Indicator-Based Assessment of Land Use Planning in Wrocław Region with CommunityViz

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1 ABSTRACT

Wise decisions regarding land use transformation should consider potential impact of human activity and assessment to measure those changes. Indicator-based assessment should be established in a way which can be implemented in a given area on time. One of main issues which should be measured is environmental group. This paper presents the use of geoinformation system – CommunityViz for impact assesment of local polices and local development plans for communes around City of Wroclaw (Large Urban Zone). Simple but very useful impact model include demographical, environmental and vehicle-journey factors. Research has shown that CommunityViz can support environmental impact assessment very well.

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

2 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. However local governments are not always able to forecast or monitor impacts of their policies effectively. The lack of consistent and 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).

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 were 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).

System used for assessment of the environmental effects is CommunityViz. It is an extension of ArcGIS Desktop. The two main components of CommunityViz are Scenario360 and Scenario3D. It's designed to assist process of decision-making by stakeholders in the planning process. It helps to evaluate the 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 CommunityViz with skilful use and cooperative society can be an effective tool to support decision-making (Walker and Daniels 2011). Case studies 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/). We used CommunityViz for assessing influence of spatial planning policy of City of Wroclaw and sourrounding communites. The essential thing was proper interpretation of principles for the formulation of indicators.

3 METHODOLOGY AND RESEARCH AREA

The research area includes Wroclaw and rural communes which are located around the city. Wrocław is the historical capital of Silesia and the largest city in western Poland. The city originated as a Bohemian stronghold at the intersection of trade routes, the Via Regia and the Amber Road. At various times it was a part of the Kingdom of Poland, Bohemia, the Austrian Empire, Prussia, and Germany. The city, as well as almost all of Lower Silesia became again part of Poland under the terms of the Potsdam Conference. In

August 1945 the city had a German population of 189,500, and a Polish population of 17,000. Almost all of the German inhabitants fled between 1945 and 1949 and were settled in Allied Occupation Zones in Germany. The Polish population increased by the postwar resettlement of Poles as well as forced deportations from Polish lands annexed by the Soviet Union in the east, especially from city of Lwów.

With over 650000 inhabitants Wroclaw is now the second city after Warsaw in terms of revenue (3.814 billion zł in 2012) and expenses (3.804 billion zł in 2012) budget in Poland. Income per capita is also second only to Warsaw. Wrocław manufactures buses, trams, railroad cars, home appliance, chemicals and electronics.

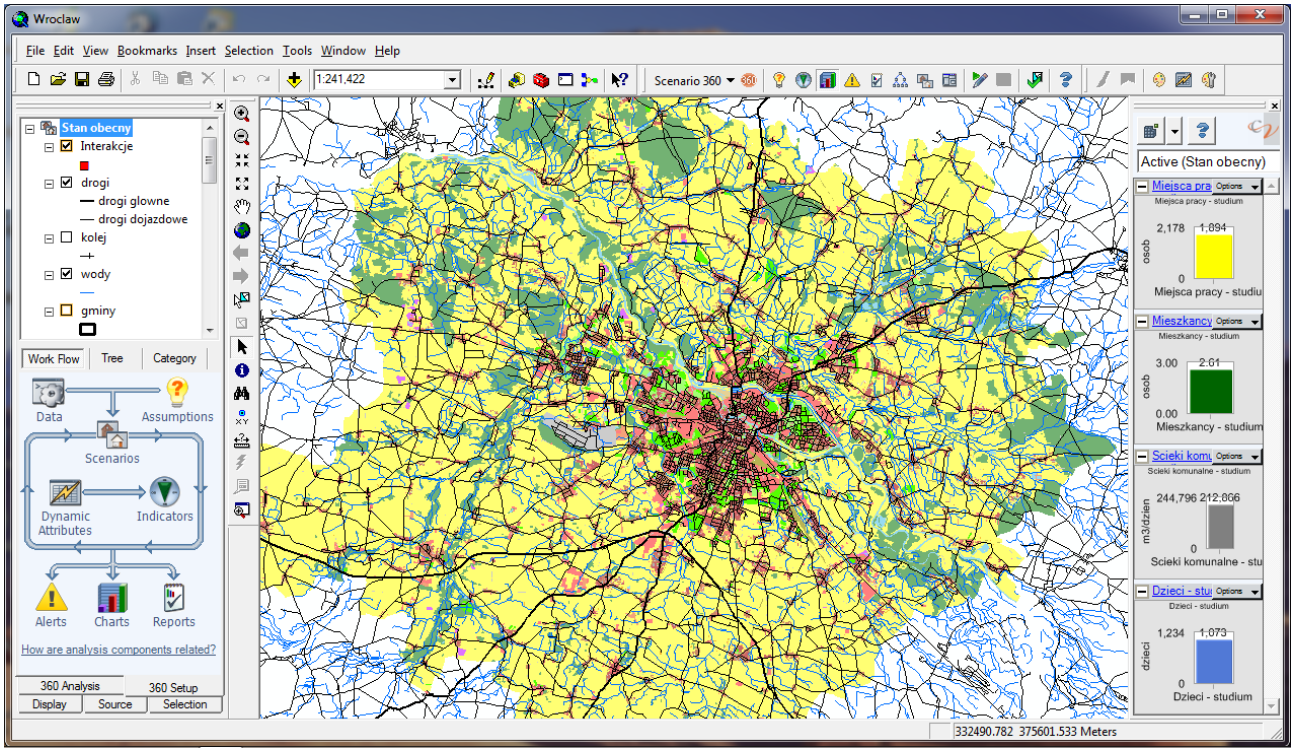

Fig. 1: Landuse of Wroclaw Region (2012)

Research was taken on local development plans for City of Wroclaw and communes located in the suburbia of Wroclaw: Miekinia, Oborniki Slaskie, Wisznia Mala, Czernica, Dlugoleka, Katy Wroclawskie, Kobierzyce, Siechnice, Zorawina and Kostomloty.

4 RESEARCH

Wanting to discuss desirable strategies for development of Wroclaw Region we started with evaluation of impact of current plans. Variety of spatial and non-spatial data including cadastral land-use, environment, changes in population, consumption of natural resources, energy and waste production was integrated. Additionally information about the approximate load of the road network by setting an indicative number of cars and daily trips as well as latest census results from National Statistical Office.

The core dataset prepared for the project was the unified landuse zoning plan for whole region. It was preapared on a base of 11 different landuse plans of communes and the city. Those plans are different in terms of abstraction level (from general to more concrete) as well meaning of definitions of landuse designation (the same designation have different meaning as well as different designation have similar meanings). The horizontaly integrated dataset includes 5748 planned landuse polygons. Polygons were interpreted to common landuse model developed with CommunityViz 4.1 and ArcInfo 9.3.1.

CommunityViz is not operating on integrated urban model like powerful predictive tools in kind of UrbanSim and TRANUS, that can run dynamic analysis of complex urban systems. CommunityViz is rather suitable for "what if", interactive sketch planning. Yet the models planners can develop with it's open modeling framework can be very sophisticated thanks to dynamic attributes, the unique capability of CommunityViz features. A dynamic attribute is based of formula that specifies how the attribute is calculated. It's value is automatically updated as any changes are made in the analysis. For example every

separate landuse plan unit is reevaluated :on the fly" as it's area, mix of use or distance to nearest infrastructure changes for any scenario. We suggest that such, relatively simple in use planning tool may very relevant to community planning.

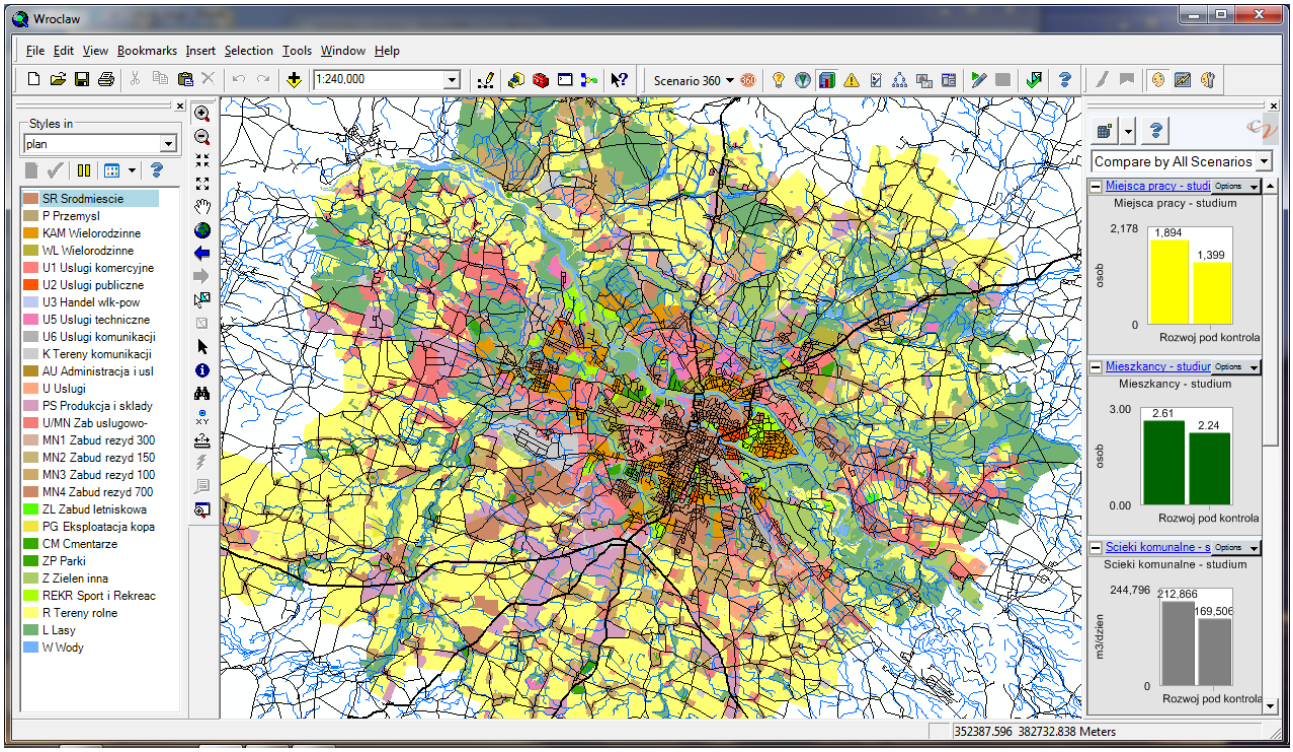

Fig. 2: Landuse models and planned landuse for Wroclaw Region (2012)

Indicator name	**Description**
Dzieci – studium	Children up to 19 years old
Emisja CO przez samochody	Total carbon monoxide emissions generated by vehicles associated with residential buildings in landuse plan layer.
Emisja CO2 przez samochody	Total carbon dioxide emissions generated by vehicles associated with residential buildings in landuse plan layer.
Emisja Hydrocarbon przez samochody	Total hydrocarbon emissions generated by vehicles associated with residential buildings in landuse plan layer.
Emisja NOx przez samochody	Total emissions of oxides of nitrogen generated by vehicles associated with residential buildings in landuse plan layer.
Gospodarstwa domowe – studium	Total number of dwelling units
Komercyjne zuzycie energii	Total annual energy used by commercial buildings in landuse plan layer for all applications, including electricity and heating.
Miejsca pracy – studium	Total number of commercial jobs
Mieszkancy – studium	Total number of inhabitants
Podatki PIT – studium	Tax (PIT income tax) revenues for local commune budget
Powierzchnie komercyjne – studium	Total commercial floor area
Scieki komunalne – studium	Waste water associated with residential buildings in landuse plan layer.
Wyjazdy samochodem	Total number of motorized trips taken each day, on average, by residential households (dwelling units).
Zuzycie energii przez GD	Total annual energy used by residential buildings for all applications, including electricity and heating.
Zuzycie wody – studium	Total water use associated with residential buildings in landuse plan layer.

Table 1: List of indicators defined to measure scenarios impact

Illustration presents application window with unified landuse plan and a list of 27 land-use models predefined for Wroclaw area. Each model (panel of the left) is given a name, symbolics and detailed characteristics (set of attributes, many of them dynamic) representing building density, mix of use, resources utilization rates etc. Using Scenario Sketch tools of CommunityViz, a land use can be applied to a feature by simply clicking on it on a map or by querying data. The planned landuse polygon takes on all the specified characteristics, and corresponding impacts are calculated automatically. Landuse models reference several regional changable, user-defined assumptions.

The set of indicators was defined within CommunityViz framework for Wroclaw region. Indicators measure accumulated impact of all plans, referencing datasets anywhere in the scenario. They provide an overall measurement opposed to landuse model attributes, which are an individual characteristic of polygons on a map. The list of indicators describing the demographic changes, build-out capacity under different zoning regulations, natural resources and energy consumption, waste production and increase the indicative amount of cars and the number of their daily trips is presented in tabular form below.

To demonstrate the technical feasibility of CmmunityViz alternative growth scenario was also defined. Concurrent to continuation reflecting development under the current growth plan, the second, more conservative scenario substantially concentrating development was proposed. It's increasing density of development in some areas by transferring growth from others reducing possible, undesirable effects of urban sprawl. Two variants are presented below side-by-side. A more sustainable scenario on the left and current growth on the right. The values of indicators are also shown.

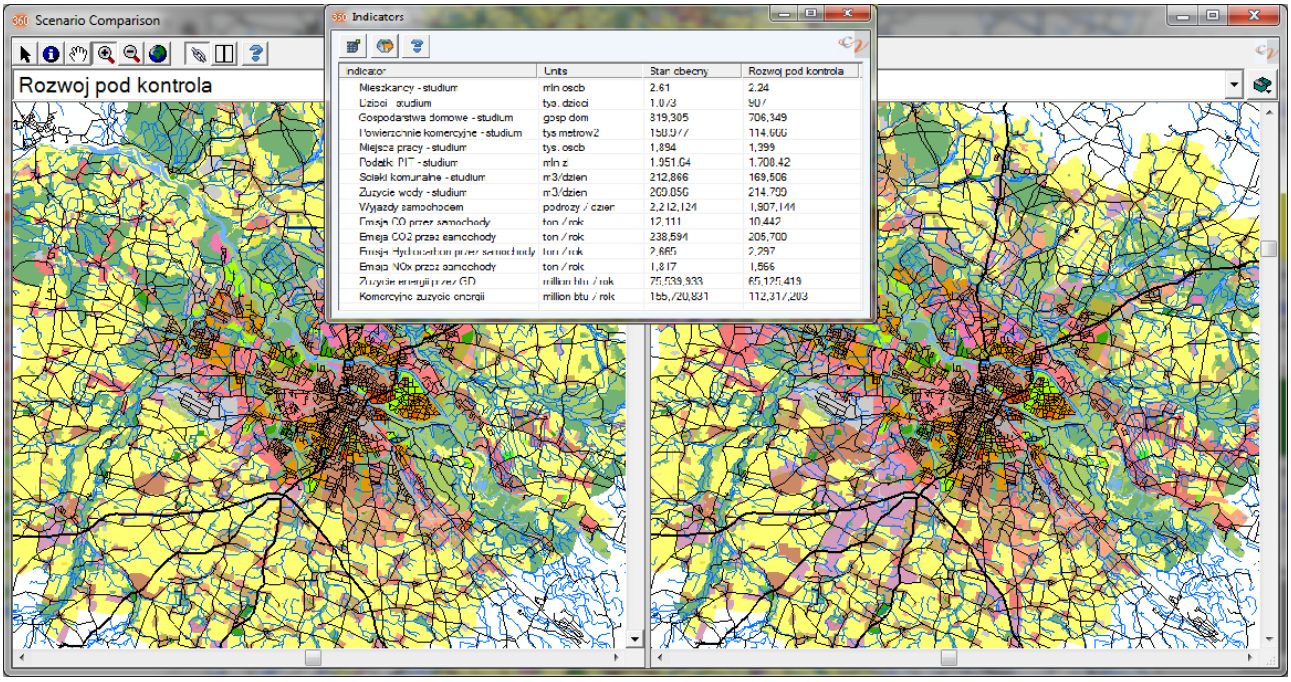

Fig. 3: Current growth plan (right) vs more conservative plan (left)

The analysis of current growth scenario provided the citizens and leaders of the Region with an understanding of the implications of their planning decisions. Big picture of land management policy conducted by independent communities not suprisingly makes negative impression. Incredible amount of land that was planed for development does not reflect any demographic trends. Plan that can make sense from the point of view of separated community is totally unrealistic for the region. It's hard to find any fit of infrastructure and landuse development. Landuse planning system does not seem to be linked with budget (planninng) capabilities of communes. It promotes rather than constraines urban sprawl.

We present here just preliminary results of the project. In comming months we are going to to determine the suitability of locations for accommodating future land use demands for residential, comercial and other land uses. Next stage is to define assumptions like population, employment and use it to project possible future land use of Wroclaw region.

5 CONCLUSION

Assessment the impact of local polices and local development plans can be carried out by using multiple techniques and tools. One of these instruments is GIS environment with 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 an understandable tool for participants, clearly outlining the results of the planned activities. The scenarios can illustrate alternative to current 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 possibility to dynamically construct and analyze impacts of many scenarios with indicators based on any combination of available geoinformation and user-defined assumptions. Very important fact is that all calculations and resulting visualizations react „on the fly", nearly 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.

Authors recommend CommunityViz as powerful educational tool for the decision-makers, planners and the citizens giving a better understanding of the complexities and impacts of land-use decisions. We recommended especially for those that want to use geoinformation creatively adding value on growing spatial data infrastructure.

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