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## Urban MAES - Ecosystem Services in Urban Areas

### ABSTRACT

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The benefits the city dwellers gained due to the features and processes occurring in the urbanised areas ecosystems become more and more appreciated element of quality of life in the city. The EU develops an instrumentation for analysing the benefits resulting from functioning of the natural systems, which is described as researching the ecosystem services.

Different types of ecosystems have their own specificity connected with their natural features, as well as forms of utilisation by humans. In that meaning the city ecosystems have a special capacity. This study has been realised in accordance with MAES (Mapping and Assessment of Ecosystems and their Services) process conducted by the European Commission, and in particular it forms a part of an implementation of Urban MAES pilot project.

The purpose of this study was to identify the spatial structures of ecosystems on the areas of the largest urbanised areas in Poland and compare them with each other in terms of a potential for providing services. The second purpose was to suggest identification and evaluation procedures of the selected services, as well as to demonstrate their spatial division in the urban areas. Based on that the recommendations for spatial planning on local and sub-regional levels have been presented.

The starting point for the analysis was also to distinguish the parts of biologically active surface in urban areas that were included into the elements constructing the green infrastructure, understood as a network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services.

The green infrastructure on the urbanised areas includes forests, surface waters, sport and recreational areas, urban green areas; thus the types of area use that were assigned the priority level of cultural and regulating ecosystem services. That set was supplemented with steady sod formed fragments of grasslands, which is the meadows, pastures and natural swards, but also the inland waterlogged areas.

Urban Atlas and the Topography Objects Database were the main source of spatial information to recognise the spatial diversity of ecosystem services in ten of the largest urban areas in Poland: Szczecin, Gdańsk-Sopot-Gdynia, Poznań, Bydgoszcz-Toruń, Łódź, Warsaw, Wrocław, Katowice, Cracow and Lublin.

The methodology of the synthetic gradation of the ecosystem services was developed using the types of the ecosystem services that can be found on the urbanised areas,

contained in common classification (CICES v.4.3.), as well as the category of land use allocated in Urban Atlas. A matrix was created where the individual combinations of the individual land use forms and types of services were allocated with the level of ecosystem services: P – priority, I – significant, N – insignificant, B – lack.

Based on the example of Poznań urbanised area a spatial diversity of the patches of land was depicted that is provisioning regulating and cultural ecosystem services. The obtained results may be a supplement for the spatial planners by a statement, in clear and synthetic form, of arguments underlining the significance for human of the parts, which are being considered as investments.

The analysis of the radiation temperature differentiation for the different forms of land use in Poznań allowed to introduce the methodology of ecosystem classification according to their regulating influence on the local climate. The data concerning the level of surface sealing was the basis for an introduction of a manner of connecting the land use with the assessment of the regulatory service regarding the precipitation water storage.

In the methodological scope connected with the spatial view of the ecosystem services differentiation an analysis was conducted that shows a vital influence of the differences in the information detail regarding the land use structure for the estimated size of the services. Urban Atlas and TOD databases comparison concerning the usefulness for ecosystem service assessment allowed to indicate their advantages and limitations.

The Topography Objects Database allows for better spatial location of the biologically active surface that accompanies the building development. Urban Atlas is characterized by a good differentiation of building development regarding the amount of the sealed surface, which is a very good indicator for regulation services analysis in the sub-regional scale and a good basis for a comparison of the urbanized areas. The Urban Atlas base underestimates the surface size with the vegetation, which accompany the development and dismisses the small developed areas near the forests and green areas.

The analysis conducted in the first stage of study were the basis for a study on situation differentiation regarding the size and structure of the ecosystem services in the largest Polish urban areas. Based on the Urban Atlas base a Green Infrastructure spatial system was distinguished in the each urban area and around its major city, and subjected to comparative statistical analysis.

The large urban areas in Poland are significantly different from each other as far as the green infrastructure is concerned. The largest amount of the green infrastructure belongs to Szczecin (more than 50%), on the other hand, the smallest amount was found in urbanized area of Lublin, where it constituted of less than 20%. Another indicator that is not divided equally between the urban areas is the GI fragmentation, although, the differentiation regularities are not clearly visible. The conurbation area of Upper Silesia is distinguished by the highest development intensity contrast between the elements of GI and the surrounding areas. It can be connected to a large amount of sub-mining areas environmentally re-cultivated that are surrounded by the industrial areas. The urban areas of Szczecin and Bydgoszcz-Toruń are distinguished by the largest amount of patches. This regularity is connected with the largest amount of forests, which create vast, dense complexes.

The indicator for the central cities of the urban areas is slightly different. The visibly lowest part of GI in the city surface is in Łódź (below 20%), however, the highest is in Szczecin (above 60%). The same cities are highlighted by the extreme average size of GI patches. This value is almost six times larger in Szczecin than in Łódź. However, Łódź, along with Cracow, positively stand out regarding the average distance between the GI patches, meaning, their number is high even though their surfaces are small. Evaluating the indicators globally it was stated that the least advantageous situation could be found in Łódź, Cracow and Lublin. Also, Warsaw and Poznań score below the average. The most favourable cities are Szczecin, then Gdynia and Bydgoszcz.

The thesis present a methodology of generalised analysis of cities regarding the level and spatial distribution of the selected regulating and cultural services provided by the ecosystems in their areas.

The effect of attenuation of the urban heat island is the most pronounced in Szczecin, where almost half of the city surface are the ecosystems inducing that effect on a priority level. On the opposite end of scale there are Cracow, Wrocław and Łódź, where the percentage of those ecosystems oscillates around 10%. In Łódź almost 2/3 of the highly invested areas are situated outside of the GI influence zones on the local climate, whereas the most advantageous indicator is in Toruń, where it does not exceeds 40%. The applied research procedure allows to indicate the areas outside the influence of larger GI surfaces

that must be taken into consideration during planning process as the areas with a deficit of cooling effect, and that should be enriched with the green infrastructure.

The ecosystem capacity for intercepting the precipitation water indicator was constructed based on the part of the sealed surface attributed to the individual area land use categories. It gave the basis for determining the level of that service in particular cities. In synthetic view the differentiation of the large cities in that regard is not very high, as the part of the sealed areas fluctuates from around 20% in Szczecin to around 45% in Warsaw. What is more important is the spatial diversification of the sealed surfaces in the city structure. It reflects the GI configuration indicators.

The valley retention - the reduction of the freshet wave. An analysis was conducted for the cities and it was found that there is a possibility to expand the green infrastructure in many cities on the lands at risk of flooding. In the valley areas of the cities such as Wrocław, Cracow or Bydgoszcz only nearly half of the areas at risk are accounted as GI.

The methodological capacity can be found in the argument regarding the operation of ecosystems as natural biogeochemical barrier. The detailed identification of the area surface allows to determine the capacity to deliver that service.

Among the cultural services a recreational use of the green infrastructure was considered. A formalised procedure was proposed for an assessment that consists of selecting the GI patches and recognising what part of the intensive development is situated within 300m and 1000m. It was found that the situation in the cities is very advantageous, as almost 100% of the development is situated within 1000m from the GI patches not smaller than 2 ha, and between 60 – 80% within 300m from it.

The distinguished part of the study was devoted to the forms of environmental protection, treated as surfaces that are protected due to the specific set of offering benefits. It allowed to evaluate the spatial range of protection for the particular advantages of the urbanised areas.

According with the presented procedures the evaluation of the level and division of the particular ecosystem services it needs to be noted that they allow for a possibility for an analysis on different levels of generalisations, from the small parts of the cities to the whole urban areas. Apart from presenting the analysis of the provided services there was also indicated a need for evaluation of the demand for the ecosystem services, the synthetic indicator of which may be the population and its density. In that regard there are some

differences between the cities as far as the availability of those statistics is concerned. Another parameter is the spatial division of the parts of the urbanised areas situated on the terrain with determined risk of flooding.

The demand for the cultural services could be estimated based on the participation of the most densely developed areas, which are located above 1km from the above-mentioned GI parts (high deficit) and located above 300m from green areas (moderate deficit). The level of air pollution in the cities might be treated as a demand for a regulating service consisting in intercepting the pollutants, especially by the trees.

The spatial planning through shaping the spatial structure is an important tool allowing to designate the areas where those services could be generated on appropriately high level. Protection of these areas against transformation and loss of the ecosystem services seems to be a key task for planning.

Another task is shaping the level of ecosystem services with a use of designing and managing of those areas. It is the next step allowing for optimisation the level of ecosystem services towards the demand with the designing solutions, adjusting plant ground composition and proper maintenance and deciding in regards of those areas.

The conducted methodological studies and comparison of the level of selected ecosystem services between the urban areas and the cities allow to formulate a range of conclusions:

1. It can be generally affirmed that the existing and available spatial databases covering the urbanised areas in Poland allow to significant extent for their interpretation in categories of services provided to people by the ecosystems. The land use is, however, an insufficient information for an analysis of some ecosystem services.
2. GI ecosystem services are influenced by the form of land development and the manner of its managing, thus, there are significant possibilities of application of this approach in spatial planning. Planning and designing of the GI land development on the urbanised areas should be directed at shaping a synergy between the different ecosystem services and minimising the collision between the regulating, cultural and production services that happen in the river valleys.
3. The human pressure on the ecosystems decreases the abilities of ecosystems to generate the ecosystem services, especially of regulating character, and at the same time increases the demand for them, as the ecosystem services in the cities could

significantly supplement the technical actions that minimise the results of natural phenomena or processes.

The performed study is of precedent nature not only in Poland, but probably in Europe, that is why it is necessary to work out own methodical paths. The research development will probably allow in the future to specify and verify the found results. However, it seems that a range of data was obtained that might be useful in both preparation of the regulation of that sphere and practical application, especially planning.