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The summary of PhD thesis:

„Modifiable Areal Unit Problem (MAUP) in land cover studies. An example of the Łódź Metropolitan Area"

Land cover is the subject of quantitative research in a large spatial scale. This is facilitated by the development of remote sensing techniques that allow obtaining land cover data from various sources, including satellite and aerial images, and Geographic Information Systems (GIS), which facilitate their processing. Land cover data are acquired at specific scales or aggregated in spatial units of various shapes and sizes. It influences the results of spatial analyses carried out on the basis of those data, which in the literature is defined as **M**odifiable **A**real **U**nit **P**roblem – MAUP.

The highlighted issues became an inspiration to undertake detailed studies on the empirical verification of research hypotheses

I. Modifiable Areal Units Problem affects the results of land cover studies, which depend on:
   - the adopted scale of the vector data and
   - the shape, number and size of spatial units used in the analysis.

II. Geographic Information Systems enable analysis of the impact of MAUP on land cover studies.

The spatial scope of the research is determined by the Łódź Metropolitan Area (ŁOM). The research was conducted using land cover data from various sources and on various scales. The data from the CORINE Land Cover 2012 database on a scale of 1:100 000 and the Data Base of Topographic Objects on a scale of 1:10 000 valid for 2012 were used. The data were harmonized according to the classification proposed by the author containing 10 types of land cover. For 6 selected areas of detailed research land cover data on a scale of 1:500 were prepared on the basis of orthophotomap from the year 2012 according to the adopted classification.

On the basis of data on a scale of 1:10 000 and 1:100 000 the land cover characteristics of the whole ŁOM were carried out, and for the areas of detailed research based on data on the scale of 1:500, 1:10 000 and 1:100 000.

The obtained results showed that in ŁOM as well as in the areas of detailed research, depending on the scale of adopted data there is a different number of land cover types, different number of land cover patches and differences in percentages of each type of land cover in the research area. The results also indicate that the impact of MAUP related to the

change in the scale of data is the strongest for land cover types of which the percentage share in the study area is small. These include wetlands, water, open areas with little or no vegetation as well mines, dumping grounds and waste storage areas

The study also involved the analysis of the spatial distribution of each type of land cover on a scale of 1:10 000 and 1: 100 0000. A method of studying spatial concentration based on the Lorenz curve was used. There were 224 types of areal units with different area and different shapes: squares, hexagons, cadastral units, concentric zones – buffers.

4256 values of concentration coefficient and concentration maps were obtained. All results were higher than 0.55. The median of obtained values of the concentration coefficient, for all types of land cover, for data on a scale of 1: 100 000 were higher than for data on a scale of 1:10 000. Only for agricultural and grass areas the median value was the same for data on both scales.

Communication areas are characterized by the highest variability of the concentration coefficient values for data on a scale of 1:10 000 and 1: 100 000 among all types of land cover. The lowest variability of the concentration coefficient values were noted for agricultural and grass areas. The variability of the concentration coefficient values for every land cover type varied depending on the data scale and areal units used.

For the regular areal units – squares and hexagons, the change of the inclination angle of polygons does not have a big influence on the change in the value of the concentration coefficient. There were also small differences in the value of K coefficient calculated for particular types of land cover in squares and hexagons of similar area. The occurring variability and differences can be considered as the margin of statistical error in the K coefficient calculation. The highest variability of the concentration coefficient due to the change of the areal unit area for data on a scale of 1:10 000 was noted for waters (7%) and for the data on a scale of 1:100 000 for forests, woodlots, shrubs (6%). For data on both scales, for almost all types of land cover for squares and hexagons the value of concentration coefficients dropped with the increase as of unit area. The exception are agricultural and grass areas.

For the cadastral units for all types of land cover for data on a scale of 1:10 000 in cadastral districts and municipalities lower values of the concentration coefficient were obtained than for data on a scale of 1:100 000. For data in both scales for almost all types of land cover the concentration coefficient values were higher for cadastral districts than for municipalities. The exception are agricultural and grass areas.

For the second type of irregular units – buffers, the highest variability of the K coefficient under the influence of the change in buffer width was recorded for mines, dumping

grounds and waste storage areas for data on a scale of 1:10 000 for buffers formed from centroid of ŁOM (14%) and for wetlands for data on a scale of 1:100 000 for buffers formed from the main points of cites in ŁOM (13%). However, the highest variability of the concentration coefficient depending on the shape of the buffer occurred for communication areas in buffers with a width of 2 km and 3 km (14%). For almost all types of land cover and types of buffers for the data on both scales, an increase in the buffer width caused a decrease in the value of the concentration coefficient. Only for the agricultural and grass areas as well as for forests, woodlots, shrubs for data on both scales and build-up areas on a scale of 1:10 000 for buffers created from centroid of Łódź there was an increase in the value of the concentration coefficient with the increase in the width of the buffers used.

The change of the data scale and the type of areal units also affects the appearance of concentration maps of every type of land cover. Differences in the appearance of selected concentration maps presenting areal units of the same type for the data on different scales are more evident for land cover types with smaller percentages in the area of Łódź Metropolitan Area and with fewer and smaller land coverage patches. These include mines, dumping grounds and waste storage areas, wetlands and water.

The use of GIS, especially for the creation and development of geoprocessing tools with the use of Python programming language and adapting existing tools to the needs of conducted research resulted in an increase of work efficiency, which allows to broaden the scope of research.

It can be concluded that owing to the use of GIS the hypothesis could be verified and the above conclusions resulting from empirical studies confirm the research hypothesis that the Modifiable Areal Units Problem (MAUP) affects the results of land cover studies depending on the data scale and the type and size of areal units used in the analysis.