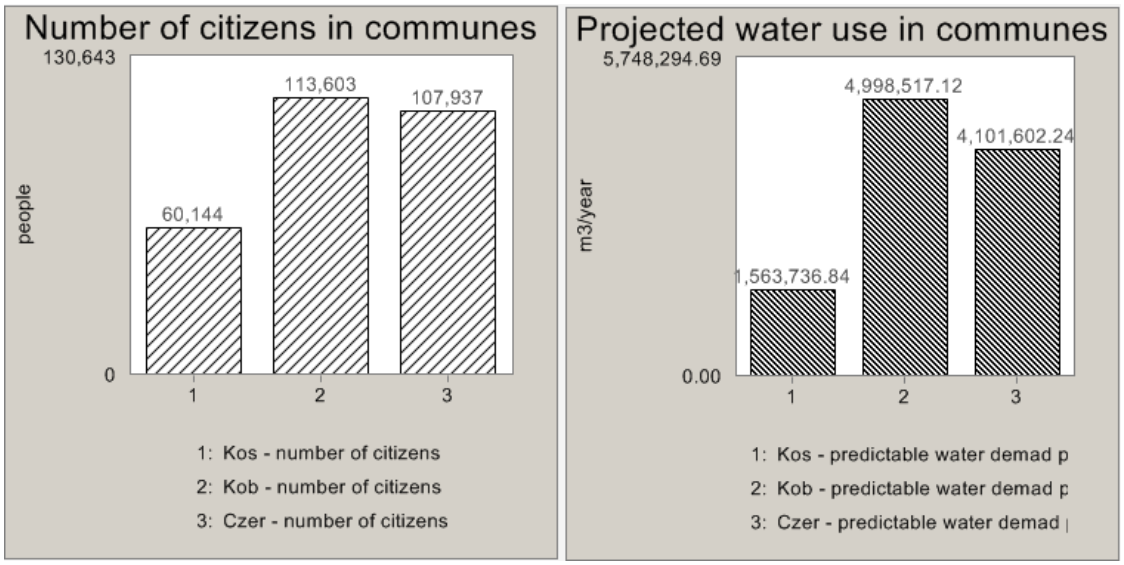

Fig. 5. Number of citizens in communes and projected water use (source: own work with use of CommunityViz)

CONCLUSIONS

Forecasting and assessing the impact caused by spatial planning can be carried out by using multiple techniques and tools. One of these instruments is CommunityViz. This system enables the assessment of the effects in parametric values, based on statistical assumptions. On the basis of the availability of local variables, the system can reliably and efficiently support the forecast, assessment and monitoring spatial transformations. CommunityViz is a clearly understandable tool for customers, clearly outlining the results of

the planned activities. The scenarios generated by the application Scenario360 illustrate the effects of spatial polices and plans and their impact on the eco-capacity of the space before making a final decision on changes to the functional areas. The system allows to estimate the future potential media consumption, waste production, estimated load of the road network and many other features of the freely-defined demographic trends. A major advantage of the system is the ability to define individual indicators based on any combination of geoinformation and defined assumptions. Very important fact is that all calculations and results' visualizations react at the same time when assumptions are modified. That is why CommunityViz can be useful not only during time-consuming research but also in discussion with society. Scenario360 can effectively support the prediction and assessment of the environmental impact of planning and zoning as well as decision-making process.

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