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The Role of Geographic Information Systems (GIS) in Land Use Planning

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Abstract

With the use of GIS (Geographic Information Systems), it is possible to clearly and understandably display complex data, empowering different stakeholders to be educated and actively engage in conversations on potential future land use changes. GIS enables the analysis of intricate geographical and temporal data, supporting resource conservation, effective land use, and community planning and development. In this article review the various literature's study on role of geographic information systems (GIS) in land use planning. It concluded that Geographic Information Systems (GIS) have revolutionized land use planning by enhancing spatial data analysis, decision-making, and urban design quality. This review highlights GIS's transformative role in optimizing land utilization, improving efficiency, and fostering sustainable development. The urban sponginess coefficient analysis in Caceres demonstrates GIS's capacity to identify disparities in land availability and sustainability indicators. As cities grow, GIS remains essential for effective land management, reducing costs, and ensuring resilience. By integrating spatial analysis and optimization algorithms, GIS supports comprehensive land use strategies, promoting balanced urban and rural development while addressing the evolving needs of expanding populations.

Keywords; Geographic Information Systems (GIS), Land use planning, digital elevation model, Urban planning, Agriculture, Weather forecasting.

INTRODUCTION

By providing data visualisations that are easy to understand, GIS (Geographic Information Systems) may help land use planners and decision makers analyse data more thoroughly. Another advantage is the capacity to provide the findings in a manner that is simple for the general public to comprehend, enabling various stakeholder groups to learn about the planning procedure and have fruitful discussions about upcoming modifications [1]. Although it has become simpler to obtain GIS information in recent years, American planners are not making the most of this technology. Despite having a wealth of GIS tools and information on its website, US government agencies like the National Park Service and the National Forest Service do not have procedures in place for publicising their findings or including the public in the planning process [2]. Using "PPGIS (Public Participation Geographic Information Systems)", some European nations, especially Finland and Poland, have concentrated on giving the general public the means and chance to participate in land use planning. The US has not done enough study or participated in its development, despite the fact that PPGIS has been shown to be a useful land use planning procedure [3], [4].

Overview of GIS

Data and related properties that are geographically referred to the Earth may be captured, stored, analysed, and managed using a Geographic Information System (GIS). Another name for the geographical information system is a geospatial information system or a geographic information system.

Geographically referenced data may be integrated, stored, edited, analysed, shared, and displayed using this information system [5]. More broadly, GIS is a software program that lets users make interactive searches, examine geographical data, modify data and maps, and display the outcomes of all these tasks. In order to create different models that are used in real-time environments, GIS technology is becoming a crucial tool for combining different maps and remote sensing data. The research that uses geographic ideas, applications, and systems is known as a geographic information system [6], [7].

The core functionalities of GIS include

- Data capture: Through the digitisation of maps or direct data collection via GPS or other surveying techniques, geographic data is acquired and entered.
- Data Storage: Efficiently retrieving and managing geographic data through the use of a structured database
- Data Analysis: Informed decision-making is facilitated by the analysis of spatial data to identify patterns, relationships, and trends.
- Data Visualization: To facilitate comprehension and interpretation, the analysed data is presented in a variety of visual formats, including maps, graphs, and charts.
- Data Sharing: The dissemination of data and analysis results to the public and stakeholders through a variety of platforms

Components of GIS system

Three elements may be seen as being integrated into a GIS system: people, data, and hardware and software. Let's go over each one individually:

Hardware and software: End-user equipment including plotters, scanners, and graphic devices are referred to as hardware. A variety of processors are used for data storage and processing. The majority of GISs have a 3-tier design as web servers have become a common component of many systems' architectures due to the growth of the Internet and web-based applications. Software components are similar to DBMSs in that they are related to the procedures used to define, store, and alter data. To offer effective methods for data modification, retrieval, and storage, many models are used [8].

Data: Vector and raster are the two major categories into which geographic data are essentially separated. Using points, lines, and polygons to represent discrete objects is known as vector data or layers in GIS. Two or more points may be joined to create lines, and a closed collection of lines is called a polygon. Layers are geometries that have similar characteristics. There is reciprocal topology among the objects in a layer. Digital maps and characteristics gleaned from picture surveys are just a few examples of vector sources [9]. In two dimensions, raster data is a continuous grid of cells; in three dimensions, it is the equivalent of cubic cells. Conceptually, raster data are separated into continuous and categorical categories. The values of each cell in a categorical raster are associated with a category in a different table [10]. For instance, the varieties of plants and soil. Land appropriateness, etc. The Digital Elevation Model, in which every pixel represents an elevation value, is one example of a continuous raster picture that often reflects continuous occurrences in space. Continuous rasters do not have an attribute/category table attached, in contrast to categorical rasters. Images from satellites, scanned maps, and aeroplanes are common raster sources [11].

People: In every stage of a GIS system's development and data collection, people are engaged. Surveyors and cartographers are among them; they make maps and examine the terrain and natural features. They also comprise system users who gather data, submit it to the system, work with it, and do analysis.

Applications of GIS

Numerous fields and businesses rely on the insights that GIS technology offers.

Urban planning: For urban planning, governments implement GIS data and GIS-based solutions. These solutions are employed in the following areas: "zoning and land use projects, natural disaster and health event response, roadway system and building design, utility distribution, energy production, and waste and resource management".

Weather forecasting: Given the increasing frequency and severity of extreme weather events worldwide, it is imperative for governments and organisations to plan and prepare for them. Advanced environmental analytics, GIS mapping, and geospatial data are integrated into software solutions that enable organisations to transform various categories of weather-related data into actionable information. With the assistance of digital maps and real-time data, companies can more accurately predict and respond to meteorological events, thereby minimising the impact on operations.

Enterprise decision-making: Strategic business choices are made possible by GIS software in a variety of domains, including consumer segmentation, real estate portfolio management, and transportation and delivery management.

Agriculture: Accurate, thorough data is provided by GIS technology, enabling productive, sustainable farming. Making better decisions and managing crops more effectively is made possible by knowledge about how land changes impact crop health and where certain crops will thrive.

Climate change: By offering a comprehensive perspective on the current state of environmental issues and their potential future development, GIS technology can be a viable instrument in the fight against climate change. Organisations monitor hazards, anticipate prospective issues, and seek solutions through the use of detailed visualisations.

LITERATURE REVIEW

(Enwin et al., 2024) [12] The goal of the research is to expose the important uses and approaches of GIS in order to provide the professional and academic communities in urban planning and architecture with a thorough grasp of the topic. A comparative study that clarifies the different functions and approaches of GIS in architecture and urban planning is the research's final product. Through the identification of similarities and differences, the study offers a comprehensive viewpoint that facilitates a basic comprehension of GIS applications and their consequences in several research fields. The study concludes by offering practical suggestions for improving the use of GIS approaches in architectural and urban planning research, in addition to adding to the corpus of current knowledge.

(Hugo & Viertel, 2024) [3] Resource conservation, effective land use, and community planning and development are all aided by the study of complex geographical and temporal data made possible by the use of GIS. Despite the increased availability of GIS tools in recent years, US land use planners have not made full use of this technology to include the public and solicit their input throughout the planning process. Best practices for integrating PPGIS into land use planning procedures in the US are determined by reviewing the literature and analysing the effects of the COVID epidemic. Using training programs, actively participating in community meetings, and engaging the public via a variety of means are some suggestions for enhancing the usage of PPGIS in the US.

(Jiménez-Espada et al., 2023) [13] Using a medium-sized Spanish city as a model, the aim of this study is to analyse the formal connection among urban sustainability and spatial morphology. It is required to create the necessary corrective actions in order to attempt to adapt the urban configuration to the goals of sustainable development, taking into account the assessment of the acquired urban model and the urban planning tools defined by the legislation. The use of urban sustainability indicators as a territorial planning tool connected to GIS tools would, in our opinion, objectively make it easier to execute policies that support raising the standard of living for the populace. However, in order to develop the translation into realistic parameters for their practical use for residents in urban areas, it is necessary to consider the availability of open data sources.

(Tao, 2023) [14] Aims to investigate how planning strategies and land policies are created using Geographic Information Systems (GIS) for rural revitalisation. GIS technology may be used to conduct a comprehensive assessment and study of rural land resources, providing a scientific foundation for land policymaking. In addition, using Geographic Information Systems (GIS) to execute rural land policy and planning strategies offers the possibility of spatial analysis, simulation, and decision support capabilities. However, when it comes to data collection and technical execution, using GIS technology comes with difficulties and restrictions. In order to support the rural economy's sustainable growth, future research endeavours need to focus on improving the use of GIS technology in rural revitalisation.

(Yusuf & Abdulquadri, 2023) [15] Land use planning is increasingly using GIS and urban data analytics because they improve efficiency and provide a spatial framework for the visualisation, analysis, and interpretation of intricate geographic data—tasks that would be difficult to do with traditional methods. The importance of urban data analytics and Geographic Information Systems (GIS) in modern land use planning is emphasised in this study. Additionally, this article looked at the ideas, identified the analytical tools for GIS and urban data utilised in land use planning, and recognised the difficulties related to these tools. The creation of sustainable and well-organised urban settings is largely dependent on the combination of GIS and urban data analytics.

(Abebe et al., 2022) [16] Shown a significant increase in bare land and bush land areas during the previous 30 years. Conversely, as farming and settlement have increased over

time, LULC classifications of high environmental significance, such grazing land and forest cover, have substantially decreased. Land tenure instability, common property rights, population increase, chronic poverty, climatic change, and a lack of public knowledge are the main reasons of LULC changes in this specific location. In order to prevent these limited natural resource bases from quickly disappearing and losing their ability to contribute to sustainable ecosystem services, it is imperative that the causes of LULC shifts be managed and that sustainable resource usage be maintained.

(Jean Pierre & Richard, 2020) [17] Evaluating the potential of GIS technology for mapping land use planning and management in Bugesera District's Ntarama sector. There are three primary goals for this study: An overview of pertinent techniques and methods for GIS-based land-use suitability mapping and modelling comes in second, followed by an introduction to geographical information technology and a historical perspective on the changing role of GIS in planning. Finally, trends, challenges, and opportunities of GIS-based land-use suitability analysis are identified. In summary, we firmly believe that GIS is crucial to the effectiveness of various LUP techniques. Using GIS technology to determine land use appropriateness should be a major factor in all planning and decision-making processes related to urban and suburban areas.

(Masoudi et al., 2017) [18] ecological capacity Overlapping geographical maps using the Boolean overlay method (as a Multi-Criteria Evaluation Method) in GIS for the Township allowed for the creation of maps of various land uses, such as forestry, agriculture, range management, environmental conservation, ecotourism, and the development of villages, cities, and industries. The research's last phase included utilising a quantitative model to prioritise land uses while taking the study area's ecological and socioeconomic features into account. The evaluation's findings showed that the greatest area of suggested uses, which is associated with irrigated agriculture, is 33.2%, indicating that this land use has significant potential and socioeconomic needs in the research region. However, dry farming is connected to the minimum area of suggested applications.

(Xhafa & Kosovrasti, 2015) [19] The necessity for urban area expansion and the design of its social and physical infrastructures for community benefit based on sustainable development principles arises from the ongoing population increase in urban centres. Urbanisation also brings with it a number of structural changes and functional cities that should be assessed in a geographical context and managed and planned in accordance with sustainable development principles. The land use and design of the urban environment, includes the physical and social infrastructure that serves the urban population, are closely related to urban planning, which is a problem on a global scale. In this subject, the use of GIS offers an alternative perspective on the space, its design and development, the analysis and modelling of the numerous activities that take place there, and the linkages between these processes or changes in space.

CONCLUSION

Geographic Information Systems (GIS) have revolutionized land use planning by enhancing spatial analysis, decision-making, and urban sustainability. As cities continue to expand, GIS applications provide critical insights into land availability, optimizing urban development while minimizing costs and improving efficiency. The calculation of the urban sponginess coefficient reveals disparities in land use, with central areas often falling below sustainability standards, while peripheral neighborhoods accommodate new developments. GIS methodologies offer a paradigm shift in architecture and urban planning by enabling multidimensional analyses, improving data visualization, and supporting informed decision-making. These advancements contribute to more resilient, aesthetically pleasing, and sustainable urban environments. Furthermore, GIS aids in evaluating current land use patterns, predicting future trends, and optimizing spatial layouts to maximize resource efficiency. Its integration into planning support systems ensures that land is utilized effectively to meet the needs of growing populations. By leveraging GIS-based spatial analysis and optimization techniques, planners can develop comprehensive land use strategies that balance development with environmental sustainability. As GIS technology continues to evolve, its role in shaping the built environment will be increasingly indispensable, driving innovation and sustainable growth in both urban and rural areas.

REFERENCES

[1] Ahmed Kareem Jebur, “Uses and Applications of Geographic Information Systems,” Saudi J. Civ. Eng., vol. 5, no. 2, pp. 18–25, 2021, doi: 10.36348/sjce.2021.v05i02.001.

[2] M. Mariye, L. Jianhua, M. Maryo, G. Tsegaye, and E. Aletaye, “Remote sensing and GIS-based study of land use/cover dynamics, driving factors, and implications in southern Ethiopia, with special

reference to the Legabora watershed," Heliyon, vol. 10, no. 1, p. e23380, 2024, doi: 10.1016/j.heliyon.2023.e23380.

[3] N. Hugo and D. Viertel, "The Use of GIS for Land Use Planning: Recommendations for PPGIS in the United States," Int. J. Eng. Sci. Technol., vol. 6, no. 3, pp. 329–337, 2024, doi: 10.46328/ijonest.220.

[4] J. Vinueza-Martinez, M. Correa-Peralta, R. Ramirez-Anormaliza, O. Franco Arias, and D. Vera Paredes, "Geographic Information Systems (GISs) Based on WebGIS Architecture: Bibliometric Analysis of the Current Status and Research Trends," Sustain., vol. 16, no. 15, 2024, doi: 10.3390/su16156439.

[5] "Geographical Information Systems (GIS)," Sustain., vol. 11, no. 1, pp. 1–14, 2019, [Online]. Available: http://scioteca.caf.com/bitstream/handle/123456789/1091/RED2017-Eng-8ene.pdf?sequence=12&isAllowed=y%0Ahttp://dx.doi.org/10.1016/j.regsciurbeco.2008.06.005%0Ahttps://www.researchgate.net/publication/305320484_SISTEM_PEMBETUNGAN_TERPUSAT_STRATEGI_MELESTARI

[6] H. Wu et al., "A review of crowdsourced geographic information for land-use and land-cover mapping: current progress and challenges," Int. J. Geogr. Inf. Sci., vol. 38, no. 11, pp. 2183–2215, 2024, doi: 10.1080/13658816.2024.2379468.

[7] S. Dabo, M. B. Jibril, H. Suberu, & Murjanatu, and G. Ayawa, "The Role of Geographic Information Systems (GIS) as an Effective Tool in Environmental Planning and Management," no. January, 2024, [Online]. Available: www.africanscholarpub.com

[8] E. S. G. Khater, S. A. Ali, M. T. Afify, M. A. Bayomy, and R. S. Abbas, "Using of geographic information systems (GIS) to determine the suitable site for collecting agricultural residues," Sci. Rep., vol. 12, no. 1, pp. 1–14, 2022, doi: 10.1038/s41598-022-18850-0.

[9] Z. Tahir et al., "Predicting land use and land cover changes for sustainable land management using CA-Markov modelling and GIS techniques," Sci. Rep., vol. 15, no. 1, p. 3271, 2025, doi: 10.1038/s41598-025-87796-w.

[10] H. Salimi, S. F. N. Bahramjerdi, and R. Tootoonchi, "The Role of Geographic Information Systems (GIS) in Participatory Conservation of Heritage Areas," Eur. J. Geogr., vol. 16, no. 1, pp. s1–s11, 2025, doi: 10.48088/ejg.si.spat.hum.h.sal.1.11.

[11] N. Firouraghi et al., "The role of geographic information system and global positioning system in dementia care and research: a scoping review," Int. J. Health Geogr., vol. 21, no. 1, pp. 1–13, 2022, doi: 10.1186/s12942-022-00308-1.

[12] A. D. Enwin, T. D. Ikiriko, and V. K. Peter, "Using Geographic Information Systems as Methodologies in Architecture and Urban Planning Research," vol. 5, no. 8, pp. 4064–4082, 2024.

[13] M. Jiménez-Espada, F. M. Martínez García, and R. González-Escobar, "Sustainability Indicators and GIS as Land-Use Planning Instrument Tools for Urban Model Assessment," ISPRS Int. J. Geo-Information, vol. 12, no. 2, 2023, doi: 10.3390/ijgi12020042.

[14] J. Tao, "Application of GIS in Land Policy and Planning Strategies in Rural Revitalization," J. Geogr. Geol., vol. 15, no. 2, p. 33, 2023, doi: 10.5539/jgg.v15n2p33.

[15] R. Yusuf and K. Abdulquadri, "Application of GIS and Urban Data Analytics to Land Use Planning," Urban Reg. Plan. Students Assoc. Niger. Natl. Conf. Novemb. 14-18, no. November 2023, p. 17, 2023.

[16] G. Abebe, D. Getachew, and A. Ewunetu, "Analysing land use/land cover changes and its dynamics using remote sensing and GIS in Gubalafito district, Northeastern Ethiopia," SN Appl. Sci., vol. 4, no. 1, 2022, doi: 10.1007/s42452-021-04915-8.

[17] M. Jean Pierre and M. Richard, "The Role of Geographic Information System Technologies in Mapping Land Use Planning And Management in Rwanda, Case of Ntarama Sector in Bugesera District," Int. J. Innov. Sci. Res. Technol., vol. 5, no. 12, pp. 93–106, 2020, [Online]. Available: www.ijisrt.com93

[18] M. Masoudi, P. Jokar, and M. Sadeghi, "Land use planning using a quantitative model and Geographic Information System (GIS) in Darab County, Iran," J. Mater. Environ. Sci., vol. 8, no. 8, pp. 2975–2985, 2017.

[19] S. Xhafa and A. Kosovrasti, "Geographic Information Systems (GIS) in Urban Planning," Eur. J. Interdiscip. Stud., vol. 1, no. 1, p. 85, 2015, doi: 10.26417/ejis.v1i1.p85-92.

[20] Ranjit Singh and Meenakshi Mritunjay 2024. AI-Driven Credit Risk Assessment in Agriculture: A Case Study of Indian Commercial Banks. International Journal of Innovations in Science, Engineering And Management. 3, 2 (Dec. 2024), 118–125. DOI:https://doi.org/10.69968/ijisem.2024v3si2118-125.