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Tretiak Vladyslav Maksymovych,
tretiak_vm@knuba.edu.ua, ORCID: 0000-0003-4825-0378,
Kyiv National University of Construction and Architecture

CREATION AND USE OF GEOSPATIAL DATA FOR MORPHOMETRIC ANALYSIS OF URBAN DEVELOPMENT USING GEOGRAPHIC INFORMATION TECHNOLOGIES

The modern urban environment requires an integrated approach to management and development that takes into account various aspects of urban development and quality of life. This article discusses the use of geoinformation technologies for the creation and use of a geospatial database in the context of urban development analysis and morphometric indicators. It emphasises the importance of collecting, analysing and using geodata for effective urban planning and development.

The article discusses various aspects of the use of geographic information systems in urban planning, including remote sensing for collecting geospatial data, analysis of morphometric indicators of urban development, development of recommendations for improving the urban environment and creation of urban plans based on the analysis of these data. The article highlights the main advantages of using geoinformation technologies in urban planning, such as increased accuracy and speed of data processing, the ability to comprehensively analyse geospatial information and simplify decision-making.

The results of the study can be useful for city authorities, architects, planners and other stakeholders involved in the development and management of the urban environment. The use of geoinformation technologies in urban planning can contribute to the sustainable development of cities and improve the quality of life of their residents by making the planning process more efficient and transparent.

The role of geoinformation technologies in the creation and use of a geospatial database for the analysis of urban development and morphometric indicators was investigated. In particular, the main aspects of creating a geospatial database, the use of geographic information systems in the collection and processing of geodata, as well as the analysis and application of morphometric indicators in urban planning were considered.

Keywords: morphometric indicators; geoinformation technologies; urban development; geospatial databases; infrastructure.

Problem statement. Modern development of cities and their infrastructure requires effective planning and management to ensure a comfortable and functional environment for residents. In this context, geoinformation technologies are of great importance, as they provide an opportunity to analyse geospatial data and create databases for studying and planning urban development. One of the key aspects of this analysis is morphometric indicators, which allow to assess various aspects of the city's geometry and structure.

This article will discuss the role of geoinformation technologies in the creation and use of a geospatial database of morphometric indicators of urban development. Starting with the definition of the basic concepts and methods of morphometric analysis, we will then consider the technologies used to collect, process and analyse geospatial data. Finally, we will illustrate the use of these approaches using examples of successful urban planning projects, and discuss the challenges and prospects for further development of these technologies in urban planning.

This material will help to better understand how geoinformation technologies contribute to the optimisation of urban development processes and allow for more informed and effective decisions in urban development [1].

State of the art and conceptual framework. Morphometric indicators are numerical measurements used to characterise the geometric and morphological properties of objects in space. In the context of urban development, morphometric indicators allow for a quantitative assessment of various aspects of the city's structure and its individual elements, such as streets, blocks, districts, etc.

The main morphometric indicators can include the following characteristics:

- Area: Area defines the amount of space occupied by the object under study. In an urban context, it can be the area of a particular block, district, or city as a whole.
- Perimeter: the length of the outer contour of an object. In urban planning analysis, this can be the perimeter of a city or the contour of a separate building block.
- Shape: is determined by the geometric structure of the object and its length to width ratio. The shape can be assessed using various coefficients, such as the compactness coefficient.
- Density: The amount of development or population in a given area. This indicator helps to determine the degree of intensity of urban development.

These morphometric indicators provide an opportunity to quantify and compare various aspects of urban development, which is important for further planning and development of cities.

To measure and analyse morphometric indicators in urban development, various methods based on the collection and processing of geospatial data are used.

Here are some of the most common methods:

Geographic Information Systems (GIS): GIS are powerful tools for collecting, storing, processing and visualising geospatial data. They allow analysing various aspects of urban development, including morphometric indicators, by creating thematic maps and performing geospatial analysis.

- Remote sensing: This method involves the use of satellite, aerial or drone imagery to obtain geospatial information about an urban area. Remote sensing can be used to measure various morphometric indicators such as area, shape and density of buildings.
- Terrain surveying: This method involves the direct measurement of morphometric characteristics on site through terrain measurements. It can be used to accurately measure parameters such as the perimeter and shape of building plots or other urban features.
- Modelling geospatial processes: The use of mathematical models to analyse and predict urban development, including the calculation of morphometric indicators based on the original geospatial data.

The combination of these methods allows for a comprehensive analysis of morphometric indicators in urban development, which contributes to a more accurate understanding and effective planning of the urban environment.

Morphometric indicators play an important role in urban planning and architectural design, providing a means for quantifying and analysing various aspects of urban development. The following are some of the ways morphometric indicators can be used in these contexts:

- Planning of city development: Morphometric indicators help to assess the current state of urban development and predict its future development. Based on this data, development strategies can be developed, such as identifying areas for new development, addressing the preservation of historic parts of the city, or establishing effective urban infrastructure projects.
- Determining urban morphology: Morphometric indicators allow for the analysis and classification of various aspects of urban morphology, including building density, shape and structure of city blocks and neighbourhoods. This helps to identify important patterns and trends in urban development.
- Transport infrastructure planning: Morphometric indicators can be used to determine the optimal location of roads, streets and public transport in a city. Analysing the geometric characteristics of city streets helps to identify ways to optimise the transport system to increase traffic flow and reduce traffic congestion.
- Architectural design: Morphometric data can be used to develop architectural designs and select optimal solutions for the location of buildings, the organisation of interior space and the structuring of the urban landscape.

In general, the use of morphometric indicators in urban planning and architectural design contributes to the creation of more efficient, functional and harmonious urban environments.

Geoinformation technologies are proving to be integral in urban planning and urban environment analysis. They provide the means for collecting, processing, analysing and visualising geospatial data, which plays an important role in decision-making and urban development.

The advantages of using geoinformation technologies in urban planning include:

- Data integration: Geoinformation technologies allow for the integration of different types of data, such as maps, images, demographic and economic data, which helps to provide comprehensive data about the city and its surroundings.
- Analysis of spatial relationships: Geographic information systems can identify and analyse the spatial relationships between different objects and phenomena in the urban environment, which helps to understand the dynamics and interrelationships in urban planning.
- Modelling and forecasting: Geoinformation technologies are used to create models of urban development and to predict the consequences of various decisions on urban infrastructure and development.
- Decision-making support: Visualisation of geospatial data in the form of maps and graphs helps to make informed decisions on the design of urban projects and development strategies.
- Communication and collaboration: Geoinformation technologies facilitate communication between different stakeholders in the urban environment, such as local authorities, architects, NGOs and city residents, which helps to ensure greater public participation in decision-making processes.

This review shows how geoinformation technologies are becoming a key tool in modern urban planning, helping to solve complex problems and contribute to the creation of more efficient, sustainable and resilient cities [1].

The purpose of the study. The purpose of this article is to study the role of geoinformation technologies in the process of creating and using a geospatial database for analysing morphometric indicators of urban development. The article is aimed at studying methods and approaches to collecting, processing and analysing geodata in order to determine the specific characteristics of the urban environment and the impact of these characteristics on urban development. In addition, the aim is to highlight the possibilities of using geoinformation technologies in urban planning, solving environmental problems and improving the quality of life of city residents.

Summary of the main material. Geographic information systems (GIS) are a key tool for collecting, processing, analysing and visualising geospatial data in urban

planning and architecture. They provide tools for integrating different types of geodata and allow creating thematic maps, analysing spatial relationships and making forecasts of urban development [2].

The main functions of geographic information systems in the context of urban development include:

- Collection of geospatial data: GIS allows you to collect a variety of geo-data such as map data, satellite images, aerial photographs, GPS data, etc. This data can be imported, processed and integrated into a single database.
- Analysis of spatial relationships: GIS provides tools for performing various analytical operations such as determining distances, zones or areas, classifying objects, and identifying and analysing relationships between geospatial objects.
- Creation of thematic maps: GIS allows you to create various types of thematic maps, which can include information about buildings, transport infrastructure, landscape features, and other aspects of the urban environment.
- City development forecasting: GIS can be used to create predictive models of city development based on various parameters such as demographic data, housing demand, economic indicators, etc.
- Monitoring and management: GIS allows monitoring of various processes and phenomena in the urban environment, which allows the city administration to make informed decisions on the management of urban resources and infrastructure.

In general, geographic information systems play an important role in planning and managing the urban environment, providing tools for analysing and solving various urban planning tasks [3].

The creation of a geospatial database (GSD) is an important step in the implementation of geoinformation technologies for the analysis of urban development and morphometric indicators. A GSD is a structured collection of geospatial data that allows storing, organising and managing information about an urban area and its characteristics.

The main aspects of creating a GSD for urban development and morphometric indicators include:

- Define the data structure: Before starting work on the DGD, a data structure should be defined that reflects the main attributes and characteristics of urban development, such as geographic coordinates, area, perimeter, building density, etc.
- Collect and process geospatial data: Geo-data for the GSD can be collected from various sources such as satellite images, aerial photographs, maps, field surveys, etc. Once collected, the data is processed and analysed using GIS.

- Integration with morphometric indicators: An important step is the integration of morphometric indicators into the structure of the DGD. This allows data on the geometric characteristics of urban development to be stored, updated and analysed along with other attributes.
- Creation of metadata: Metadata is a description of information about data, such as source, format, accuracy, etc. Creating metadata helps to ensure that the data is used and interpreted correctly in the future.
- Providing access and management: The created LHD should be accessible to users and allow easy access to information. It is also important to regularly update and manage the data to ensure its relevance and integrity.

The creation of a DBD for storing morphometric indicators of urban development is a key stage in the use of geographic information technologies for managing and planning the urban environment. This allows to provide access to up-to-date and reliable information for making informed decisions in the field of urban development.

This section analyses the main morphometric indicators to assess the state of urban development. Morphometric indicators provide an opportunity to quantify the geometric and structural characteristics of the urban environment, which allows to understand its functioning and identify potential problem situations [4].

The main aspects of this analysis include:

- Building density: An assessment of the amount and location of development currently in place. This may include an analysis of the building area per unit of urban area, as well as determining the evenness of the distribution of buildings across the city.
- Block and neighbourhood structure: The study of the shape and size of blocks and quarters in the urban development. This helps to determine the level of compactness of the development and the possibility of using the space for different purposes.
- Location of green spaces: Analysis of the location and size of green spaces in the city. This is important for ensuring an ecological balance and creating a comfortable urban environment for residents.
- Form and structure of the street network: An assessment of the shape and structure of the street network, its density and connectivity. This can affect the ease of movement of residents and the organisation of traffic flows in the city.
- The analysis of these morphometric indicators allows us to understand the structure and functioning of the urban environment, identify its strengths and weaknesses, and develop planning strategies to improve the quality of urban life.

This section explores how morphometric indicators can be used to predict future urban development and formulate planning and development strategies. This is

done by analysing urban development trends and their impact on the morphometric parameters of urban development.

First of all, various factors affecting city development are considered, such as demographic changes, economic development, transport infrastructure, technological innovations, etc. The analysis of these factors allows us to understand the trends and needs of the city in the future.

Next, the impact of these factors on the morphometric parameters of urban development is assessed. For example, a change in the economic status of a city may affect the size and structure of new construction projects, or population growth may lead to an increase in building density and changes in the structure of urban blocks.

By analysing these influences, predictive models can be developed to predict future changes in the morphometric parameters of urban development depending on different scenarios of urban development. These predictive models can be used to formulate planning and development strategies for the city, taking into account its needs and prospects.

Thus, the use of morphometric indicators to predict urban development allows for more informed and effective urban development management, contributing to the creation of more sustainable, functional and harmonious urban environments [5].

After analysing the morphometric indicators in Section 3.1, we obtained important data on the state and characteristics of the urban environment. Based on these data, recommendations can be developed to improve the urban environment and optimise urban development [6].

Key aspects of this process include:

- Structural changes: The assessment of morphometric parameters can indicate the need for structural changes in urban development. For example, if the analysis shows excessive building density in certain areas, recommendations may include strategies to preserve green space or expand low-density areas.
- Growth management: Morphometric analysis can be used to develop strategies for managing urban growth. For example, identifying growth trends and development rates can help determine the need for infrastructure development or development restrictions in certain areas.
- Green spaces: Morphometric analysis can identify the lack of green space in a city. Recommendations may include the creation of new parks, squares or alleys to improve the quality of life of residents and preserve ecological balance [7].
- Transport safety and efficiency: Analysis of morphometric indicators can also reveal problems with transport infrastructure and road safety. Recommendations may include the construction of new roads, pedestrian crossings, and the development of urban transport plans.
- Social infrastructure: Morphometric analysis can identify areas with

insufficient access to social infrastructure, such as schools, healthcare facilities, or cultural centres. Recommendations may include expanding or improving existing social facilities.

These recommendations help urban planners, architects and authorities to make informed decisions on city development aimed at improving the quality of life of residents and ensuring sustainable development of urban areas [8].

After analysing morphometric indicators and developing recommendations for improving the urban environment, the next step is to create urban plans. This allows for systematisation and specification of proposals for urban development management, as well as setting strategies and goals for further development of the city. The main aspects of creating urban plans based on morphometric analyses include:

- Defining goals and objectives: This is the first stage where the main goals and objectives of urban planning are defined, taking into account the results of the morphometric analysis. These goals may include improving the quality of life of residents, preserving natural resources, developing an efficient transport infrastructure, etc.
- Identification of priority development areas: Based on the analysis of morphometric data and recommendations, priority areas for city development are identified. This may include the development of green areas, reconstruction of existing districts, creation of new infrastructure and other measures.
- Development of specific measures and projects: At this stage, specific measures and projects are formulated to achieve the identified goals. This may include the construction of new facilities, reconstruction of existing infrastructure, landscaping, and other measures [9].
- Identification of resources and budget planning: Once specific measures have been identified, it is necessary to calculate the resources required and to create
- A budget for their implementation. This includes identifying the financial, human and material resources needed to implement the plan.
- Monitoring and evaluation of results: After the implementation of urban plans, it is necessary to systematically monitor and evaluate their effectiveness. This allows for timely identification of problems and adjustment of city development strategies.

The creation of urban plans based on morphometric analyses helps city authorities and planners to develop a systematic and targeted approach to urban development aimed at achieving sustainable development and improving the quality of life of residents [10].

Conclusions and Prospects for the Study. This article investigates the role of geoinformation technologies in the creation and use of a geospatial database for the

analysis of urban development and morphometric indicators. In particular, the main aspects of creating a geospatial database, the use of geographic information systems in the collection and processing of geodata, as well as the analysis and application of morphometric indicators in urban planning were considered.

The study has shown that geoinformation technologies and the analysis of morphometric indicators can be used to comprehensively monitor and manage the urban environment, which contributes to the sustainable development of cities and improve the quality of life of their residents. The data in this report can be useful for urban planners, architects, authorities and other stakeholders in solving urban development and planning problems.

Continued research in this area can contribute to further improvement of urban development analysis methods and the development of effective urban development strategies that meet modern requirements of sustainable development and ensure the balanced development of urban areas.

Третяк В.М.,
Київський національний університет будівництва і архітектури

СТВОРЕННЯ ТА ВИКОРИСТАННЯ ГЕОПРОСТОРОВИХ ДАНИХ ДЛЯ МОРФОМЕТРИЧНОГО АНАЛІЗУ МІСЬКОЇ ЗАБУДОВИ З ВИКОРИСТАННЯМ ГЕОІНФОРМАЦІЙНИХ ТЕХНОЛОГІЙ

Сучасна міська обстановка потребує всебічного підходу до управління та розвитку, який враховує різні аспекти міської забудови та життя мешканців. У цій статті розглядається використання геоінформаційних технологій для створення та використання бази геопросторових даних у зв'язку з аналізом міської забудови та морфометричних показників. Звертається увага на важливість збору, аналізу та використання геоданих для ефективного міського планування та розвитку.

Стаття описує різноманітність застосування геоінформаційних систем у міському плануванні, включаючи віддалене зондування для збору геопросторових даних, аналіз морфометричних показників міської забудови, розробку рекомендацій для покращення міського середовища та створення міських планів на основі такого аналізу. Особливу увагу приділяється перевагам використання геоінформаційних технологій у міському плануванні, таких як підвищена точність та швидкість обробки даних, здатність до комплексного аналізу геопросторової інформації та спрощення процесу прийняття рішень.

Результати дослідження можуть бути корисними для міських влад,

архітекторів, планувальників та інших учасників, які займаються розвитком та управлінням міським середовищем. Використання геоінформаційних технологій у міському плануванні може сприяти сталому розвитку міст та покращенню якості життя їх мешканців, роблячи процес планування більш ефективним та прозорим.

Розглянуто роль геоінформаційних технологій у створенні та використанні бази геопросторових даних для аналізу міської забудови та морфометричних показників. Особливо акцентується на основних аспектах створення такої бази даних, використанні геоінформаційних систем у зборі та обробці геоданих, а також аналізі та застосуванні морфометричних показників у міському плануванні.

Ключові слова: морфометричні індикатори; геоінформаційні технології; міська забудова; бази геопросторових даних; інфраструктура.

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