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INDICATOR-BASED ENVIRONMENTAL IMPACT ASSESSMENT OF SUBURBANISATION PROCESS IN SIECHNICE COMMUNE*

Summary: The dynamic growth of cities results in the increasing problem of suburbanisation. The formation of changes in the suburban area requires specific identification of the problem and a unified system of determining transformations in a quantified way. In view of the implementation of sustainable development it is necessary to assess the economic, social and environmental issues. This paper describes the analysis of environmental changes in Siechnice commune, located in the agglomeration of Wrocław. The analyzes included the structure of land use, issued building permits, the increase in new buildings, conversion of land in terms of their quality, natural resource consumption and waste production. The study used the project of the European Environment Agency − CORINE Land Cover (CLC). It also carried out simulations using CommuneViz programme.

Keywords: suburbanisation, indicator-based assessment, environmental changes.

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1. Introduction

The paradigm of urban planning seems to be unsuitable to the times in which we operate and the space that we shape. The main disadvantage of this way of thinking is lack of limit. People think that they can colonize new areas more and more, without paying attention to other needs of their own existence, which they are not aware of. Thus, recent years have brought a paradigm for the creation of living space. It seems to be more suited to the needs of the modern world [Angel et al. 2011]. Contemporary societies are struggling with the problem of maintaining a balance between rapid economic growth and development of technical infrastructure, and environmental protection, natural resources and preserving biodiversity in nature. Today's consumption and its rate is significantly different from that of twenty years ago. More and more rural areas are incorporated into the cities, resulting in the fragmentation of the natural environment − including agricultural areas. This results

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in negative impacts on wildlife such as limiting the free migration of animals, reducing their genetic variability, displacement of animals from their former habitats, etc. The common goal is to give effect to the objectives of sustainable development.

One of contemporary challenges facing the experts in town planning and urban development strategies is the partial inhibition or restriction of activities aimed at gradual transformation of green areas, rural areas, meadows, pastures, and even forests into urban areas. What is more, today it is noted that the above areas are not only turned into housing estates, but they also give location to: service centers, malls, business centers, supermarkets and industrial plants. This contributes to increased pollution, the transformation of the terrain, soil degradation, and in the case of coastal development − the deterioration of water quality.

Nature plays a big role in the human life. According to CBOS survey, the number of people who declare their willingness to live in rural areas increases (from 30% to 42%) and at the same time the number of supporters of urban life disappeared (from 67% to 55%) [CBOS 2006]. People want to live surrounded by picturesque scenery, breathe clean air, maintain the cultural richness, but, paradoxically, their actions (new development) lead to environmental deterioration.

2. Polish suburbanisation

Urban development has consequences on the spatial, economic, social and environmental ground [Litwińska 2010]. The latter has often been a neglected element of development policy, until the increase in public awareness that nature is not a product of the infinite and its resources are limited. From the point of view of nature − as defined in the New Charter of Athens 2003 − the uncontrolled spread of urban trend is a harmful tendency ("damaging trend"), which should be led to a state in which it would be able to monitor the evolution and development of the city [Kozłowski 2006]. The environmental objections occurred already in the second anti-sprawl campaign in the middle of XX century and since then it is still a matter of considerations [Bruegmann 2005]. Sprawl changes typical elements of a city that it is hard to call them cities. Sprawl plans are in opposition to neighborhood plans, shopping centers and offices parks take over the function of former main streets [Duany et al. 2001].

The problem of rapid urban sprawl is known to spatial development and increased interest in peripheral areas has been noted in Poland for several years. Researchers of the issue agree that in our country the process of "urban sprawl" began in the late twentieth century and continues today [Gonda-Soroczyńska 2009; Kajdanek 2011; Lorens 2005]. The main causes of urban sprawl in the post-socialist cities were: economic restructuring, demographic change, land policy and property rights as well as quality of life [Pichler-Milanovic et al. 2007]. The first time a negative balance of migration to Wrocław, with simultaneous positive balance of migration for the communes surrounding the city, was registered in 1995. The research was carried out by M. Zathey [Kajdanek 2011]. The process of suburbanisation is a sequence of

cause and effect at the beginning of which there is a factor of property price. Agricultural areas that usually are devoid of most technical infrastructure and social services (these elements need construction or further expansion) are the cheapest.

Agricultural plots are often not included in local spatial development plans, so the legal basis for settlement is a building permit. As a result of a decision containing a building permit, there is a free (unstructured) process of creating new housing estates. The creation of new local spatial development plans in these areas, starts a sequence of processes related to real estate. In consequence commune, owners, developers and planners get profits, and the "victims are − spatial order, landscape and ecology" [Podhalański 2008].

The research proves the importance of preservation of natural resources (including high class soils) and the need for regular application of the relevant research and analysis of indicators, which are to assess the actual environmental effects caused by changes in the suburban area. Conducting research in this field, will allow actions which are aimed at minimizing the impact of human activities on the surrounding countryside.

3. Purpose, range and methodology of the study

The aim of the study is an attempt to assess the environmental effects of uncontrolled urban sprawl on the example of the suburban of Wroclaw – Siechnice commune. The study was preceded by an analysis of the used indicators and the choice of those that seem to reflect anthropopressure on the natural environment in the best way. The evaluation of Siechnice commune development in terms of environmental aspects is based on the functional – spacial structure analysis.

The range of the terrain covers an area of Siechnice commune, exactly premises located in the western, central and northern parts, neighboring Wrocław, creating a ring around the city, which is the administrative border. They include: Żerniki Wrocławskie, Radwanice, Siechnice, Prawocin, Zacharzyce, Smardzów, Święta Katarzyna, Biestrzyków, Radomierzyce, Iwiny and Mokry Dwór. In terms of substantive and crucial changes in the urban structures there was a quantified analysis of commune features such as: the structure of land use, issued building permits, quantitative and spatial growth of new buildings, quantitative and spatial transformation of land, their quality and natural resource consumption and waste production.

Methods depending on the parameter were based on an analysis of changes resulting from the comparison in two time horizons: CORINE Land Cover project and orthophoto maps. Figures from the register of administrative decisions regarding building permits have been submitted to the division of premises and years over a decade, so that it was possible to control remote sensing data correctness according to the year of each building construction. The exclusion of land resulting from the analysis of orthophotomaps and the identification of new buildings is compared to

a soil map, indicating its quality in particular areas. When defining the rates of resource consumption and waste production, the CommuneViz programme was used, so it allowed the construction of appropriate assumptions and indicators. The correlation of constant assumptions used in the calculation was based on *The Study of Conditions and Directions of the Siechnice Commune of 2010.*

4. Environmental indicators of suburbanisation process

Indicator-based environmental impact assessment was made on the example of Siechnice commune. The results are shown partially for the whole commune, and partially for selected geodetic premises. In order to interpret the spatial layout of the studied phenomena, in addition to the calculated indicators there are some maps showing the spatial distribution of some features.

The first assessment included the structure of land use in the commune. For this purpose, data from a project of the European Environment Agency − Corine Land Cover (CLC) of 2000 and 2006 were used. Documentation of changes in land cover, which is the goal of this project, determined the percentage change of use of the commune land for the years 2000 and 2006. In this project there are three levels of detail types of use. The first general level classifies land into five classes, the second level consists of 15 classes, while the third level distinguishes 44 unique classes. The study used the third level of classification to maximize the accuracy of the analysis. However, not all forms are present in the analyzed area. Selected results of the analyzes (differences exceeding 1%) of percentage changes in land use are shown below (Table 1).

Table 1. Some changes in land use in Siechnice commune in 2000-2006

	Code	Land cover in 2000 [%]	Land cover in 2006 [%]	Difference 2000-2006
Non-irrigated arable land	211	60,13	57,37	-2,76
Discontinuous urban fabric	112	1,36	9,21	7,85
Complex cultivation	242	8,89	2,61	-6,28

Source: [Stasica 2012].

For six years there has been a very large increase in built-up areas, particularly in the following villages: Żerniki Wrocławskie, Biestrzyków, Radomierzyce, Iwiny, Święta Katarzyna, Siechnice and Radwanice. The form of land cover − a complex cultivation − turned into a loose urban development, reflecting an increase in development intensity in these localities. This proves the validity of the research which focused on specific research premises characterized by the major changes of use.

There were also new forms of land cover, such as sports and recreational areas. A very little change in the development of buildings and their conditions is noted in

the southern part of the commune within the time horizon. According to the analysis, there was a reduction of areas with deciduous forests, meadows and pastures and arable land. There was also a change in water conditions in the commune.

The first step in implementing the building investment is to obtain a building permit. Therefore the analysis concentrated on a meter, which is the number of administrative decisions of the construction permit. From 2000 to 2010, 1622 permissions were given in selected premises in Siechnice commune. Receiving a planning decision involves costs and lengthy administrative process, hence the assumption that persons who received the decision were determined to begin an investment. Therefore, it is assumed that all the applications with a positive decision, have been implemented within two years from the date of issue, since that is a legal term of validity of decisions.

In order to illustrate the changes in building, there was an analysis of cadastre. The analysis used ortofotomaps, which allowed the identification of existing buildings prior to 2004 and buildings which were constructed later, until 2009. Their spatial relationships allow us to assess building density and preservation of their historic layout. A good example illustrating the reported changes is Biestrzyków precinct (Figure1).

Residential buildings constructed after 2004 tend to be separated from buildings from before 2004. The reason for this setting of buildings has sociological character, in contrast to the trend from before 1990 when people wanted to live close to „civilization". Delighted with easy access to services, eager for entertainment, people migrated to the city center. Now people are looking for peace and quiet, and even try to keep a considerable distance between their home and the home of a neighbour.

The study carried out on data from cadastre shows also a broader problem. In addition to the newly constructed buildings we can see a division of building plots, which after the sale will be separate properties. The result may probably be new buildings. Therefore, the image of plots makes it possible to imply a projection of future trends of rural development.

Siechnice is characterized by high agricultural usability of soils. Quality classes I − II occupy 20.60% (2 031.09 ha) of the total area of the commune. Class III is 23.47% (2 315.08 ha) of the total area of the commune. Farmland of protected classes I−III is 45% of total area of the region (94.87% of agricultural land), which in the case of a change of local zoning requires the approval the Minister of Agriculture. Classes IV−VI are only 3.39% (334.07 ha) of the total area. Soils which are of best quality and are used the most in agriculture can be found in western and south-western part of the commune. Permanent grassland makes up 15% of the total area of agricultural land and dominates in the north-eastern part of the commune. The area of farmland in the district can be divided into areas of: wheat complex – about 76%, rye complex – about 18% of arable land, areas of wetland soil – about 6% of arable land and grassland – about 20% of the total area of agricultural land.

Figure 1. Buildings within Biestrzyków by year of construction on the base of cadastre

Source: [Stasica 2012].

A characteristic feature in the development of a village is "going out" of a new building outside the old typically rural (development sprawl to the outskirts), farm buildings, and scattering new buildings around the core of a village. Such proceedings create a disturbance in the spatial order and are contrary to the concept of a compact

unit, satisfying the needs of residents in an optimal manner. This also leads to the phenomenon of fragmentation of land. Single-family residential development creates a small, scattered clusters of buildings, which create barriers for moving animals in large fields. The examples of new buildings location in comparison with the soil quality and finally fragmentation of the environmental habitats are shown in Figure 2 and 3.

Figure 2. Location of new buildings in comparison with the soil quality within Smardzów

Source: [Stasica 2012].

The adopted methodology was the basis for a comparison of natural resources consumption in Siechnice commune in 2004 and 2009. The change in consumption is associated with a growing population and its density. In this case, the study used a tool created to analyze economic and financial effects of local plans of land management – CommuneViz programme [Walker, Daniels 2011]. The year 2004 was chosen as a basis and it was compared to 2009. According to the simulations water consumption grew by 7893 m^3. The comparison of this indicator to *The Study of Conditions and Directions of Siechnice Commune of 2010*, made the assumptions probable and constant. In the case of electricity, its consumption increased by 2937950 kWh/year within five years. According to the website postCarbon.pl the average monthly electricity use in households in Europe is 340 kWh, so within a year it gives a value of 4080 kWh. In Siechnice commune the consumption is below the average, which may result from different from the average European standard of

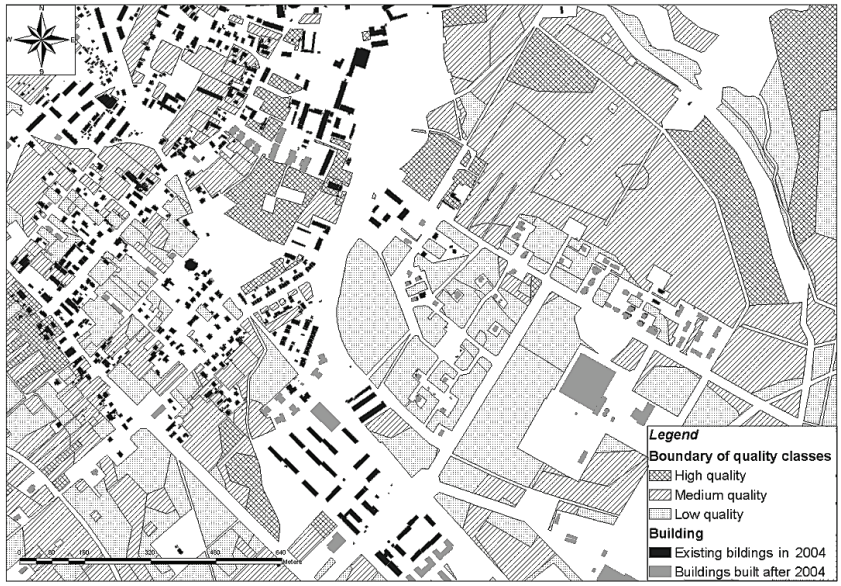

Figure 3. Location of new buildings in comparison with the soil quality in Siechnice

Source: [Stasica 2012].

living. The result of the development of the analyzed premises is approximately 8% increase in the consumption of raw materials, such as water or electricity. Waste production within 5 years increased by about 300,000 liters. These findings are a proof of dynamic changes in Siechnice commune, associated with the immigration of population.

The increase in water consumption is due to the successive growth of commune facilities in the technical infrastructure. In 2005, the length of the pipe network was 129 km and up to 2008 it was increased by 11.4 km, totaling 140.4 km. The growing number of users of water, leads to an increase in annual water consumption. Lifestyle changes: usable area of houses and backyard gardens that require care are bigger. New residents of the commune often use their own electronic devices such as computers, household appliances, that is why the power consumption is higher. Population growth also results in the increase of waste. This proves the fact that there are more wealthy newcomers among the inhabitants of the commune, the houses have more facilities with higher standard and comfort of living. Strong anthropopressure leads to the excessive transformation of natural environment and its intensive exploitation.

Changes in land use and changes in soil filtration properties directly affect the condition and quality of ground water, water intake, and microclimate. A big part of the building plot is impervious by means of its buildings (soil sealing). Such elements as driveways, arbors, swings, the surface under the building, free-standing garages, etc. have an impact on it.

5. Conclusions

The analysis confirmed that the processes of suburbanisation, transformation of landscape and land use structures is dynamic. In terms of planning, the most important issue is the manner in which the processes of transformation appear, not just their spatial extent. The inhibition of building expansion is not possible but there can be an influence on the quality attributes of a new human living space such as: environmental values, quiet, pedestrian-friendly environment, or a sense of security and isolation from the noisy environment, which may result in the improved quality of life. Taking action in new forms of land planning means necessary research and analysis that show the problems associated with the environment exploitation, leading to the reduction of natural resources. The attempt to quantify these processes to eliminate the subjective human factor determining the changes is extremely important.

The research conducted in Siechnice commune shows some characteristic features of the urban sprawl in peripheral areas such as: multi-functionality of the area and "blurring" the borders between settling units. Furthermore, there is a sharp rise in number of residential buildings − single family (detached) houses, as well as population growth in a suburban belt of Wrocław agglomeration. Population growth has generated road transportation problems, and prolonged the time to get to work and return home. The creation of new habitats changes the landscape of the commune, leads to higher waste production and natural resources consumption. Describing the process by using the indicators is a helpful tool for spatial policy and their stakeholders. The indicators should be used as a reference frame in spatial modeling.

One of the negative environmental effects is the transformation of previously agricultural soils in urban areas. What is more, this applies to soils which are classified as of high quality and agricultural usability. Therefore, there is a conflict between the demand for living space and space for agricultural production, so planners are forced to find a compromise. New buildings are not only outstanding because of their innovative design solutions, as a result being different from an old farm building, but also because of locating them in a scattered manner. The dispersion of the buildings has an impact on land fragmentation, disturbance of the spatial order, disruption of urban pattern and neighborhood ties, combining the traditional inhabitants of the village.

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WSKAŹNIKOWA OCENA SKUTKÓW ŚRODOWISKOWYCH PROCESU SUBURBANIZACJI W GMINIE SIECHNICE

Streszczenie: Dynamiczny rozwój miast skutkuje narastaniem problemu suburbanizacji. Kształtowanie zmian w strefie podmiejskiej wymaga szczegółowej identyfikacji problemu zagospodarowania tych terenów oraz jednolitego systemu umożliwiającego określenie zmian w sposób skwantyfikowany. W celu wdrażania idei zrównoważonego rozwoju niezbędna jest możliwość pomiaru zmian w ujęciu ekonomicznym, społecznym i środowiskowym. Niniejszy artykuł przedstawia analizy skutków środowiskowych w gminie Siechnice, będącej częścią aglomeracji Wrocławia. Analizy obejmują sposób użytkowania terenu, wydane pozwolenia na budowę, przyrost nowej zabudowy, ochronę gleb w zależności od jej jakości, zużycia zasobów naturalnych oraz produkcję odpadów komunalnych. Badania wykorzystują dane pochodzące z projektu Europejskiej Agencji Środowiska – CORINE Land Cover (CLC). Wykorzystano również symulacje wykonane przy pomocy programu CommunityViz.

Słowa kluczowe: suburbanizacja, ocena wskaźnikowa, zmiany środowiskowe.