Methodological bases of assessment of lands of a populated item, taking into account the influence of road networks

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Abstract. The content of regulatory documents of Ukraine on the zoning of the territory of a settlement is analyzed. The possibility of using open geographic data to perform the above work is considered. The quality criteria of residential areas are established. Technique for a comprehensive point assessment of the territory based on weighted average indicators, including the results of mathematical GIS analysis of the territory and data of subjective expert assessment has been developed. The conducted GIS analysis of the territory clearly demonstrated the effectiveness of the integrated assessment method because it combines both a rigorous mathematical assessment of the mutual arrangements of the city elements and the subjective opinion of individuals. The practical use of the results of the assessment allows us to identify places of long-term development on the territory of the city, plan transport infrastructure, and establish technical and economic indicators for measures to develop urban infrastructure.

1. Introduction
Modern society requires new approaches to the development of settlements. Earlier the “housing – work” theory dominated, but today people require different approaches to the organization of the city. Among these concepts, it is worth highlighting the following ones: work is combined with housing, which is typical for people working remotely on the Internet. Work on a rotational basis, i.e. labor activity that involves working with utmost efforts and long rest. The desire of people to live in the private sector near a big city. Production areas in cities are rapidly decreasing, and the released space is being used to accommodate residential and public premises, shopping centers, etc. At the same time, designers of post-Soviet countries often use outdated urban approaches, which lead to the emergence of areas with an uncomfortable urban environment.

2. Known research results
Recent studies [1, 2, 3, 4] are aimed at improving methodological approaches to the organization of the city territory. Philosophical rethinking of the concept of "quality of the urban environment", the definition of external factors affecting life in the city. As a rule, a comprehensive assessment of the territory of a settlement is not carried out by researchers.
3. Statement of the research problem
The above reasons require a radical revision of urban planning methods, the use of new approaches. This is facilitated by the emergence of high-resolution spatial data in the public domain. Among these data, the following should be highlighted: cartographic services of remote sensing (surface relief [5, 6], temperature, etc.). These data can be successfully used to solve urban problems using various GIS packages, in particular the QGIS package.

4. Main material
Development of urban planning documentation is based on a system of legislative acts in the field of urban development. Among such legislative acts, it is worth highlighting: the Land Code of Ukraine, the Law of Ukraine On Regulation of Urban Planning, DBN B.2.2-12: 2018. The Territory Planning, Order of the Ministry of Agrarian Policy No. 489 dated 11/25/2016 On approval of the Procedure for a normative monetary valuation of land in settlements, DBN B.1.1-22: 2017. The composition and content of the zoning plan of the territory. For the development of projects on territory zoning of a settlement, the last two documents are of paramount significance. DBN B.1.1-22: 2017 actually duplicates the content of the Order of the Ministry of Agrarian Policy No. 489, which establishes the procedure for the implementation of the normative monetary assessment, regulates the size of the coefficients of urban development value of the territory and local coefficients characterizing the features of the location of the plot of land. At the same time, in DBN B.1.1-22: 2017 there is no point assessment of the town-planning value of the territories, which greatly complicates the practical use of the results of design work on zoning the territory and the development of city’s general plans. The regulatory document under consideration establishes the following types of zones of the settlement: public P, residential R, recreational R, resort R, transport infrastructure zones TR, engineering infrastructure zones EI, communal and storage KS, industrial B, special S, land zones of historical and cultural significance HC, land zone of the nature reserve fund NRF.

Zones of agricultural land, water and forest funds are not singled out into a separate category, which somewhat reduces the practical value of the normative document.

It is proposed for all types of zones, except for special ones, to calculate the town-planning value according to the following formula:

\[ P = \frac{P_{DBN} \cdot n_1 + P_{exp} \cdot n_2 + P_{ass} \cdot n_3}{n_1 + n_2 + n_3} \]  

(1)

where
\( P \) – overall zone assessment
\( P_{DBN} \) – zone assessment for compliance with specifications of DBN B.2.2-12:2018;
\( P_{exp} \) – expert zone assessment
\( P_{ass} \) – zone assessment by citizens
\( n_1, n_2, n_3 \) – weight coefficients.

The sum of the weight coefficients must be 100%. The following ratio of coefficients is recommended: \( n_1=50%, n_2=35%, n_3=15% \).

Assessments can vary on different scales, for example, from 1 to 5:
- \( P = 1 \) - the zone does not meet the requirements
- \( P = 2 \) - the zone partially meets the requirements
- \( P = 3 \) - the zone fully meets the requirements
- \( P = 4 \) - the zone slightly exceeds the requirements
- \( P = 5 \) - the zone significantly exceeds the requirements

In assessing the zone for compliance with DBN (\( P_{DBN} \)), a special role is played by the methods of spatial analysis of the GIS system. Among these methods, we distinguish the following: calculation of the built-up area (polygons) within the zone, getting of objects into a given polygon (for example, calculating the number of houses within walking distance to a community center or in a zone of negative influence of a production facility); calculating the concentration of objects across the territory of the settlement (method of analyzing the area on a regular grid), counting the number of lines in the
polygon, analyzing a digital raster model of the area to identify geologically hazardous areas, optimizing the placement of public centers using Voronoi diagrams. It is possible to use other algorithms based on methods of computational geometry and transformations of raster images [7, 8, 9, 10]. When calculating several indicators of DBN compliance, the coefficient of \( P_{DBN} \) is determined as weight-average of the values of each indicator.

The conformity of the quality of a particular zone to the requirements of DBN is often formal. For a more objective assessment of the zone, an expert assessment method can be used. This method consists in the fact that a group of experts is offered a set of questions containing the characteristics of the object of assessment, the expert assesses each characteristic, and then the average or average weighted characteristic of the object is calculated. So, the following indicators will be most important for residential development:

1. The technical condition of housing;
2. Accessibility of public spaces for everyday use (shops, pharmacies, gyms, children’s educational institutions, etc.);
3. The presence of recreational areas near housing;
4. Environmental factors affecting quality;
5. The technical condition of public spaces near housing;
6. Aesthetic appeal;
7. Social portrait of residents.

For public, recreational and resort areas, the following indicators are of fundamental importance:

1. The competitive nature of the provision of services;
2. The level of service;
3. Compliance with regulatory requirements for the provision of services;
4. Security of the services provided;
5. Subjective expert opinion on the service provided.

The assessment of the zone by citizens is determined by the method of questioning or analysis of reviews about a particular object on the Internet. It is often subjective in nature.

If a zone has several functional purposes, then its score is calculated by the formula:

\[
P_{ZONE} = \frac{P_1 S_1 + \ldots + P_n S_n}{S_1 + \ldots + S_n}
\]

where \( P_{ZONE} \) – overall zone assessment;
\( P_1, \ldots, P_n \) – subzone assessment;
\( S_1, S_n \) – weight of every subzone.

The percentage of the area that the subzone occupies is taken as the weight of the subzone.

To verify the above hypotheses, we analyzed a section of the Shevchenkovsky district of Kharkov at the intersection of August 23 Street and Science Avenue. The distance of walking from the geometric center of the block to the intersection in question, which is a public center, is taken as an evaluation criterion. Nearby there is a metro station, a market, shops, bank branches.

At the initial stage of the study, the necessary vector data were loaded into the project from the OpenStreetMap project’s website, and then the blocks were classified according to DBN B.1.1-22:2017.

The influence of a public zone of 500 m in size is established by constructing a buffer zone around a point object indicating the center of the zone (the intersection of the above streets) and then by identifying the blocks that are inside the buffer zone or are suppressed by it (figure 1).
5. The discussion of the results

As a result of the GIS analysis, the area of the blocks, the location of the blocks relative to the buffer of the community center and score of dwelling blocks were established. The assessment of dwelling blocks (code Ж) was made on a 5-point scale. The blocks which are partially overlapped by the buffer zone were evaluated according to formula 2. The expert and civil assessments of blocks were made on the basis of real estate appraisal and residents’ opinions; the results of the general assessment of the blocks are presented in (figure 2).

The analysis of Fig. 2 shows that territories directly adjacent to the community center have the greatest value. These territories are represented by buildings of typical series of the 60s, 70s of the XX century, as well as individual multi-storey buildings of high comfort, which were built over the past
15-20 years. The lowest rating has one-story housing, located near Klochkovskaya street, due to its remoteness from the community center, as well as the legal complexity in the development of this territory. Most sites in this area are privately owned.

6. Conclusion

The conducted GIS analysis of the territory clearly demonstrated the effectiveness of the integrated assessment method because it combines both a rigorous mathematical assessment of the mutual arrangements of the city elements and the subjective opinion of individuals. The practical use of the results of the assessment allows us to identify places of long-term development on the territory of the city, plan transport infrastructure, and establish technical and economic indicators for measures to develop urban infrastructure.

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