Research Journal of Agricultural Science, 57 (4), 2025; ISSN: 2668-926X

http://doi.org/10.59463/RJAS.2025.4.27

GIS APPLICATIONS IN URBAN PLANNING: ASSESSING BUILDING FUNCTION AND PHOTOVOLTAIC POTENTIAL IN CERNETEAZ LOCALITY, WESTERN ROMANIA

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Abstract: *The present work aims to create a thematic map highlighting the function of buildings in the locality of Cerneteaz, Timiș County, western part of Romania. The locality of Cerneteaz, through its construction characteristics and data availability, provides a good example of how such a small-scale, but high-impact, initiative can be started. The analysis was performed using QGIS, a powerful open-source software used in processing and visualizing geospatial data. Data regarding the buildings were obtained through the systematic cadastral process conducted at the local level. This data provides an accurate vector representation of the building contours and allow the association of relevant attributes for functional analysis. In this study, buildings were classified based on their primary use (e.g., residential, commercial, industrial) with the goal of highlighting how they are spatially distributed in the area. Understanding the functional structure of a locality provides valuable information for authorities, urban planners, and communities, allowing for the identification of deficient areas, dysfunctions, or investment opportunities. The use of GIS technology allows not only the visualization of this information as a thematic map but also the generation of statistics and interpretations useful for understanding the functional structure of the locality. Thus, the work fits into a practical context, with relevance in the fields of spatial planning and urban management.*

Keywords*: GIS, QGIS, green energy, thematic map, building function.*

INTRODUCTION

Geographic Information Systems (GIS) are an essential tool for collecting, storing, analysing, and visualizing spatial data, providing support for decision-making in a variety of fields. In urban planning, GIS facilitates the representation of territorial structures and the integration of descriptive information about buildings and land, contributing to the establishment of coherent development policies. According to a classic definition formulated by Burrough and McDonnell (1998), GIS can be considered a set of tools for collecting and analysing spatial data, which explains its increasing use in territorial planning, environmental protection, agriculture, transport, and public administration.

One of the particularly relevant applications in local urban planning is the mapping of building functions, a process that identifies and classifies the use of constructions (residential, commercial, institutional, industrial, etc.). Understanding the functional structure of a locality provides valuable information for authorities, urban planners, and communities, allowing for the identification of deficient areas, dysfunctions, or investment opportunities. The use of GIS for this type of analysis offers clear benefits: high precision, the possibility of real-time updates, and integration with other types of data, which makes it superior to traditional mapping methods.

This paper aims to analyse the function of buildings in the locality of Cerneteaz (Timiș County) through a thematic map created in the QGIS platform. Cerneteaz was chosen as a case study due to several factors: the existence of complete and updated cadastral data, the representativeness of the peri-urban area in the proximity of the city of Timișoara, and the recent

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dynamics of residential development. This locality offers a relevant framework for observing the interaction between traditional (agricultural) and modern (residential, commercial, services) functions, reflecting the rural-to-urban transition process characteristic of many communes in the metropolitan area.

In addition to the central objective—functional mapping—the analysis also integrates an innovative perspective on evaluating the photovoltaic potential of buildings. Correlating information on function with data on building height and constructive characteristics allows for the identification of roofs suitable for the installation of solar panels. This interdisciplinary approach highlights the role of GIS not only as a tool for urban analysis but also as a support for the energy transition and sustainable development at the local level.

In conclusion, by applying GIS technologies to the analysis of building functions and energy potential, this research contributes to a deeper understanding of the spatial organization of peri-urban localities and provides concrete support for decision-making regarding territorial planning and sustainable energy strategies.

MATERIAL AND METHODS

The analysis of building functions in the locality of Cerneteaz was conducted using the open-source platform QGIS (version 3.42.3), which offers a complex set of tools for managing and processing spatial data. The methodological steps included: selecting data sources, importing and processing them, functional classification of buildings, validation using orthophotomaps, thematic symbology, and, finally, map composition.

Initially, we considered using the OpenStreetMap (OSM) database, but the incomplete coverage of buildings in Cerneteaz led to the choice of an official dataset, which was the result of the systematic cadastral process completed at the Giarmata commune level. This vector database provides precise geometry and complete coverage, ensuring the reliability of the results obtained.

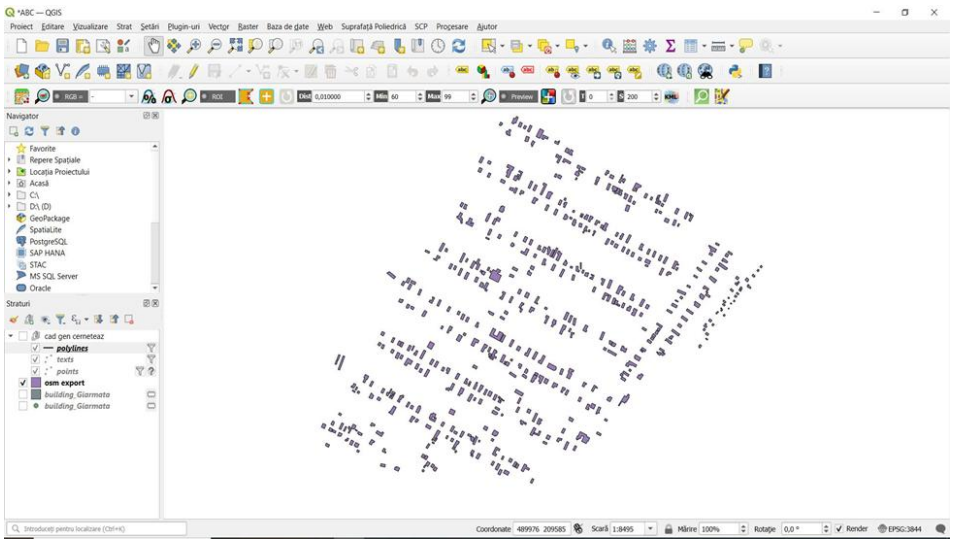

Figure 1. Buildings imported from OSM (note the missing areas)

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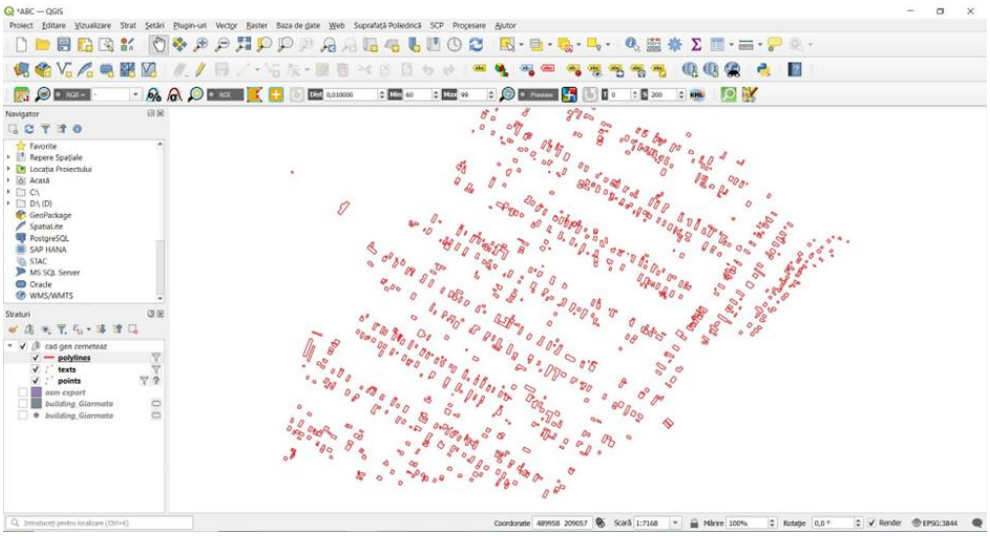

Figure 2. Buildings from the systematic cadastre (all constructions are present)

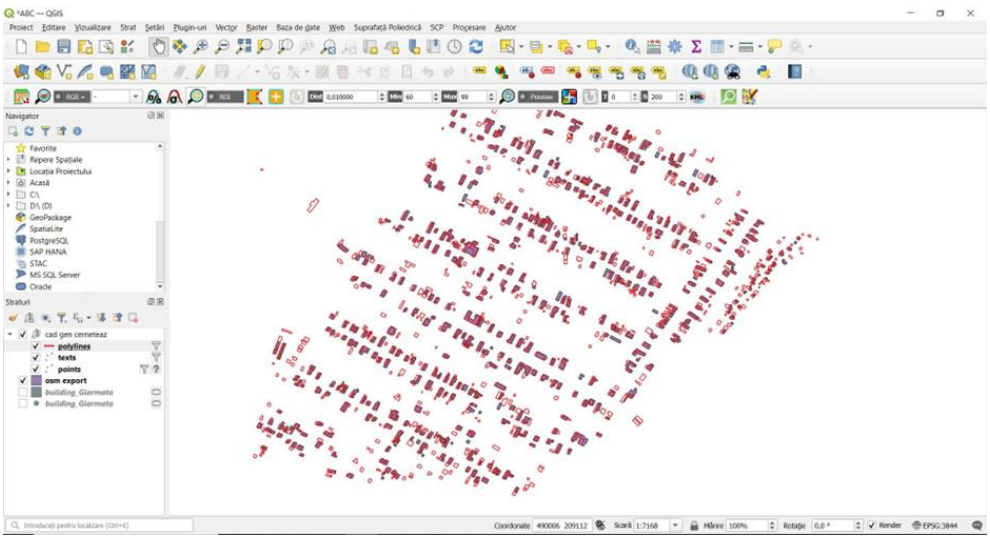

Figure 3. Overlay between the two sources (the differences are visible)

The vector data (Shapefile format) was imported into QGIS, with the Stereo 70 projection system (EPSG:31700), which is the national standard. To extract the buildings from the built-up area, the Clip command was used, with the administrative boundaries of the locality serving as the mask layer.

To verify the geometry and completeness, the vector data was overlaid on a recent orthophotomap, accessed via the QuickMapServices plugin. This step allowed for the identification of any discrepancies and the adjustment of building positions.

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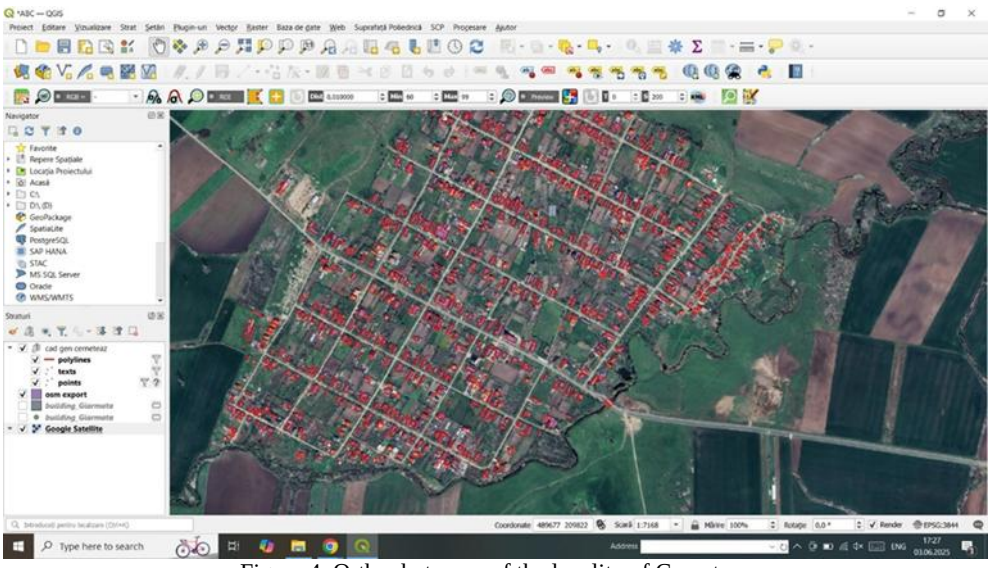

Figure 4. Orthophotomap of the locality of Cerneteaz

Classification was carried out directly in the attribute table by unifying heterogeneous names and assigning standardized categories: residential, commercial, institutional, annex, agricultural, etc. In cases where data was missing, a neutral category, "unclassified," was used.

Table 1

Categories and colors assigned in QGIS

Category	Assigned color
Residential building	Red
Annex	Dark green
Church	Pink
Cultural center	Gray
Kindergarten	Purple
Restaurant	Blue
School	Orange
Auto repair shop	Light blue
Commercial space	Khaki
Barn	Light green

For high legibility, the Categorized symbology was used, with each function having a distinct colour (e.g., red for residential, orange for school, dark green for an annex). The final map was composed in the Print Layout module, including a title, legend, scale bar, and north arrow.

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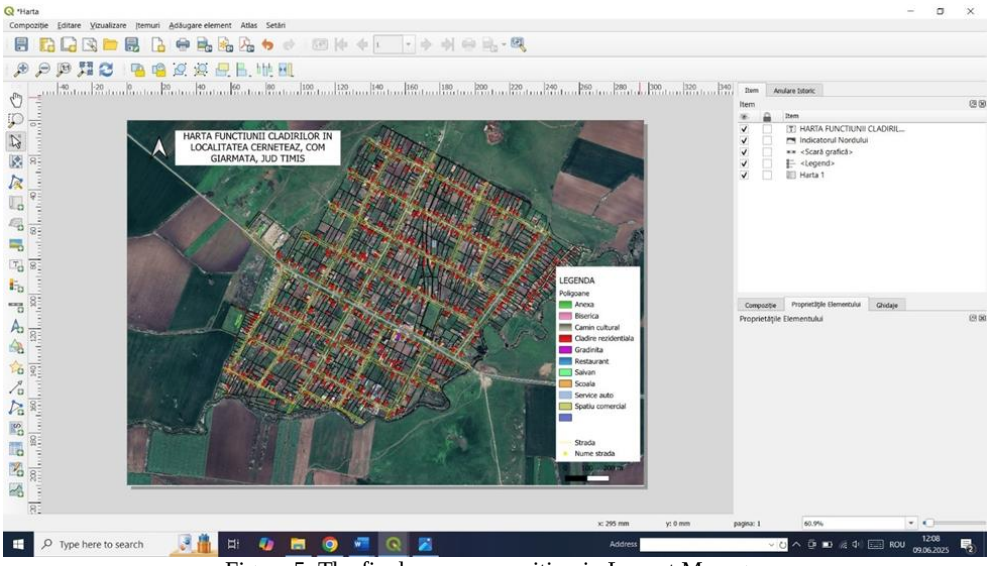

Figure 5. The final map composition in Layout Manager

During the processing, several difficulties were identified: the lack of functional attributes, the absence of a CRS (Coordinate Reference System) for some layers, and incorrect overlays. These were resolved by manually completing the missing values, correctly setting the coordinate system, and correcting erroneous vectors.

The methodology described is not limited to creating a thematic map. By associating functional data with attributes about the built area or the height regime, the analysis can be extended to evaluate photovoltaic potential or to 3D modeling for advanced cadastre.

RESULTS AND DISCUSSIONS

The main result of the analysis is the thematic map of building functions in the locality of Cerneteaz, created based on cadastral data and the manual classification of functions. It provides a clear picture of the spatial organization, highlighting the predominance of residential buildings, along with secondary functions such as public institutions, commerce, and agricultural annexes.

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Figure 6. Map of building functions in the locality of Cerneteaz

Statistical analysis of the function distribution confirmed the predominantly residential character of the locality, which is typical for peri-urban areas. Commercial and institutional buildings have a low proportion but are concentrated in the central area, indicating the existence of a minimal urban core. Agricultural functions are located on the outskirts, confirming the centrifugal development model.

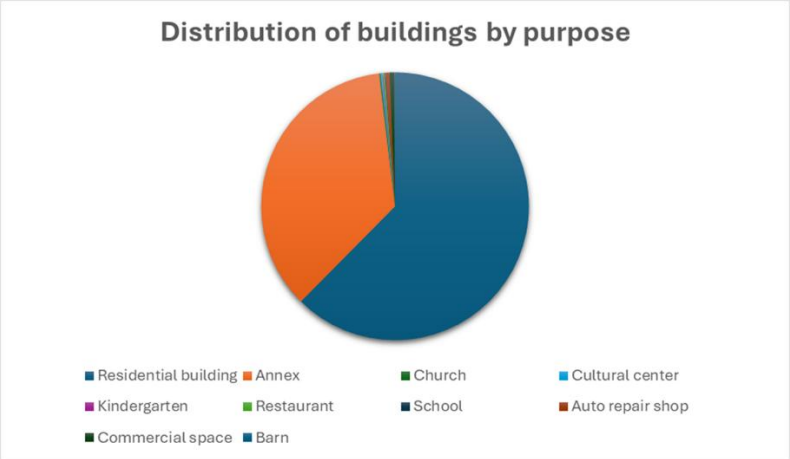

Figure 7. Distribution of buildings by purpose

An additional aspect was the estimation of the building height regime, which was carried out based on the built-up areas. The results showed that most dwellings are single-story or single-story plus attic, which reflects the peri-urban specific and provides a basis for analysing the suitability of roofs.

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Table 2

Classification of buildings by height regime

Height regime	Number
P	627
P+1E	125
P+M	262

A practical application was the evaluation of the buildings' photovoltaic potential. Correlating functions with the height regime suggests that individual dwellings and public institutions have adequate roof surfaces for installing solar panels. Simple roofs, with a southern orientation and a lack of major obstacles, mean the locality offers real opportunities for implementing renewable energy. This information can be used by the local administration in its sustainable development strategies.

Overall, the results confirm that GIS is not just a tool for cartographic representation but an analytical support for local urban planning and sustainable energy planning. The study demonstrates the potential of integrating geospatial data in supporting decisions regarding territorial development, infrastructure, and the green transition.

CONCLUSIONS

This paper demonstrated the applicability of GIS systems in local urban planning by creating a thematic map of building functions in the locality of Cerneteaz, Timiș County. The methodological process included the integration of official cadastral data, functional classification, and validation using orthophotomaps, leading to a precise and relevant cartographic product.

The results highlighted the predominantly residential character of the locality, which is typical for expanding peri-urban areas, along with the presence of commercial, institutional, and agricultural functions arranged in a centrifugal pattern. The analysis of building height regimes complemented the functional perspective, confirming the prevalence of low-rise constructions, which are typical of the rural-urban transition environment.

An innovative contribution of this research was the correlation of functional and constructive data with the evaluation of the potential for installing photovoltaic panels. The results suggest that both individual dwellings and public institutions have favourable characteristics for integrating renewable energy sources, which can serve as a basis for local sustainability policies.

Therefore, GIS proves to be not just a technical representation tool, but also a strategic support for sustainable development, facilitating the correlation of urban information with energy and environmental goals. The Cerneteaz case study demonstrates that an interdisciplinary approach, based on geospatial data, can generate useful results for administration, the community, and academia.

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