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FUNCTIONAL SYSTEMATIZATION AND A CONCEPTUAL SEQUENCE FOR APPLYING GEOINFORMATION METHODS TO SPATIAL PLANNING TASKS IN TERRITORIAL COMMUNITIES

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Abstract. *This article presents a functional systematization of contemporary geoinformation methods used to address spatial planning tasks in territorial communities. The aim of the study is to identify the functional purposes of geoinformation methods and develop a conceptual sequence for selecting and combining them according to the nature of a spatial planning task, the composition of the input geospatial data, and the expected spatial outcome. The methodological basis*

comprises comparative analysis, classification and generalization methods, and conceptual modelling.

The study identifies eight functional groups of geoinformation methods: spatial integration and overlay analysis; proximity and impact-zone analysis; network analysis and spatial accessibility assessment; spatial statistics and geostatistical modelling; remote sensing and change monitoring; multicriteria assessment of territorial suitability; scenario-based spatial modelling; and GeoAI (geospatial artificial intelligence) and machine learning methods. Relationships were established among spatial planning tasks, input geospatial data, methods of processing those data, and the spatial outputs obtained. The appropriateness of combining several functional groups of methods sequentially or in an integrated manner is substantiated depending on the task at hand.

A conceptual sequence was developed: “spatial planning task → input geospatial data → analysis or modelling method → spatial result → result validation → planning decision”. Its application is illustrated through geoinformation processing of cadastral materials for the Svirzh Castle land parcel and conceptual modelling of territorial restrictions in QGIS. The example demonstrates how reconstruction of the digital parcel boundary, thematic representation of restrictions, and buffer modelling can be combined. The need to distinguish calculated geoinformation modelling results from legally established boundaries of protected zones is emphasized.

The practical significance of the findings lies in the potential to use the proposed functional systematization and conceptual sequence to support informed selection and combination of geoinformation methods when addressing spatial planning tasks in territorial communities. The results are conceptual and methodological in nature. Further research will involve practical testing of the proposed approach, refinement of the geometric parameters of modelled zones, and quantitative validation of the results.

Keywords: *geographic information systems for territorial communities, geoinformation modelling of land resources, spatial planning, spatial analysis of land use, Earth remote sensing, multicriteria analysis, GeoAI (geospatial artificial intelligence).*

Problem statement. Sustainable spatial development of territorial communities requires well-founded planning decisions on the use of land resources that take account of natural, socioeconomic, infrastructural, environmental, and urban-planning factors. For local self-government bodies to substantiate such decisions, they must draw on substantial volumes of heterogeneous spatial and statistical information describing, among other things, the condition of land resources, land-use dynamics, and the regimes governing territorial restrictions. Combining cadastral, topographic, urban-planning, environmental, infrastructural, and statistical data with Earth remote sensing materials makes it possible to establish a comprehensive information environment for studying community territories. Together with digital management tools, these datasets create the prerequisites for introducing digital land-use models for territorial communities. Such models should be understood as analytical models based on geoinformation technologies that can integrate heterogeneous datasets within a single information environment, construct digital cartographic models of territories, analyse conditions governing land use for different purposes, and automate other analytical operations involving geospatial data in order to improve the information available to local self-government bodies and support their management decisions.

Modern geographic information systems not only perform their inherent functions of collecting, organizing, and cartographically representing data but also support spatial analysis, modelling of territorial processes, evaluation of development alternatives, and the information-based support of planning decisions concerning community land.

The expansion of the functional capabilities of existing geoinformation technologies has led to the development of numerous spatial analysis and modelling methods. These methods can be used to investigate land-use structure, identify spatial relationships, delineate impact zones and territorial restrictions, assess accessibility, detect spatial conflicts, analyse territorial changes, and develop scenarios for future development. Alongside conventional spatial analysis methods, multicriteria assessment, predictive modelling, and geospatial artificial intelligence technologies are increasingly being used.

At the same time, the growing range of geoinformation methods available for these tasks makes their well-founded selection an increasingly important issue. The same spatial planning outcome may be achieved using different datasets and analytical procedures. The effectiveness of a particular method depends on the nature of the task, the geographical extent of the study, the completeness and currency of the source information, accuracy requirements, and the way results are presented. Accordingly, the challenge is not only to apply individual GIS analytical tools but also to systematize them in relation to the spatial development tasks of territorial communities.

Review of recent research and publications. The current stage of geoinformation technology development is characterized by a shift from predominantly cartographic representation of spatial data towards comprehensive territorial analysis, modelling of spatial processes, and support for planning decisions. Recent studies regard geographic information systems as an integrative environment combining cadastral, topographic, urban-planning, environmental, infrastructural, and remote sensing data [1–3].

An important application of geoinformation methods is the identification and modelling of territorial restrictions and land-use conflicts. Novakovskiy et al. [1] substantiated the use of geoinformation analysis methods to delineate land-use restrictions in spatial planning, emphasizing the integration of geospatial analysis and

Earth remote sensing data. Mansourihanis et al. [4] proposed a quantitative geospatial approach to assessing land-use compatibility, enabling the identification of spatial conflicts and the localization of areas with different levels of functional compatibility. These studies illustrate a gradual transition from straightforward overlay of thematic layers to formalized modelling of spatial relationships.

A separate body of research addresses land suitability assessment and multicriteria spatial analysis. Sahin et al. [5] combined remote sensing data, GIS, the analytic hierarchy process, and land-use development modelling to identify areas suitable for prospective urban development. Their findings confirm the value of integrating natural, infrastructural, and socioeconomic spatial criteria within a unified geoinformation environment. Nevertheless, multicriteria methods should be regarded not as universal tools but as one functional group whose selection depends on the specific spatial planning task.

The integrated use of GIS and Earth remote sensing data has become widespread. It enables the detection of land-cover and land-use changes, assessment of natural and anthropogenic components of a territory, identification of trends in territorial system transformation, and updating of geospatial information [5–7]. Kulikovska et al. [6] demonstrated the potential of integrating UAV photogrammetry and GIS to construct a digital elevation model and address urban land-use planning tasks. This approach extends the conventional set of input data for spatial analysis through high-resolution aerial imagery acquired recently.

The practical value of geoinformation technologies is particularly evident at the levels of territorial and urban-planning governance. Kulikovska, Stupen, and Kolodiy [7] examined the development of an electronic GIS-based urban-planning cadastre for Kryvyi Rih as part of the municipal urban development programme. This demonstrates a transition from the use of individual GIS tools to integrated information systems designed to collect, update, and spatially analyse data needed for management and planning decisions. A similar trend can be observed in recent

research on geoinformation support for urban development monitoring in territorial communities [8] and the use of GIS in urban-planning decisions [9].

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A promising area is the use of geospatial artificial intelligence (GeoAI), which combines geoinformatics, machine learning, and spatial modelling. Janowicz et al. [10] systematised the conceptual foundations of GeoAI and its role in identifying geographical patterns. Aidaoui et al. [11] examined GeoAI in relation to land-use change analysis and the optimisation of urban planning. Recent research also associates GeoAI with automated processing of large geospatial datasets, predictive modelling, and the development of spatial data infrastructures [12]. Nevertheless, applying these methods requires input-data quality control, interpretability of results, and independent validation.

A distinct area of current research involves spatial statistics and geostatistical modelling. These groups of methods should be differentiated according to their functional purposes. Spatial statistical methods primarily aim to identify patterns in the spatial distribution of phenomena and include the assessment of global and local spatial autocorrelation, cluster analysis, and hot- and cold-spot analysis. Geostatistical methods focus on investigating the spatial structure of quantitative variables, modelling continuous spatial surfaces, and estimating prediction uncertainty through semivariogram analysis, kriging, and cokriging. The quality of the resulting

geostatistical models is assessed using cross-validation and spatial interpolation error metrics.

Of particular interest in this context are studies by Ukrainian researchers [16, 17] in which geoinformation analysis and modelling were applied to spatial planning tasks. Specifically, study [16] combined buffer and morphometric analyses with spatial autocorrelation assessment, semivariogram modelling, ordinary kriging, and cokriging; the quality of the results was evaluated using RMSE. This approach demonstrates that geostatistical modelling can serve not merely as a supplementary tool but as a component of the evidence base for spatial planning decisions. In study [17], geoinformation analysis was used to support decisions concerning land exchange and consolidation within territorial planning.

Accordingly, an approach is needed in which contemporary geoinformation methods are considered not in isolation but as interconnected components of a sequence: spatial planning task → input geospatial data → analysis or modelling method → spatial result → result validation → planning decision. This sequence establishes the logic of the subsequent study and can be used for the structured selection and combination of geoinformation methods according to the nature of spatial planning tasks faced by territorial communities.

The aim of the study is to functionally systematise geoinformation methods for addressing spatial planning tasks in territorial communities and to develop a conceptual sequence for selecting and combining these methods, taking into account the nature of the task, the composition of input geospatial data, expected results, and the need for their validation.

To achieve this aim, the study seeks to analyse current applications of geoinformation technologies in spatial planning; systematise geoinformation methods by their functional purposes; establish correspondences between types of spatial planning tasks, input data, and methods of processing them; and develop a conceptual sequence for selecting and combining geoinformation methods.

Materials and methods. This methodological study aims to systematise contemporary geoinformation methods in relation to spatial planning tasks in territorial communities. Its information base comprised recent scientific publications on the use of GIS, spatial analysis, Earth remote sensing, multicriteria assessment, scenario modelling, and GeoAI in spatial and territorial planning [1–17]. Publications were selected according to their thematic relevance to the principal areas of geoinformation support for spatial planning: analysis of territorial restrictions, accessibility, land-use change, land suitability, scenario modelling, and GeoAI applications.

The main types of geospatial information considered were topographic and cadastral data; land-use and land-cover information; digital elevation models; Earth remote sensing and UAV survey materials; data on transport, utility, and social infrastructure; environmental and other territorial restrictions; and statistical, socioeconomic, and urban planning information.

The methodological basis comprised comparative analysis, classification and generalisation methods, and conceptual modelling. Functional matching was used to establish relationships between types of spatial planning tasks, the composition of input geospatial data, methods of processing these data, and forms of the resulting outputs. Comparative analysis identified the capabilities and limitations of different groups of geoinformation methods, while classification and generalisation were used to group them according to the spatial planning tasks they address.

The systematisation was carried out sequentially according to five attributes: the type of spatial planning task; the composition of input geospatial data; the analysis or modelling method; the form of the resulting spatial output; and limitations on application. This systematisation provided the basis for a conceptual sequence that also includes result validation and planning decisions. At the first stage, the nature of the spatial planning task and the required geospatial data were identified for each area of GIS application. At the second stage, analysis or modelling methods functionally

suited to the task were determined. At the third stage, the methods were grouped by the predominant analytical operation and the nature of the spatial result produced. At the fourth stage, the functional capabilities and principal limitations of the identified groups were compared. At the final stage, correspondences were established among the elements of the sequence: spatial planning task → input geospatial data → analysis or modelling method → spatial result → result validation → planning decision.

This approach made it possible to develop a functional classification of geoinformation methods and represent the relationships among spatial planning tasks, input geospatial data, processing methods, spatial outputs, and their validation in the form of summary matrices and a conceptual diagram.

Main research results. The analysis established that contemporary geoinformation methods should be systematised not according to the software used to implement them, but according to their functional role in addressing spatial planning tasks in territorial communities. This approach links a specific task with the necessary input geospatial data, an appropriate processing method, and the expected spatial result.

Eight principal functional groups of geoinformation methods are proposed: spatial integration and overlay analysis; proximity and impact-zone analysis; network analysis and spatial accessibility assessment; spatial statistics and geostatistical modelling; remote monitoring and change analysis; land suitability assessment and multicriteria spatial analysis; scenario modelling; and GeoAI and machine learning methods.

Spatial integration and overlay analysis methods have long been, and remain, fundamental to comprehensive territorial studies. They enable cadastral, topographic, urban planning, environmental, infrastructure, and other thematic layers to be combined, allowing spatial relationships between objects to be established, territorial

conflicts to be identified, and areas subject to the simultaneous overlap of several conditions or restrictions to be delineated.

Proximity and impact-zone analysis is used to determine spatial interactions between objects as a function of the distances separating them. Buffer modelling makes it possible to delineate protection, sanitary protection, riparian, and other zones, and to assess areas within a given spatial sphere of influence. In spatial planning for territorial communities, this group of methods is particularly important for accounting for territorial restrictions and identifying potential land-use conflicts.

Network analysis and spatial accessibility assessment focus on transport and other network connections. Their application makes it possible to determine routes, service areas, and travel-time or distance-based accessibility to social, transport, and utility infrastructure. The spatial outputs may include zones with differing levels of accessibility and areas underserved by the relevant services.

Spatial statistics and geostatistical modelling methods provide quantitative assessments of territorial patterns and spatial relationships. Spatial statistical methods help identify spatial concentrations of phenomena, clusters, local anomalies, and spatial autocorrelation. Geostatistical modelling is applied to investigate the spatial variability of quantitative indicators, construct continuous spatial surfaces, and assess spatial interpolation results.

Network analysis and the assessment of spatial accessibility focus on the study of transport and other network connections. Their application makes it possible to determine routes, service areas, and the temporal or distance-based accessibility of social, transport, and engineering infrastructure facilities. The spatial outcomes of such analyses may include zones with different levels of accessibility and areas underserved by the relevant services.

Spatial statistics and geostatistical modelling methods provide a quantitative assessment of territorial patterns and spatial relationships. Spatial statistics can identify the spatial concentration of phenomena, clusters, local anomalies, and spatial

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Remote monitoring and change-detection methods constitute a separate functional group based on multitemporal satellite and aerial imagery. They make it possible to update land-cover and land-use information, detect and locate landscape changes, transformations of agricultural and natural areas, changes in vegetation condition, and other territorial processes. Integrating remote sensing data, UAV imagery, and GIS increases the level of detail of spatial analysis and enables regular data updates.

Territorial suitability assessment and multicriteria spatial analysis are used when a planning decision depends on the simultaneous consideration of several spatial criteria. The input indicators are normalized and integrated into an overall assessment, on the basis of which the territory can be differentiated by its degree of suitability for a particular use. Criterion weights can be determined by various methods, including the Analytic Hierarchy Process (AHP). In this context, AHP is regarded as one possible multicriteria analysis tool rather than a mandatory component of geoinformation modelling.

Scenario modelling extends spatial analysis beyond assessing current conditions to examining possible options for territorial development. Developing alternative scenarios makes it possible to compare the consequences of different planning decisions, assess potential changes in land-use structure, and identify areas most sensitive to the corresponding transformations.

Based on an analysis of recent scientific publications and the functionality of specialized online services, GeoAI and machine learning methods were identified as a promising functional group for geospatial data processing. Their use can support automated land-cover classification, spatial object recognition, change detection, identification of hidden spatial patterns, and forecasting of territorial processes. At the

same time, GeoAI does not replace traditional geoinformation analysis methods but extends their capabilities, provided that input data are of adequate quality, the results are interpretable, and spatial validation is performed.

The generalized correspondence between functional areas of geoinformation analysis and modelling, input geospatial data, spatial planning tasks, and the resulting spatial outputs is presented in Table 1.

Table 1

Functions of geoinformation analysis and modelling for spatial planning in territorial communities

Functional area	Main input data	Spatial planning task	Main analytical output	Key limitations
Cartographic integration of heterogeneous data and overlay analysis	Cadastral, topographic, urban planning and environmental layers	Identification of spatial relationships and conflicts	Boundary intersection zones; identification of conflicts and assessment of territorial restriction regimes	Dependence on accuracy and consistency of input data layers
Proximity and impact-zone analysis	Objects and territorial boundaries; regulatory distances	Delineation of impact zones and restrictions	Buffer and protective zones	Dependence on the correct selection of regulatory parameters
Network analysis and transport accessibility	Transport network, infrastructure facilities, population	Assessment of access to services and infrastructure	Routes, isochrones and service areas	Quality and completeness of network data
Spatial statistics and geostatistical modelling	Spatially referenced quantitative indicators	Identification of territorial patterns and modelling of spatial variability	Clusters, concentrations, spatial anomalies, continuous spatial surfaces and predicted values	Dependence on scale, spatial aggregation, structure and quality of input data; need for validation
Remote monitoring and change analysis	Satellite and aerial imagery; orthophotos	Monitoring of land use and territorial changes	Maps of changes and territorial dynamics	Spatial and temporal resolution of data
Suitability assessment and	Natural, environmental,	Assessment of territorial	Zones with different	Selection and normalization of

multicriteria analysis	infrastructural and urban planning criteria	suitability	suitability levels	criteria and assignment of weights
Scenario modelling	Current territorial conditions, restrictions and development trends	Comparison of development alternatives	Spatial scenarios	Dependence on initial assumptions
GeoAI and machine learning	Remote sensing datasets	Territorial classification, change detection and forecasting	Automated classifications and predictive models	Need for training data, interpretation and validation

Source: compiled by the authors based on the generalization and systematization of contemporary geoinformation methods [1–17].

The systematization results indicate that the choice of a geoinformation method is primarily determined by the nature of the spatial planning task, and that solving such a task generally requires the sequential or integrated application of several groups of methods. Accordingly, the next stage of the study was to establish the correspondence between the principal spatial development tasks of territorial communities and appropriate combinations of geoinformation methods (Table 2).

Table 2

Correspondence between spatial planning tasks of territorial communities and combinations of geoinformation methods

Spatial planning task	Principal geoinformation methods	Additional methods	Expected spatial output
Identification of territorial restrictions	Overlay analysis; buffer analysis	Spatial queries; proximity analysis	Restricted zones and areas subject to different land-use regimes
Identification of land-use conflicts	Overlay analysis	Spatial statistics; compatibility analysis	Areas where incompatible or potentially conflicting land uses overlap
Assessment of transport accessibility	Network analysis	Proximity analysis; spatial statistics	Routes, isochrones and transport accessibility zones

Assessment of accessibility of social infrastructure	Network analysis; service-area analysis	Spatial statistics	Service coverage areas and territories with insufficient access to services
Monitoring of land-use and land-cover changes	Remote sensing; multitemporal data analysis	Overlay analysis; image classification	Change maps, directions and intensity of territorial transformation
Territorial suitability assessment	Suitability analysis; multicriteria spatial analysis	Overlay analysis; AHP or other weighting methods	Territorial zoning by suitability for a specified type of use
Identification of areas for future development	Restrictions analysis; suitability assessment	Accessibility analysis; MCDA; scenario modelling	Areas potentially suitable for priority development directions
Analysis of spatial concentration of phenomena	Spatial statistics	Overlay analysis	Clusters, concentration zones and spatial anomalies
Modelling the spatial distribution of quantitative indicators	Geostatistical modelling; kriging	Semivariogram analysis; cokriging; cross-validation	Continuous spatial surfaces, predicted values and assessment of modelling accuracy
Development of spatial development alternatives	Scenario modelling	MCDA; suitability analysis; network and overlay analysis	Alternative spatial development scenarios
Automated detection of objects, changes and patterns	GeoAI; machine learning	Remote sensing; spatial statistics	Classified objects, detected changes, spatial patterns and predicted results

Source: developed by the authors based on the systematization of contemporary geoinformation methods and the analysis of scientific publications [1–17].

The results presented in Table 2 demonstrate that individual geoinformation methods can be used to address different spatial planning tasks, with their functional significance changing according to the objective. At the same time, complex spatial development tasks require combinations of methods in which the output of one analytical stage serves as the input for the next.

Thus, geoinformation support for spatial planning should be regarded as a sequence of interconnected analytical procedures. On this basis, a conceptual sequence for applying geoinformation methods was developed, as shown in Figure 1.

To illustrate the proposed conceptual sequence for selecting and combining geoinformation methods, the land parcel of Svirzh Castle (cadastral number

4623386400:12:001:0263) was considered. The purpose of this example is not to comprehensively establish all territorial restrictions but to demonstrate the transition from input data to the selection of operations, generation of a modelled spatial output, and its verification.

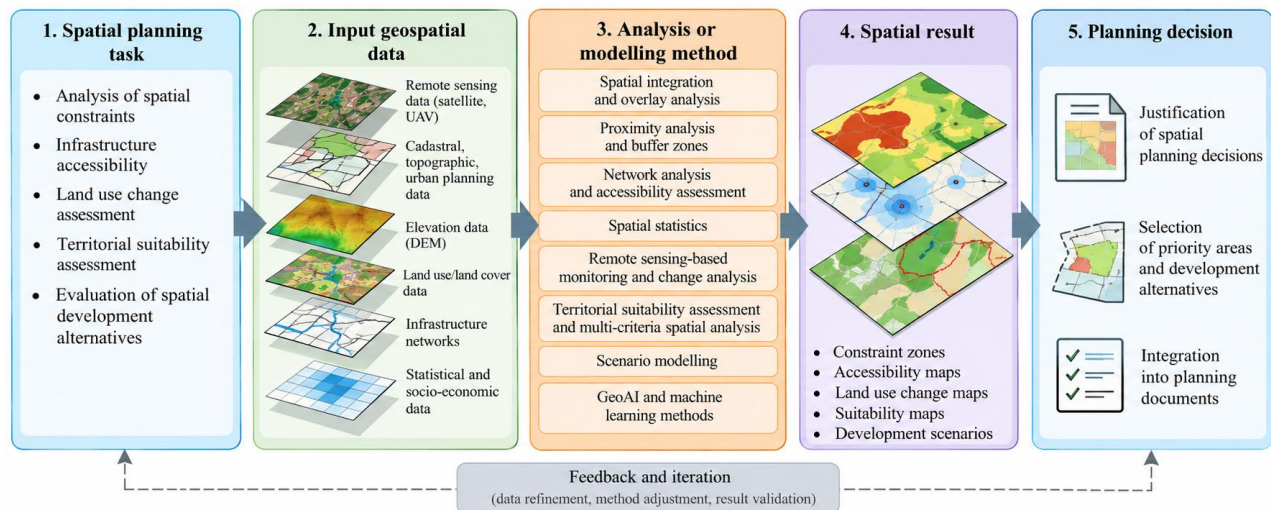


Fig. 1. Conceptual sequence for applying geoinformation methods to spatial planning tasks in territorial communities

Source: developed by the authors based on the study results.

The information base comprises the cadastral plan, the cadastral exchange XML file, information about the cultural heritage site, and a digital representation of the castle building geometry. The XML file contains coordinates of boundary turning points in the SK-63 coordinate system, a description of the land parcel boundaries, and information about registered restrictions, including codes 01.05.1 and 05.01. Information about the monument's heritage status is used to formulate the modelling task; however, it does not, in itself, define the geometry of a legally established heritage protection zone.

Table 3

Composition of input data for conceptual modelling of territorial restrictions

Input information component	Purpose in modelling
Cadastral plan of the land parcel	Visual verification of the configuration and

Input information component	Purpose in modelling
	comparison with the digital boundary
Cadastral XML (SK-63)	Reconstruction of parcel geometry; retrieval of attributes and geometry of registered restrictions
Information on the cultural heritage monument	Identification of the site and justification of the need to verify protection regimes
Digital outline of the castle building (CASTLE_BUILDING)	Input geometry for the illustrative buffer-zone model
Regulatory and design documents on zone regimes	Required for legal interpretation and confirmation of boundaries; completeness of these data requires verification

Source: developed by the authors.

At the first stage, the graphical cadastral plan was compared with the boundary reconstructed from the XML coordinates. This makes it possible to verify the shape of the land parcel and move from a document to a geometrically defined spatial object (Fig. 2). The registered restrictions were used solely as examples of thematic layers; their comprehensive legal analysis is beyond the scope of this article.

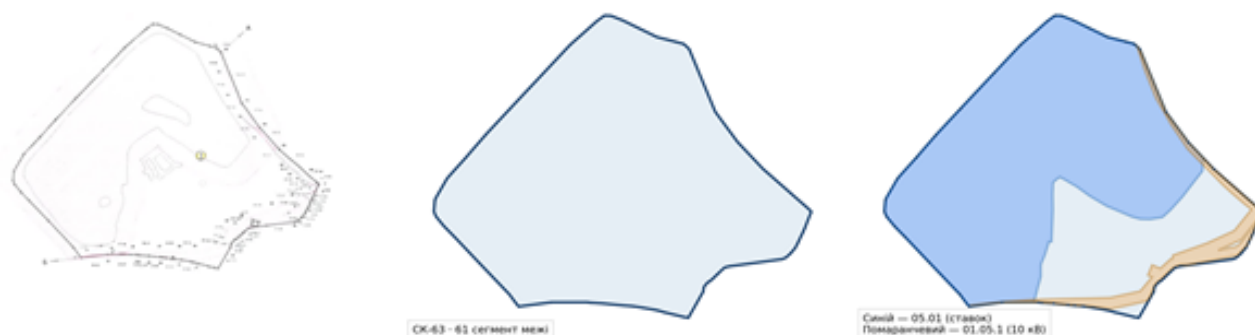


Fig. 2. Original cadastral plan (a), reconstructed digital boundary of the land parcel (b), and results of geoinformation visualization of territorial restrictions (c)

Source: compiled by the authors based on the processing of cadastral materials.

To illustrate the selection and combination of geoinformation methods, an algorithm for processing the geometry of the Svirzh Castle building was developed in QGIS (Fig. 3). The model provides for the creation of two illustrative buffer zones at

distances of 20 and 100 m. The 20 m parameter was chosen to demonstrate analysis of the building's immediate surroundings, whereas 100 m was used to examine a wider spatial extent. These distances are experimental parameters, not legally prescribed boundaries of the Svirzh Castle heritage protection zones. The legal framework for defining monument protection zones and land-use regimes within the relevant territories is established, in particular, by Article 32 of the Law of Ukraine 'On the Protection of Cultural Heritage' [18].

The proposed conceptual sequence allows for the automation of individual stages of geoinformation modelling of territorial restrictions, including the generation of zones with specified parameters, determination of the coordinates of their boundary vertices, calculation of areas, and creation of the corresponding geospatial datasets. These operations can be implemented in GIS software environments using buffering, vertex extraction, geometric attribute calculation, and spatial analysis tools.

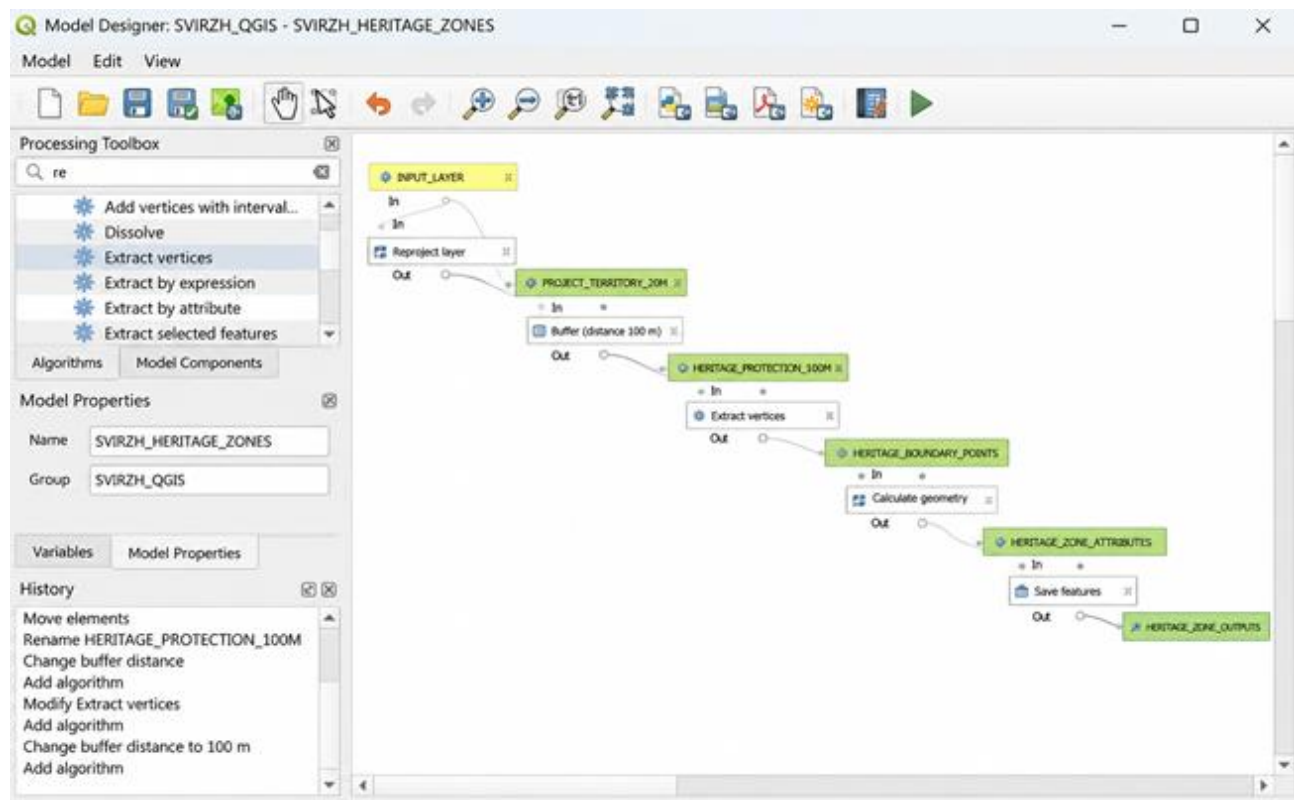


Fig. 3. Conceptual model of the sequential application of geoinformation operations in QGIS using Svirzh Castle as an example

Source: developed by the authors.

An important advantage of this approach is the possibility of modifying input parameters in accordance with regulatory requirements, rerunning geoinformation operations, and updating modelling outputs. This ensures reproducibility of modelling results, provides a basis for their spatial validation, and enables their subsequent integration into GIS for spatial planning in territorial communities.

The example illustrates the possibility of selecting geoinformation methods in a structured manner and combining them sequentially according to the available data and the nature of the spatial planning task. However, the boundaries of zones generated by geoinformation modelling for Svirzh Castle are computational and must not be equated with the legally established boundaries of the monument's protection zones. Further research will involve refining geometric parameters and determining the coordinates of boundary vertices for the relevant zones, taking into account approved scientific and design documentation and the requirements of the Law of Ukraine 'On the Protection of Cultural Heritage' [18].

Discussion of results. The proposed systematization broadens the traditional understanding of geoinformation support for spatial planning by bringing individual methods together within a single functional sequence and linking their selection to the nature of a specific spatial planning task. This corresponds to the contemporary transition from cartographic representation of spatial information to comprehensive geoinformation modelling of territorial processes [1–5].

The findings complement approaches to the geoinformation analysis of territorial restrictions presented by Novakovskiy et al. [1], because the proposed systematization covers not only the identification of land-use restrictions but also the analysis of accessibility, territorial suitability, land-use changes, and possible development scenarios. The findings are also consistent with the approach of Mansourihanis et al. [4] regarding the need to consider the spatial compatibility of land uses and confirm the importance of overlay analysis for detecting potential

territorial conflicts. Combining remote sensing and geoinformation methods expands the possibilities for updating input data and monitoring territorial changes. Satellite data, UAV imagery, and digital elevation models can supplement traditional cadastral and topographic sources with up-to-date information on actual territorial conditions. This is consistent with studies on the integrated use of remote sensing and GIS [5, 6]. Nevertheless, the use of such data requires consideration of their spatial and temporal resolution, accuracy, and suitability for the scale of the task.

The systematization results also indicate that multicriteria spatial analysis is most appropriate for tasks requiring the simultaneous consideration of several groups of spatial criteria. In such cases, AHP may be used as one method of determining criterion weights [5]; however, the choice of weighting method should depend on the nature of the study and the availability of sufficient justification. This avoids the unjustified application of a single method to all types of spatial planning tasks. A distinctive feature of the proposed approach is its focus not on a particular software product or analytical tool but on the sequence 'task – data – method – result – validation – decision'. This structure makes it possible to use different software environments and geospatial data sources without changing the overall logic of the analysis. It also allows methods to be combined according to the complexity of a specific task, which is particularly important for territorial communities differing in area, land-use structure, degree of urbanization, and availability of geospatial data.

The practical implementation of this approach largely depends on the information resources available for spatial planning. The development of integrated geoinformation systems and urban planning cadastres [7–9] provides the prerequisites for the systematic accumulation and updating of spatial information needed for territorial analysis. In this context, consistency among cadastral, topographic, urban planning, infrastructure, and remote sensing data in terms of coordinate systems, temporal currency, spatial detail, and semantics is of crucial importance.

The potential of GeoAI merits particular attention. Unlike conventional GIS operations, GeoAI methods can automate the classification of large geospatial datasets and the detection of changes and complex spatial patterns [10–12]. However, their application in spatial planning should be viewed as an extension and enhancement of traditional geoinformation analysis rather than its replacement. The quality of training data, interpretability of models, and independent verification of spatial outputs remain particularly important.

Thus, the study findings substantiate the appropriateness of functionally oriented selection and sequential combination of geoinformation methods according to the nature of spatial planning tasks in territorial communities. The conceptual sequence developed reflects the relationships between task type, input geospatial data, processing methods, expected spatial outputs, and validation procedures, thereby providing a methodological basis for informed selection of geoinformation methods.

At the same time, the proposed conceptual sequence is a generalized methodological framework and does not prescribe a universal set of geoinformation methods for all territorial communities. Their selection and combination depend on the nature of the spatial planning task, territorial coverage, availability and quality of input data, and the characteristics of the study area. The Svirzh Castle example demonstrates individual stages of geoinformation operations but does not constitute a completed experimental validation of the proposed conceptual sequence.

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Conclusions and directions for further research. The study has provided a functional systematization of contemporary geoinformation methods used to address spatial planning tasks in territorial communities. Eight functional groups have been identified: spatial integration and overlay analysis; proximity and impact-zone analysis; network analysis; spatial statistics and geostatistical modelling; remote sensing and change monitoring; multicriteria assessment; scenario modelling; and GeoAI and machine learning methods.

The functional correspondence between the main types of spatial planning tasks, the composition of input geospatial data, the methods used to process them, and the expected results has been established. It has been shown that addressing complex spatial planning tasks requires not only the application of individual geoinformation methods but also their sequential combination, taking into account information prerequisites, territorial characteristics, and requirements for the reliability of results.

A conceptual sequence has been proposed: “spatial planning task → input geospatial data → analysis or modelling method → spatial output → result validation → planning decision”. Its distinctive feature is the alignment of geoinformation method selection with the nature of the task and the provision for verifying the results before using them to substantiate planning decisions.

Using the cadastral materials for the Svirzh Castle land parcel as an example, the study examined the possibilities of applying individual geoinformation operations to visualize territorial restrictions and conceptually model impact zones. The need to distinguish computational boundaries generated by geoinformation modelling from legally established boundaries of heritage protection zones was established. The example is illustrative and does not constitute a completed experimental validation of the proposed approach.

The practical significance of the results lies in establishing a methodological basis for the structured selection and combination of geoinformation methods in spatial planning for territorial communities. Further research should focus on practical

testing of the proposed sequence using actual geospatial data, quantitative assessment of modelling results, and verification of their compliance with regulatory and planning requirements.

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**FUNCTIONAL SYSTEMATIZATION AND CONCEPTUAL
SEQUENCE OF APPLYING GEOINFORMATION METHODS TO SPATIAL
PLANNING TASKS IN TERRITORIAL COMMUNITIES**

The article presents a functional systematization of modern geoinformation methods used to address spatial planning tasks in territorial communities. The aim of the study is to determine the functional purposes of geoinformation methods and to develop a conceptual sequence for their selection and combination depending on the nature of the spatial planning task, the composition of the input geospatial data, and the expected spatial outcome. The methodological framework of the study includes comparative analysis, classification and generalization methods, and conceptual modeling.

The study identifies eight functional groups of geoinformation methods: spatial integration and overlay analysis; proximity and impact zone analysis; network analysis and spatial accessibility assessment; spatial statistics and geostatistical modeling; remote sensing and change monitoring; multicriteria land suitability assessment; scenario-based spatial modeling; and GeoAI (geospatial artificial intelligence) and machine learning methods. Relationships between spatial planning tasks, input geospatial data, processing methods, and resulting spatial outputs are established. The feasibility of sequentially or comprehensively combining several functional groups of methods is substantiated according to the nature of the task.

A conceptual sequence is developed: “spatial planning task → input geospatial data → analysis or modeling method → spatial result → result validation → planning

decision.” Its application is illustrated through the geoinformation processing of cadastral materials for the Svirzh Castle land parcel and the conceptual modeling of territorial restrictions in the QGIS environment. The potential for combining operations involving the reconstruction of the digital boundary of the land parcel, thematic representation of restrictions, and buffer modeling is demonstrated. Particular emphasis is placed on the need to distinguish between calculated results of geoinformation modeling and legally established boundaries of cultural heritage protection zones.

The practical significance of the findings lies in the potential application of the proposed functional systematization and conceptual sequence to support the justified selection and combination of geoinformation methods when addressing spatial planning tasks in territorial communities. The results are conceptual and methodological in nature. Further research will focus on the practical testing of the proposed approach, refinement of the geometric parameters of modeled zones, and quantitative validation of the results.

Keywords: geographic information systems of territorial communities, geoinformation modelling of land resources, spatial planning, spatial analysis of land use, Earth observation, multicriteria analysis, GeoAI (Geospatial Artificial Intelligence).