EPRA International Journal of Economic Growth and Environmental Issues- Peer Reviewed Journal
ISSN: 2321-6247
Volume: 13 | Issue: 2 | February 2025 | Journal DOI: 10.36713/epra0713 | SJIF Impact Factor (2025): 8.825

OPTIMISING RESOURCE-EFFICIENT LAND USE THROUGH GIS-BASED ZONING AND SPATIAL ANALYSIS

Ayomide D Akinyemi[1], Gerald Chekwube Ezeamii[2], Andy Osagie Egogo-Stanley[3], Oluwatosin Michael Ibrahim[4]

[1]*Eastern Illinois University*
[2]*Department of Applied Instrumentation and control, school of Computing, Engineering and Built Environment, Glasgow Caledonian University, UK*
MSc in Applied Instrumentation and Control
[3]*Bachelor of Science in Surveying and Geoinformatics*
[4]*Applied Geology, Ladoke Akintola University of Technology, Oyo State, Nigeria.*

Article DOI: https://doi.org/10.36713/epra20106
DOI No: 10.36713/epra20106

ABSTRACT----------
Resource-efficient land-use planning is quite of significance within urban areas, especially because it discourages resource exploitation and facilitates proper spatial organisation of population and resources. Studies indicate that the absence of efficient resource-efficient land-use planning frameworks in urban regions have instigated resource exploitation, biodiversity degradation and the unregulated expansion of the urban population to the detriment of land resources. However, the emergence and commonization of GIS-based zoning and spatial analysis has made the optimisation of land-use more efficient and quite feasible for a more expanded purpose. Therefore, this review paper aims to highlight viable GIS-based techniques for zoning, density mapping, and green space allocation to enhance resource-efficient land use planning in urban areas, especially those with constrained resources. To achieve this aim, the paper adopts an integrative review approach and a desk research method to synthesize the findings of multiple studies across the purview of the research interest. The findings of the paper pinpoints categorically that urban land-use planners and stakeholders need to do more in the areas of resource-efficient land use through zoning and spatial analysis. Thus, the research proffers practical recommendations for urban land-use planners and other stakeholders seeking to optimize resource-efficient land use for sustainable urban growth.
KEYWORDS: *Efficient, GIS, Land Use, Resource----------*

INTRODUCTION

The need for resource-efficient land use planning globally has been intensified substantially by the indices of urbanisation and resource exploitation. Of course, according to a study by Zhang et al. (2024), the unprecedented rate of urbanisation in many countries has instigated the expansion of the metropolitan population and its associative variables such as housing, industrialisation and even commercialisation. These activities to an expanded degree has led to the exploitative consumption of land resources, which has elicited environmental degradation, biodiversity loss, unsustainable resource utilisation and land-use conflicts in some regions according to Zhang et al. (2024). It has even become increasingly difficult to balance environmental sustainability with socio-economic development given this circumstance (Barbosa et al., 2017; Faye et al., 2022). As Koshkalda et al. (2023) observes in his study, this situation owes to the fact that there are no concrete or functional frameworks for resource-efficient land use in many parts of the world, especially in the third world countries. Thus, in this direction, the Geographic Information System (GIS) has emerged as an advanced and innovative tool for resource-effective land-use planning through its spatial analysis and zoning techniques. With regards to the use of GIS, several studies have further expanded on its roles for land-use optimisation.

According to a study by Wang et al. (2015), the GIS innovation has demonstrated its suitability for use in land-use impact and topographical analysis, and on a broader scale, in environmental impact analysis. Koshkalda et al. (2023) also asserts that GIS use has enhanced urban growth modelling, demographic information mapping as well as resource appropriation in different regions across the world. In the area of conservation studies, spatial organisation of wildlife and forest resources has been made easy with the use of GIS, helping experts to better

understand the availability and ecological density of these resources (Barbosa et al., 2017; Faye et al., 2022). To handle these applications effectively, the GIS system employs spatial data integration with remote sensing techniques to produce valuable outcomes needed for decision making (Wang et al., 2015; Koshkalda et al., 2023; Enoguanbhor et al., 2024). Studies like Peña et al. (2022) and Li et al. (2023) have shown that recent innovations in GIS for land-use analysis have incorporated machine learning algorithms to ensure a more efficient framework. However, with regards to land resource use planning, more studies are required to comprehensively focus on the areas of spatial analysis and zoning in resource land-use planning.

Given this knowledge gap, this review article aims to examine the various techniques of GIS use in the areas of resource-efficient land use, particularly in the urban areas affected by resource constraints. The review will also effectively cover case studies on zoning, density mapping, and green space allocation with GIS, thus, drawing insights for a comprehensive framework in sustainable resource-efficient land use planning. The objectives of this review paper specifically includes providing a comprehensive overview on GIS based zoning techniques for enhancing urban land use, highlighting GIS based techniques for density mapping and green space allocation within urban areas and investigating a comprehensive framework for sustainable urban land use planning. To achieve these objectives, a desk-based research method is adopted in this paper to examine existing literature on the various variables of the study. Case studies are also incorporated and highlighted to demonstrate the success and drawbacks of the application of the various GIS techniques in the areas of density mapping, zoning, and urban green space allocation. Therefore, by highlighting existing knowledge on the role of GIS based techniques in zoning, density mapping, green zone allocation and sustainable urban land-use planning for resource-efficient land use, this review paper presents a comprehensive framework for the optimisation of urban land-use.

GIS-Based Zoning for Resource-Efficient Land Use

Zoning Regulations and GIS Integration

According to Deng et al. (2022), through the definition of certain zones or regions for residential, business, conservation and even recreational purposes, regulations on zoning become very important instruments, especially for the regulation of urban growth. Rahman and Szabó (2021) asserts that to guarantee public welfare, ensure orderly urbanisation, and minimise conflict of demand regarding land resources that are becoming scarce, zoning regulations must be enacted and implemented. However, Wang et al. (2015) maintains that the utilisation of the GIS innovation has been appraised as a groundbreaking stride in the area of urban planning. Since this innovation even tackles the issues of land degradation, environmental impact assessment and even demographic analysis, it has rendered the use of traditional zoning techniques as archaic and lacking the capacity to adapt to changing landscapes within the field. A close examination of a study by Peña et al. (2022) reveals that with the use of GIS, urban planners are now able to integrate the use of spatial data and system features for better land-use zoning. This is because they have a more enhanced understanding of patterns of land use for differential purposes (Li et al., 2023). Moreover, with the optimisation of zoning regulations through site suitability and spatio-temporal data analysis, it becomes easy for urban planners to map topography, density of population, infrastructure points, and even vegetation cover.

Spatial Analysis Techniques for Zoning Optimisation

To enhance the methods in which resources should be allocated, as well as on urban land-use patterns (Wang et al., 2015). This perspective by Wang et al. (2015) equally indicates that spatial analysis in the context of GIS utilises a wide range of methods and techniques that help urban planners to integrate spatial data, analyse land use patterns, create simulations for land-use scenarios and basically engage in zoning optimisation. As Rahman and Szabó (2022) expounds, these techniques assist in the complex task of implementing effective use of land use systems particularly in urban regions initiating the use of spatial analysis and GIS zoning concept. One spatial analysis technique often adopted for zoning optimisation is the *multi-criteria decision analysis (MCDA)* (Rahman and Szabó, 2022). According to a study by Rahman and Szabó (2021), this technique combines several spatio-temporal datasets to evaluate land suitability, and examine economic indices of land-use and environmental impact, while simulating infrastructural accessibility. A similar study by Rahman and Szabó (2022) also elucidates that with the use of MCDA, several factors can be balanced by urban planners including the establishment of more green space and reduction of urban concentration or population density at certain points. Another very spatial analysis technique is *density mapping* which according to Deng et al. (2022) helps urban planners not just in the analysis of population density or structural composition, but in the visualisation of building and population density in urban areas. Wang et al. (2015) appraises this technique as innovative owing to the fact that it can help land-use planners to determine areas that require decongestion of both human population and buildings, as well as areas for improvement. *Proximity technique* is yet one of the numerous spatial techniques involved in urban land-use optimization. Proximity technique is a geospatial technique that eliminates the border distance between various

places of interest that caters to the fundamental needs of man as Droj et al. (2022) explains. Droj et al. (2022) stresses that proximity technique employs the use of distance reduction as its major focus in order to reduce stress and improve productivity, growth and development in urban areas. In order that this technique may be fully implemented, the concept of distance reduction is fully placed into context and land use tailored to that concept. *Network analysis* is another technique in spatial analysis that focuses on enabling transit media that allows the displacement of people and goods from one geographic zone to the other (Das et al., 2019). In GIS applications, machine learning algorithm systems and 3D modeling are handy tools to manage land use in urban areas when adopting this technique. This is because machine learning algorithms work on the concept of future prediction of the use of land compared to the predicted population growth chart in the future. Thus, it compares past case studies with regards to land mass, predicts future obstacles pertaining to land use and ensures ways to tackle these complications in the long run (Das et al., 2019).

Case study 1: Successful zoning implementation - Portland's Urban Growth Boundary

Portland has the leading role in the world of successful land use in urban areas. The introduction of Urban Global Boundary (UGB) in the 1970s into the land use system of Oregon places a balance between its population and urban development (Adler, 2022). According to a study by Lu et al. (2021), Urban Global Boundary in Portland rules a firm Iine between these two concepts as it emphasizes on the growth of population while taking note of its effects on ecology and natural habitat conservation. Portland's adoption of the Urban Global Boundary aptly defines a clear boundary between population growth and urbanisation. Therefore, as urbanisation seeks to propagate itself to a higher dimensional level, Portland's use of Urban Global Boundary curtails and levels up the population growth chart (Adler, 2022). Infact, Urban Global Boundary as a geographic tool looks after the advantages of population density and the effects on the ecological balance of the area (Lu et al., 2021). It is no wonder that Portland thrives under the umbrella of the UGB concept as this forum gives just the right push to urban areas. Portland's UGB as Adler (2022) emphasizes works to separate the two concepts distinctly. While Lu et al. (2021) strongly believes that Urban Global Boundary helps contain excessive outspread of population, other experts opine that UGB has the potential to manage population to prevent clumping. All in all, Portland's UGB has proven to be a useful tool in spatial analysis and caters to the local needs of those in urban areas (Lu et al., 2021).

Inferences Drawn and Best Practices

The proper maximization and utilisation of GIS zoning and spatial analysis tools is to be encouraged and enforced as these tools go a long way in ensuring that urban planners put land-use into proper planning. The use of relevant data on population coupled with GIS tools such as proximity analysis and 3D modeling gives an avenue for urban planners to evaluate, contrast, predict and tackle incoming challenges according to a study by Li et al. (2023). Due to the versatility of these GIS tools, mapping out and tackling issues likely to emerge in future is feasible. Distance reduction is also achieved and the dimensional outlining of urban areas are fully detailed. All these practices ensure that the natural ecology of the environment is ensured while catering to the needs of urban lifestyle, thereby striking a concordance. As highlighted by Rahman and Szabó (2021), social interaction between land law regulators and stakeholders in urban zones is greatly enhanced and communication links between stakeholders in urbanity are very much improved. Best practices entails initiating a workshop to educate and train personnel in the art of handling GIS tools and maximising its relevance in GIS based zoning and spatial analysis to an optimal level.

Density Mapping and Green Space Allocation

Density Mapping Techniques Using GIS

Chang and Cheng (2015) postulates that GIS based zoning and spatial analysis techniques permits the overview of population density per unit area and its effects on urban settings. It also facilitates the identification of areas of sparse population and those of dense population to help prevent overcrowding in some areas and scale population indices on a balance (Chang and Cheng, 2015). Other studies like Ullah et al. (2019) and Kucukpehlivan et al. (2023) highlight that it employs several techniques under its coverage; heat maps, KDE, point density mapping among others. While point density mapping points out areas of low population to ensure even distribution of resources, KDE involves calculations of numeracy over a range of continuous spatial cycles (Deng et al., 2022). This technique prevents population clusters while enforcing land use optimization. Data analysis based on the density of spatial curriculum per urban area determines the overspread of population and manages areas with low spatial data effectively. According to the review on density mapping proposed by Deng et al. (2022), density mapping maps out areas in urban regions where there is low density and takes practicable measures to counter these challenges. Again, areas with high spatial density can be carefully analyzed and tackled with. Allocations are on point and delivered to points of scarcity as clusters of population are avoidably reduced by allocation (Kim

and Kwon, 2021). Furthermore, density mapping techniques also enhance good distribution indices among the population of urban zones.

Green Space Allocation Strategies

According to a study by Kim and Kwon (2021), Green Space Allocation is described as the cultivation and conservation of greenery in urban regions. It therefore defines a need for the containment of green vegetation in urban areas and its promotion in residential and work zones. Thus, while Green Space Allocation strategies such as allocation based on policy works hand in hand with community and political stakeholders to allocate green vegetation to urban spaces, Chang and Cheng (2015) underscores that land suitability analysis ensures that greenery are transported and maintained in suitable strategic locations based on soil texture, soil porosity and other survival factors. Still just as Kim and Kwon (2021) elucidates based on his observations, the green vegetation aids the water and oxygen cycle and needs to be accessible to housing areas as well. An evaluation of fauna and flora life support systems is taken into critical consideration in urban land-use with the aid of Green Space Allocation approach (Chang and Cheng, 2015). As far as the analysis involving the allocation of green vegetation is concerned, ecology is conserved using the Gis strategies and it foresees and makes conservative plans for the preservation of ecology in the long term (Peña et al., 2022). Ullah et al. (2019) supports the fact that flooding and erosion can cause environmental damages in areas and recommends that Green Space Allocation strategies be employed by urban land-use planners to address these environmental issues and improve ecology as a whole.

Case Study 2: Effective Density Mapping and Green Space Allocation - Vancouver's Greenest City Action Plan

According to a paper by Scerri and Holden (2014), Vancouver has effectively implemented its plan to improve greenery conservation and balance spatial density. It names this plan or sustainable land-use stride the Greenest City Action Pian (Scerri and Holden, 2014). According to an investigation conducted by Holden and Larsen (2015) in his study, this stride serves as a conservation tool as well as a population check and balance technique in many urban regions. Its work is to sustainably address any environmental hazards or land-use crises while balancing urbanisation and spatial count. MacDonald (2020) is of the opinion that the Greenest City Action Plan aims to project Vancouver on the list of cities involved in the conservation and allocation of greenery before the year 2020. This opinion happens to stand true as Vancouver's use of the Greenest City Action Plan involves utilizing GIS density mapping tools to point out less dense regions and also look into the ecological needs of the urban communities (Holden and Larsen, 2015). In consensus with Holden and Larsen (2015), MacDonald (2020) proposes that using Vancouver's plan can afford urban communities the right GIS tools and zoning techniques to enhance their spatial count balance and conserve ecology in an urbanised environment. This notwithstanding, Greenest City Action Plan encapsulates the theory that ecological habitats and niches should be conserved and naturally maintained as this will bring about ecological diversity and take advantage of urban space (Scerri and Holden, 2014).

Implications for Resource-Efficient Land Use

The tools and strategies that the Geographic Information System employs in land-use planning in urban regions takes advantage of ecological opportunities and population balance. As Peña et al. (2022) observes, the optimisation of land-use in urban regions requires a lot more than formulating strategies to cater for the needs of urbanisation. It covers the instrumentation of these Geographic Information System tools and employs the use of GIS technicalities to improve urban land-use. Even though these tools and strategies execute the purposes of eradicating environmental hazards, reducing social distances between work and homespace, providing an architectural outline of urban buildings, and predicting future incoming challenges with regards to land use, it also evaluates the pertinence of the conservation of ecological floral and fauna (Kim and Kwon, 2021). Ullah et al. (2019) confirms that time and again, GIS tools ease the protocol of channeling resources into the right areas of concentrated scarcity and urban planners need to critically evaluate the needs or the relevance of these GIS zoning tools and strategies. On that note, studying the case studies critically in order to effectively initiate them in cases of low population indices in urban settings is very important. Moreover, attention given to vegetation should be further improved and expertise should be emphasised on the utilisation of resources in the urban setting.

Spatial Analysis for Urban Planning Decision-Making

Spatial Analysis Techniques for Urban Planning

Kucukpehlivan et al. (2023) is of the view that spatial analysis should be able to identify important trending development in land-use and the effects of such development in the years to come. As such the techniques of spatial analysis should improve urban land-use and should be timely, predictive and analytical. One of these techniques include *proximity analysis* which as earlier highlighted seeks to eradicate the distance between the dwelling homes of man and a comfort of any stead that caters to his needs. The study by Kim and Kwon (2021)

also recommends that *environmental effect analysis* goes a long way to associate urbanization and industrialization with biological factors in order to promote a dichotomy of purpose; the ecology of urban zones and the optimisation of land-use. Theerathitichaipa et al. (2024) further mentions that the mapping out of population clusters and spotting of sparse areas attributes to the mechanism of density and overlay analysis. However, it is imperative to note that this analysis puts a balancing wedge between urbanisation and population density and apportions resources to zones where they are limited. Transportation system is the main idea behind the *network analytical technique* as it focuses attention on the displacement of people and commodities within an urban setting (Zhong et al., 2014). Theerathitichaipa et al. (2024) argues that network analysis has proven to be very practicable in spatial analysis due to its ability to foresee challenges in the transport sector and invent ways to tackle them onward. Zhong et al. (2014) maintains the notion that network analysis ensures that the transport system is handled efficiently and seeks to navigate the urban transit sector in the right direction. More techniques involved in spatial analysis in land-use planning subserves in ensuring a reliable database as well as integrating relevant conceptual ideas (Kucukpehlivan et al., 2023). In all, spatial analysis ensures that excessive overcrowding of the population of a given urban area is regulated (MacDonald, 2020).

Integrating GIS with Urban Planning Decision-Making

In order for stakeholders in communities and government in urban zones to successfully host an urban land use, GIS based zoning tools and techniques need to work hand in hand with the policies involving land use structure. Political stakeholders need to set policies that stand in favor of GIS application goals and framework (Rahman and Szabó, 2022). On the other hand, Kucukpehlivan et al. (2023) emphasizes that the GIS system should be employed in such a way that government and community policies are accommodated in every ramifications. Multipurpose analysis needs to be employed in GIS and data should be built and driven in from every link built on the concept of urban setting. Ullah et al. (2019) explains that the use of modeling techniques to set up the architectural outlining of urban settings both vertically and horizontally aids good construction and makes good use of land space. Hence, urban strategists can utilize these techniques to arrive at several resolutions with respect to urban planning. The Geography Information System (GIS) again points out factors that may affect urban planning common to the environment using spatial data, thereby helping urban land-use planners to protect urban settings from the danger of environmental degradation. This aspect of GIS gives pollutants and hazards to restraining order against the encroachment of the ecosystem of urban settings. Ullah et al. (2019) agrees that the use of GIS as a whole needs to be incorporated with urban planning to achieve versatility in zoning uniformity as regards land-use. The merging of urbanisation and GIS zoning will achieve better learning of the GIS and put them to good use in urban planning (Kucukpehlivan et al., 2023).

Case study 3: GIS-Based Spatial Analysis for Urban Planning - New York City's PlaNYC

New York's PlaNYC is actually a strategic climate plan that seeks to protect the dwellers of New York from climate threats and promote green economy (Ghosh et al., 2022). However, this approach adopts GIS spatial analysis in its bid to promote green economy within New York. Due to this, it has been appraised as one of the approaches for the birth of New York's urban planning innovation as it aims for groundbreaking ways to improve greenery within the New York urban scenario (Kato, 2020). Apart from the fact that it endeavors to enhance quality of life through its initiatives, it also carries on to improve the cultivation of greenery and makes greenery more accessible, protecting it from environmental hazards. The PlaNYC approach supports the fact that communities need networking, facilities and structures to facilitate their transit movement (Ghosh et al., 2022). Therefore as Kato (2020) explains, the PlaNYC approach adopts several mechanisms and innovations of transit system improvement and solves the issue of population clustering in New York. Moreover, it is also quite feasible in balancing the population density within different urban regions.

Implications for Urban Planning and Resource-Efficient Land Use

The usage of Geographic Information Information System in urban land-use, particularly spatial analysis has been effective in enhancing land use. Based on the data output given by this Geographic Information System, Enoguanbhor et al. (2024) confirms that a better allocation of results and decisions are achieved using the GIS spatial analysis tools. According to Ullah et al. (2019), GIS tools aid in the facilitated promotion of greenery and introduces natural landscape to city spaces making it accessible to the population. Kim and Kwon (2021) is of the consensus that the introduction of green vegetation and enhanced spatial analysis in urban zones aids in the cycle of oxygen and water while improving its interaction with the atmosphere. Enoguanbhor et al. (2024) posits that GIS zoning tools also assist in the enhancement of underdeveloped urban spaces while reducing chances of poor networking. Urban planners take advantage of these spatial analysis techniques to enhance their planning strategies and carry on distance reduction for the improvement of accessibility to essential comfort. In spite of the urban networking system, GIS zoning and spatial analysis systems easily navigate and point out specific areas

that need more resources and areas that pose a challenge to urbanization. On that note, urban stakeholders, land-use planners and communities can share a part in the optimisation of land-use in urban zones using these VIS techniques of spatial analysis.

Recommendations for Practitioners and Policymakers

The GIS zoning tools and strategies are ideal for the implementation of resource-efficient land use optimization in urban zones but all hands need to be on deck to ensure this. Policy makers need to set up policies that accommodate spatial analysis initiatives for the actualization of sustainable land use focusing on the development of urban structures and utilities. For a fact, this study recommends the following;

- The development of policies and frameworks should be instigated to guide the implementation of GIS strategies in urban land-use planning and discourage the use of environmentally degrading practices within the urban ecosystem. Such policies and frameworks should equally necessitate that spatial data utilised in the GIS system be accepted and verified only from sources that are reliable, accurate and unambiguous. In fact, any spatial data from internet sources should be evaluated thoroughly to checkmate its accuracy and relevance in the urban setting before its integration into the GIS. Despite the fact that data sources must be reliable and verifiable, data should readily be sourced from other sources like reconnaissance and remote sensing than the internet.
- More and active engagements from urban stakeholders as regards land-use needs and planning initiatives should be encouraged and their contributions should be appreciated. It is certain that such strides will boost up the development of resource-based land use in urban settings and promote uniformity and productivity.
- Urban land-use planners should equally endeavor to utilize the availability of GIS tools to improve GIS zoning and spatial analysis. This will entail that provisions for workshops and technology based training be made adequately available to urban planners in order to hone their skills and proficiencies in GIS zoning and spatial analysis. Environmentalists, Architects, Biologists, Physiologists should as well be involved in the workings of GIS as they too have a part to play in helping urban land-use planners understand the place of green economy within urban settings.

CONCLUSION

Recap of Key Findings

It is for a fact that over the years the use of land in urban zones has been grossly abused. Of course, scholars have agreed that degrading practices that are toxic to the urban environment such as deforestation, erosion, oil spillage, pollution and many others have rendered the urban environment and its usage environmentally unsafe, hazardous and unsustainable. Urban planners have therefore seen the need to critically evaluate land use in urban zones in order to fully and optimally utilise land spaces in these urban areas. The introduction of the GIS based zoning and spatial analysis have aided in this critical evaluation of land use within urban zones as these innovative techniques have mapped out different methods in which population can be balanced in urbanisation while ensuring that urban residents are catered for with efficient resources. It has equally assisted with predictions of challenges that are likely to occur in future, while giving directions for mitigation. Studies also indicate that spatial analysis not just helps to conserve natural wildlife in urban environments, but equally levels the populace numerics on a balance, thus, allocating resources evenly to the nooks and crannies of these urban zones. From the perspectives of various studies, spatial analysis employs distance reduction, 3D outlines, networking and other techniques to aid the optimisation of land use in urban zones. More studies support the notion that GIS tools used in optimizing land use in urban zones can actually assist in the task of conserving ecology, putting a balance between industrialization and ecological growth while supporting the concept of ecology as a whole. This review has even encapsulated case studies of the various GIS initiatives other countries have adopted with regards to land use optimisation in urban areas. Globally, urban land-use planners can glean a lot of information from these case studies and incorporate them into their planning framework to ensure the viable optimization of land-use in urban areas.

Directions for Future Research

GIS tools are feasible for the betterment of urban planning as it goes a long way to look into and solve difficulties in urbanization. Given the highlights presented within this paper, this study recommends that more research should be conducted in the evaluation of the results of artificial intelligence in urban land-use planning, and explore ideals of its integration with GIS tools. It is true that urban planning needs to evolve around technological advancement and should be able to analyze and combat problems associated with land use. However, resources can be effectively reimbursed and efficiency of processes can be tripled if artificial intelligence is incorporated into the GIS system of land use. Future research on the optimisation of resource-efficient land use using GIS should be centered on improving land usage within the urban zones, tackling the challenges of urbanisation and utilizing 3D tools for land optimisation. Thus, more focus is needed to be put into creating a Geographic Information System

forum that accepts input from differential sources in the urban communities. These inputs can tackle the challenges that are really complex to handle. This study also suggests that further studies should be conducted on the reliability and relevance of these GIS based zoning tools which should primarily focus on improving their differential weaknesses. As many studies confirm, Artificial Intelligence (AI) is a unique concept on its own and curtails predictive mistakes likely to occur in future. Thus, with more studies in this direction, Artificial Intelligence can be incorporated into the matrix of Geographic Information System and it can influence urban land-use planning in a positive way. Lastly, further studies should also be focused on the modulation of GIS tools and the innovation of variable effective strategies that can help level up land use optimization in urban zones.

BIBLIOGRAPHY

1. *Adler, S. (2022). Planning the Portland urban growth boundary: The struggle to transform Trend City. Oregon: Oregon State University Press.*
2. *Barbosa, A., Vallecillo, S., Baranzelli, C., Jacobs-Crisioni, C., Silva, F., Perpiña-Castillo, C., Lavalle, C. and Maes, J. (2017). Modelling built-up land take in Europe to 2020: An assessment of the Resource Efficiency Roadmap measure on land. Journal of Environmental Planning and Management, 60 (8), pp. 1439-1463.*
3. *Chang, H. and Chen, T. (2015). Decision making on allocating urban green spaces based upon spatially-varying relationships between urban green spaces and urban compaction degree. Sustainability, 7 (10), pp. 13399-13415.*
4. *Das, D., Ojha, A., Kramsapi, H., Baruah, P. and Dutta, M. (2022). Road network analysis of Guwahati city using GIS. SN Applied Sciences, 1, pp. 1-11.*
5. *Deng, Y., Gadocha, S., Spitzer, W. and Prinz, T. (2022). GIS-based Identification of Densification Types. Mobility, Knowledge and Innovation Hubs in Urban and Regional Development. Proceedings of REAL CORP 2022, 27th International Conference on Urban Development, Regional Planning.*
6. *Droj, G., Droj, L. and Badea, A. (2022). GIS-based survey over the public transport strategy: An instrument for economic and sustainable urban traffic planning. ISPRS International Journal of Geo-Information, 11 (1), pp. 16.*
7. *Enoguanbhor, E., Enoguanbhor, E., Chukwurah, G., Oloruntoba, E., Edo, I., John-Nsa, C., Fotang, C., Yangni, G., Oladosu, O., Agunbiade, M., Njunda, F. and Achenui, R. (2024). Spatial Interactions of a City-Region Using GIS and Survey-based Data. East African Journal of Interdisciplinary Studies, 7 (1), pp. 176-185.*
8. *Faye, B., Du, G. and Zhang, R. (2022). Efficiency analysis of land use and the degree of coupling link between population growth and global built-up area in the subregion of west Africa. Land, 11 (6), pp. 847.*
9. *Ghosh, S., Byahut, S. and Masilela, C. (2022). An overview of climate protection and resiliency planning in the New York megacity region. Smart Global Megacities: Collaborative Research: Tokyo, Mumbai, New York, Hong Kong-Shenzhen, Kolkata, pp. 287-313.*
10. *Holden, M. and Larsen, M. (2015). Institutionalizing a policy by any other name: in the City of Vancouver's Greenest City Action Plan, does climate change policy or sustainability policy smell as sweet? Urban Research & Practice, 8 (3), pp. 354-370.*
11. *Kato, Y. (2020). City of Forests, City of Farms: Sustainability Planning for New York City's Nature by Lindsay K. Campbell. Journal of Planning Education and Research, 40 (1), pp. 120-122.*
12. *Kim, I. and Kwon, H. (2021). Assessing the impacts of urban land use changes on regional ecosystem services according to urban green space policies via the patch-based cellular automata model. Environmental Management, 67 (1), pp. 192-204.*
13. *Koshkalda, I., Dombrovska, O., Stoiko, N. and Riasnianska, A. (2023). Land resource management system in the sustainable development context: scientific and practical approaches. IOP Conference Series: Earth and Environmental Science, 1254 (1), 012129.*
14. *Kucukpehlivan, T., Cetin, M., Aksoy, T., Kurkcuoglu, M., Cabuk, S., Pekkan, O., Dabanli, A. and Cabuk, A. (2023). Determination of the impacts of urban-planning of the urban land area using GIS hotspot analysis. Computers and Electronics in Agriculture, 210, 107935.*
15. *Li, F., Yigitcanlar, T., Nepal, M., Nguyen, K. and Dur, F. (2023). Machine learning and remote sensing integration for leveraging urban sustainability: A review and framework. Sustainable Cities and Society, 96, 104653.*
16. *Lu, J., Liu, C. and Buxton, M. (2021). The Impact of Urban Growth Boundaries in Melbourne on Urban Sustainable Development. Engineering Heritage Journal (GWK), 5, pp. 34-41.*
17. *Macdonald, E. (2020). Urban design for sustainable and livable communities: The case of Vancouver. Transportation, Land Use, and Environmental Planning, pp. 83-104.*
18. *Peña, D., Perrotti, D. and Mohareb, E. (2022). Advancing urban metabolism studies through GIS data: Resource flows, open space networks, and vulnerable communities in Mexico City. Journal of Industrial Ecology, 26 (4), pp. 1333-1349.*
19. *Rahman, M. and Szabó, G. (2021). Multi-objective urban land use optimization using spatial data: A systematic review. Sustainable Cities and Society, 74, 103214.*
20. *Rahman, M. and Szabó, G. (2022). Sustainable urban land-use optimization using GIS-based multicriteria decision-making (GIS-MCDM) approach. ISPRS International Journal of Geo-Information, 11 (5), pp. 313.*

21. *Scerri, A. and Holden, M. (2014). Ecological Modernization or Sustainable Development? Vancouver's Greenest City Action Plan: The City as 'manager' of Ecological Restructuring. Journal of Environmental Policy & Planning, 16 (2), pp. 261-279.*
22. *Theerathitichaipa, K., Wisutwattanasak, P., Se, C., Seefong, M., Jomnonkwao, S., Champahom, T., Ratanavaraha, V. and Kasemsri, R. (2024). Assessment of Disparity in Accessing Railway Stations in Thailand: an Application Geographic Information System Network Analysis. Journal of Geovisualization and Spatial Analysis, 8 (1), pp. 6.*
23. *Ullah, H., Wan, W., Haidery, S., Khan, N., Ebrahimpour, Z. and Luo, T. (2019). Analyzing the spatiotemporal patterns in green spaces for urban studies using location-based social media data. ISPRS International Journal of eo-Information, 8 (11), pp. 506.*
24. *Wang, C., Johnston, J., Vail, D., Dickinson, J. and Putnam, D. (2015). High-precision land-cover-land-use GIS mapping and land availability and suitability analysis for grass biomass production in the Aroostook River Valley, Maine, USA. Land, 4 (1), pp. 231-254.*
25. *Zhang, H., Zheng, J., Hunjra, A., Zhao, S. and Bouri, E. (2024). How does urban land use efficiency improve resource and environment carrying capacity? Socio-Economic Planning Sciences, 91, 101760.*
26. *Zhong, C., Arisona, S., Huang, X., Batty, M. and Schmitt, G. (2014). Detecting the dynamics of urban structure through spatial network analysis. International Journal of Geographical Information Science, 28 (11), pp. 2178-2199.*