

GIS Applications in Land Management: Enhancing Flood Risk Assessment and Village Replanning

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Abstract

The rapid increase in urbanization and population growth presents substantial obstacles for the management of land and the development of cities. Geographic Information Systems (GIS) are now indispensable tools for doing spatial analysis to tackle these difficulties. This study investigates the application of GIS in the process of village replanning and flood risk assessment. The research focuses on a specific case study conducted in Al Muqrin, Sudan. Al Muqrin is situated near the town of Atbara, spanning from approximately 34°00'44" E to 34°00'46"E longitude and 17°39'N to 17°40'N latitude. This region, characterized by a semi-arid climate, plays a vital role as an agricultural and industrial area. We utilized a weighted methodology to combine various datasets, such as rainfall, Digital Elevation Model (DEM), slope, and stream data, in order to assess the likelihood of flooding. The average sizes of the parcels were 6.69 and 6.73448 before and after the removal processes, respectively. The slope ratings ranged from 0.57 to 9.96, indicating mostly flat terrain. The investigation revealed that all parcels have a high susceptibility to flooding, with risk ratings of 10 on a scale of 0-10. The flood risk map generated identifies specific places that necessitate proactive mitigating techniques. This study emphasizes the crucial significance of Geographic Information Systems in strengthening urban planning and supporting disaster resilience in swiftly developing areas.

Key words-Urbanization, Geographic Information Systems (GIS), Flood Risk Mapping, Al Muqrin, Sudan, Rainfall Records

I. INTRODUCTION

GIS significantly enhances the efficiency, effectiveness, and inclusivity of rural and urban development, contributing to the advancement of sustainable land management practices. Through GIS integration, village re-planning processes promote participatory decision-making and sustainable development strategies. Additionally, GIS aids in accurate flood risk mapping by integrating various datasets. Urbanization and population expansion have heightened the need for adept land management and urban development strategies. Within this context, Geographic Information Systems (GIS) have emerged as indispensable tools for analyzing, planning, and overseeing spatial data. A pivotal application of GIS technology is evident in the domain of village or rural area planning, facilitating thorough assessments of land use, infrastructure, and environmental factors to inform strategic decision-making. Recent studies have underscored the transformative potential of GIS in village replanning endeavors. Through the integration of diverse datasets encompassing land use patterns, population demographics, transportation networks, and environmental indicators, GIS empowers planners to visualize and evaluate various scenarios, optimizing resource allocation and infrastructure development [1]. Also, GIS has the ability in pinpoint suitable locations for new residential areas while minimizing environmental impact [1]. In addition, GIS plays a pivotal role in streamlining transportation routes, enhancing accessibility and connectivity within rural communities. The incorporation of GIS in village replanning fosters participatory decision-making processes by actively engaging stakeholders and community members. The effectiveness of GIS-based public participation platforms in eliciting feedback and integrating local knowledge into planning initiatives has been demonstrated,

nurturing a sense of ownership and inclusivity. The significance of community involvement in formulating and executing land use policies is emphasized, facilitated by GIS-based tools for data visualization and communication [2]. Furthermore, GIS provides robust analytical capabilities for evaluating the socio-economic and environmental ramifications of village replanning strategies. The utilization of GIS-based spatial modeling assesses the potential impacts of land use changes on aspects such as agricultural productivity, natural habitats, and water resources. Such insights are pivotal in formulating sustainable development strategies that harmonize economic growth with environmental preservation and social equity [3], [4]. In summary, the integration of GIS technology into village replanning processes holds enormous promise for augmenting the efficiency, efficacy, and inclusivity of rural development endeavors. By synthesizing findings from a diverse array of scholarly research, this paper elucidates the multifaceted benefits and methodologies associated with leveraging GIS in the replanning of villages, thereby contributing to the advancement of sustainable land management practices [5].

A. GIS Applications in Urban Planning and Replanning

Geographic Information Systems (GIS) play a crucial role in contemporary urban planning and replanning processes by facilitating informed decision-making through spatial analysis and visualization. A synthesis of multiple research articles underscores the diverse applications of GIS in this field [6]. GIS serves as a fundamental tool for urban planners, aiding in the integration of various datasets such as demographic information, transportation networks, and environmental factors to formulate comprehensive urban plans. Additionally, GIS-based modeling techniques enable planners to simulate different

scenarios and evaluate their impacts on urban systems. In the context of urban replanning, GIS assists in identifying areas susceptible to hazards and vulnerabilities, thereby supporting resilience strategies [7], [8]. Through the overlay of spatial data on hazard maps, planners can prioritize areas for redevelopment or mitigation measures. Furthermore, GIS facilitates stakeholder engagement and participatory planning processes by providing accessible visualizations of proposed changes [9]. The integration of GIS with emerging technologies such as remote sensing and big data analytics further enhances its utility in urban planning. Satellite imagery and LiDAR data, when coupled with GIS, allow for detailed mapping of land cover, vegetation, and topography. This spatial intelligence supports precise planning and infrastructure design, contributing to sustainable urban development. In summary, GIS stands as an indispensable tool in both urban planning and replanning endeavors, offering capabilities for data integration, spatial analysis, and visualization. Leveraging GIS technologies, planners can make informed decisions, enhance stakeholder engagement, and foster resilient urban environments[10] [11], [12], [13].

B. Digital Elevation Models (DEMs)

Digital Elevation Models (DEMs) are indispensable assets in urban planning, as evidenced by extensive scholarly research. These models offer crucial insights into topography, aiding planners in understanding and visualizing terrain features essential for urban development. Among their diverse applications, DEMs play a central role in site suitability analysis, facilitating the evaluation of potential development sites based on terrain attributes such as slope, aspect, and elevation, thereby informing decisions regarding infrastructure and land use[14] [15], [16], [17]. Furthermore, DEMs are instrumental in flood risk assessment, enabling precise delineation of floodplains and the development of mitigation strategies to protect urban areas from flooding hazards [18], [19]. Moreover, DEM-derived elevation data support various aspects of urban planning, including urban growth modeling, infrastructure planning and design, visual impact assessment, slope stability analysis, green space planning, transportation planning, and solar potential analysis. By facilitating these critical functions, Digital Elevation Models contribute to the advancement of sustainable urban development and enhancement of urban livability [20], [21], [22].

C. Flood Risk Mapping

Numerous scholarly investigations have extensively explored flood risk mapping methodologies, integrating diverse datasets such as rainfall records, slope characteristics, Digital Elevation Models (Digital Elevation Models), and stream networks [23], [24]. These studies employ a range of geospatial techniques to effectively evaluate and delineate flood-prone areas with a high degree of precision and dependability. Rainfall data are utilized to estimate the potential flood caused by precipitation events, while slope analysis assists in identifying topographic features that significantly influence flood dynamics [25],[26]. Detailed elevation information provided

by Digital Elevation Models is crucial for accurately modeling flood extents and depths. Furthermore, stream networks play a vital role as indicators of potential flow pathways during flood events. Through the integration of these datasets and analytical approaches, researchers generate comprehensive flood risk maps that offer valuable support to planners, policymakers, and local communities in mitigating flood hazards and bolstering resilience to flooding incidents [27].

D. Study Area

Atbara city is strategically positioned at the confluence of the Atbara River and the Nile River, making it a crucial transportation hub and economic center in the region. The city experiences a semi-arid climate and plays a significant role in agriculture and industry, particularly in cotton cultivation and food processing [28]. Al Muqrin, located within Atbara, holds importance as both a residential and commercial area, contributing significantly to the socio-economic landscape of the city. The precise coordinates of the bridge in Al Muqrin are approximately 17° 40' 50" N latitude and 34° 00' 42.6" E longitude, as depicted in Figure (1). The Nile River State in Sudan has experienced notable flooding events, particularly in August 2022 and September 2023. These floods, driven by seasonal variations in the Nile River's flow and heavy rainfall, have caused significant disruption to local communities, infrastructure, and agriculture. The region's low-lying topography exacerbates its vulnerability to flooding. Recent increases in the severity and unpredictability of floods may be linked to climate change. Addressing these challenges requires improved flood forecasting, resilient infrastructure development, and effective water management strategies [29].

E. Study Objective

- 1) Investigate the use of GIS in village replanning and flood risk assessment in Al Muqrin, Sudan.
- 2) Develop a flood risk map by integrating datasets such as rainfall, DEM, slope, and stream data using a weighted methodology.
- 3) Assess the susceptibility of parcels in the study area to flooding and the effectiveness of GIS in identifying flood-prone areas.

F. Contributions

- 1) Demonstrates the crucial role of GIS in improving the efficiency and inclusivity of rural land management, especially in flood risk assessment and village replanning
- 2) Provides a comprehensive flood risk assessment methodology applicable to other semi-arid regions prone to flooding.
- 3) Highlights the significance of GIS-based flood risk mapping in supporting decision-making processes for infrastructure development, land use planning, and disaster resilience.

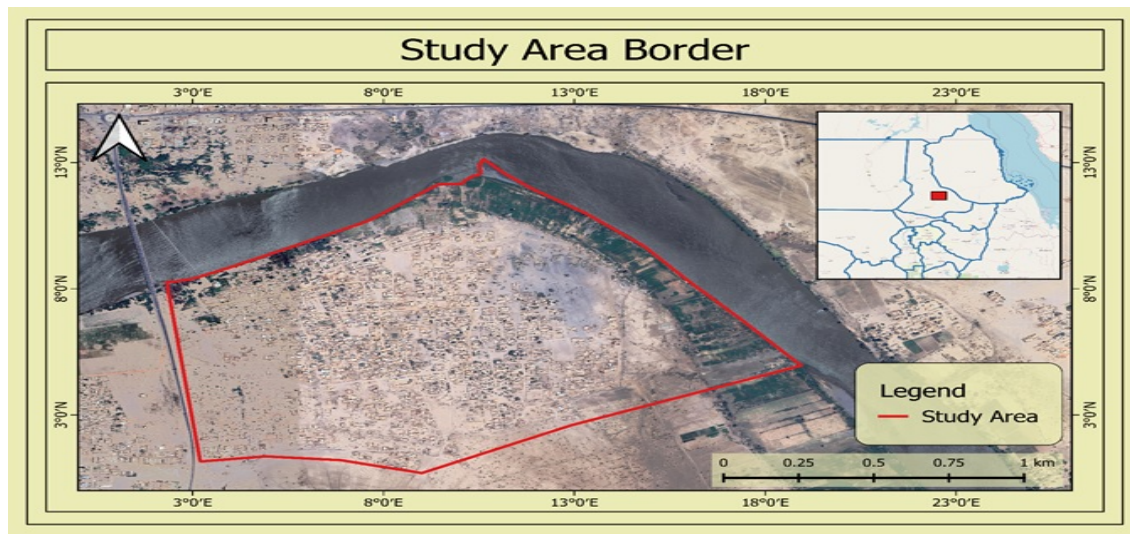


Fig. 1. Study Area Location

II. METHODOLOGY

In this investigation, the utilization of Google Earth Pro 7.3.4 and ArcGIS Pro 3.0.2 facilitated the digitization of parcels and streets within the research locale, respectively, subsequently converting them into shapefiles. Following this, Digital Elevation Model (DEM) datasets, specifically utilizing SRTM (Shuttle Radar Topography Mission) data, were harnessed to derive elevation and slope parameters for individual blocks within the study area. The SRTM dataset provides high-resolution elevation data captured by radar aboard the Space Shuttle Endeavour during its mission in February 2000. Integration of these datasets enabled the creation of flood risk maps, wherein flood risk values were assigned to each block. Additionally, an array of tools was employed to delineate streets with a width of 7 meters according to the regulations of the Sudanese Ministry of Planning, concerning rural roads. And to identify parcels impacted by road buffers. The determination of removal areas from parcels intersecting with road buffers was conducted, followed by the elimination of intersecting zones. Attribute tables were then employed to ascertain parcel areas and to identify parcels with dimensions below 200 square meters. This comprehensive methodology facilitated an exhaustive examination of parcel attributes and the assessment of flood risk within the study vicinity.

III. RESULT

The research methodology employed in this study follows a structured approach for the digitization and conversion of geographical data using Google Earth Pro 7.3.4 and ArcGIS Pro 3.0.2. Initially, the designated village area is identified, and the necessary software and hardware are ensured for data acquisition. Subsequently, the digitization process in Google Earth Pro 7.3.4 involves the meticulous use of polygon and line tools to delineate parcel boundaries and trace road alignments while adhering to established cartographic standards. Following this, rigorous data management and quality assurance procedures are implemented before exporting the digitized

data to KML/KMZ format for organizational purposes. In ArcGIS Pro, the imported KML/KMZ files are converted into shapefiles to facilitate further analysis. Additional steps such as coordinate system alignment and comprehensive validation are conducted to ensure data accuracy. The methodology is concluded with finalization, documentation, and a comprehensive conclusion, underscoring the paramount importance of maintaining data integrity and usability throughout the entire process.



Fig. 2. Parcels and Roads

The image presented in Figure (2) depicts the cartographic rendering of parcel boundaries and road networks within the village vicinity. This visual representation signifies the conclusion of the digitization and conversion procedures elucidated in the methodology segment. The map exemplifies the spatial arrangement and interconnection of parcels and roads, offering insightful perspectives for geographical scrutiny and land administration. Figure 2 highlights the critical role of precise data depiction in enabling informed decision-making protocols related to village advancement and infrastructure strategizing. During the initial phase of replanning, a primary objective is to establish uniform road widths of 7 (Sudanese standards) meters throughout the area. This is achieved by

utilizing the buffer tool in ArcGIS Pro 3.0.2 to generate buffers along the roads, each precisely set to a width of 7 meters. Furthermore, parcels located at road intersections are identified and selectively eliminated to optimize traffic flow and enhance spatial organization within the replanning framework.



Fig. 3. Roads buffers

A graphical depiction presented in Figure (3) illustrates the road buffer, effectively showcasing the spatial extent of the buffer zones established along the roads. Each buffer zone is accurately delineated to a standardized width of 7 meters. This visualization elucidates the buffer's significance in defining road boundaries and spatial configurations within the research area, offering valuable insights to inform planning and decision-making endeavors. Subsequent to the elimination of parcels intersecting with the buffered road areas, Figure (4) presents a cartographic depiction showcasing the revised parcel map following the removal process. Moreover, Figure (5) offer detailed map delineating the specific parcel intersect with road buffer and Figure (6) offers a detailed map delineating the specific parcels subject to removal. These visual representations serve to elucidate the spatial adjustments undertaken in the parcel distribution, thereby providing a comprehensive portrayal of the updated land parcel layout subsequent to the erasure procedure.



Fig. 4. parcel after erasing process

The overall area encompassed by all parcels totals 484,716 square meters, with 96,335 square meters designated for removal due to their intersection with road buffers. Figure (6) represents approximately 19.89% of the overall parcel area.

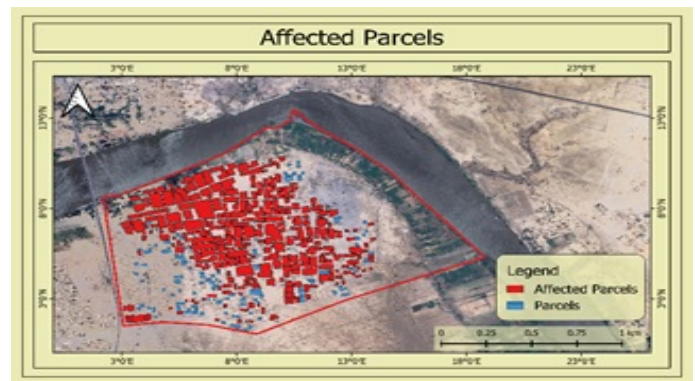


Fig. 5. Parcels intersect with Road buffer

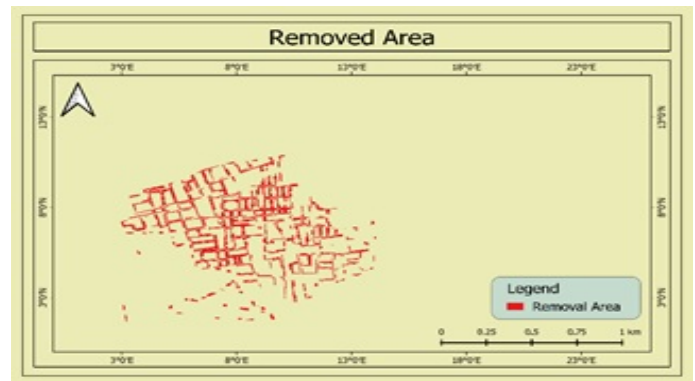


Fig. 6. Removed Area

Subsequent to the elimination of parcel segments intersecting with road buffers, an attribute table was utilized to determine and designate parcels with an area smaller than 200 square meters. (As per the regulations of the Sudanese Ministry of Planning, concerning rural roads.) Parcels with an area less than 200 square meters, counted as 16, approximately 1.426% of the total parcels (1122), are depicted in Figure (7).

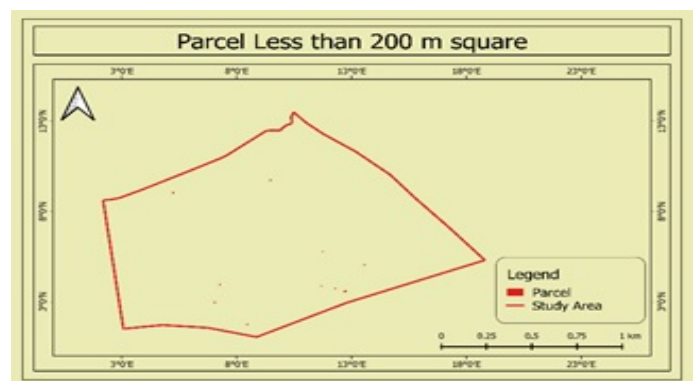


Fig. 7. Parcels less than 200 m square

Discussion and Analysis: The distribution of parcel area exhibited a significant alteration before and after the removal procedure. Prior to the deletion, the mean area was calculated to be 6.69, with a median of 6.94089 and a standard deviation of 0.89641. Conversely, following the elimination of intersect-

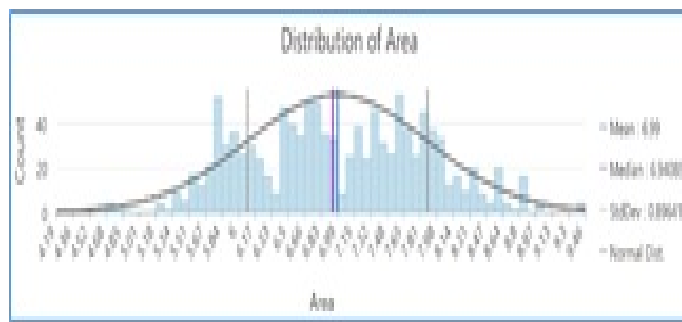


Fig. 8. Distribution of Area Before erase

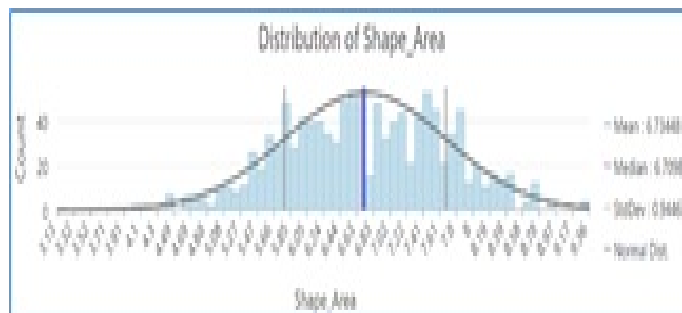


Fig. 9. Distribution of Area After erase

ing segments, the mean area increased slightly to 6.73448, with a median of 6.70983 and a standard deviation of 0.94462. This observed change in mean area implies a reduction in the average parcel size subsequent to the removal of sections intersecting with road buffers.

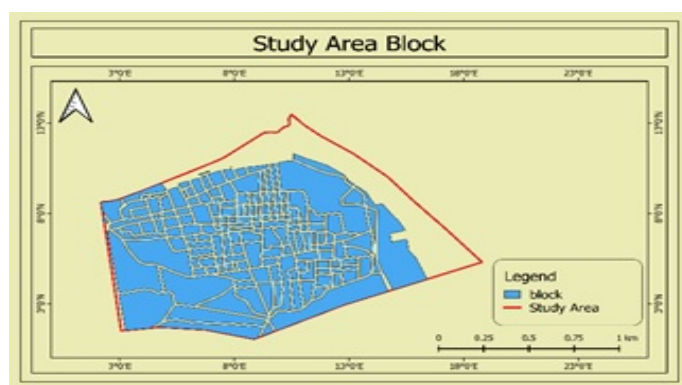


Fig. 10. Blocks Layer

Figures (8 and 9) present graphical depictions of block representations, accompanied by their corresponding mean elevations extracted from the SRTM DEM dataset. The range of mean elevation values spans from 342 meters as the lowest to 357 meters as the highest. These visual representations offer valuable insights into the topographic nuances within the study area, providing a comprehensive understanding of the

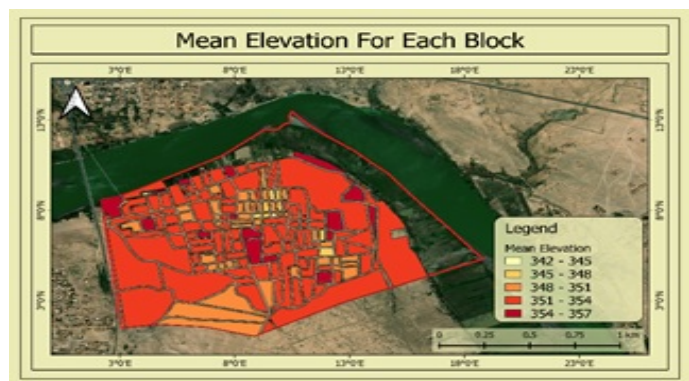


Fig. 11. Mean Elevation for Blocks

terrain characteristics. Such data is indispensable for informing multiple facets of planning and analysis, including but not limited to infrastructure development, flood risk assessment, and site suitability analysis.

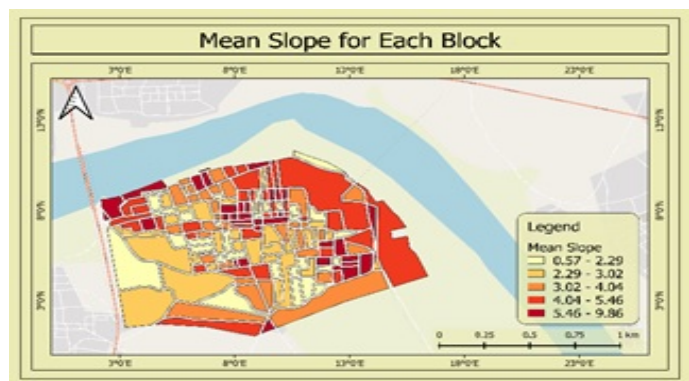


Fig. 12. Mean Slope for each block

Figure (10) illustrates the mean slope values for individual blocks, showcasing a range from 0.57 to 9.96. The findings indicate a minority of low slopes across the land, with the majority falling within the narrow range of 0.57 to 9.86. This observation suggests that the terrain is characterized by predominantly flat or gently sloping topography. This study presents a methodology for creating a flood risk map covering the entire state by integrating various datasets, including rainfall, Digital Elevation Model (DEM), slope, and stream data. Figure (11) illustrates the application of a weighted approach, with different weights assigned to each dataset: rainfall (0.30), DEM (0.20), slope (0.25), and distance from streams (0.25). These weights are determined based on the relative significance of each data layer in assessing flood risk. Subsequently, zonal statistics are utilized to calculate risk values for the study area, leading to the generation of the flood risk map. The resulting values are presented in tabular format for thorough analysis, as demonstrated in Figure (12). This methodology enables a systematic evaluation of flood risk across the state, facilitating informed decision-making and proactive measures for disaster management and urban planning endeavors.

In the study area, all parcels demonstrate a notable predis-

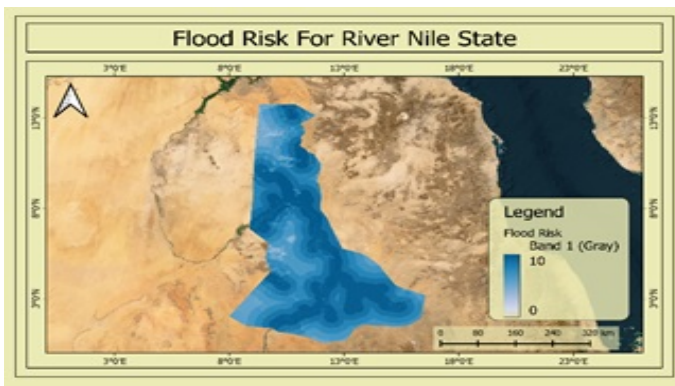


Fig. 13. Flood Risk Map

position to flooding, as evidenced by the flood risk map's findings. Each parcel has been allocated a flood risk rating of 10 within a scale of 0 to 10, indicating a substantial vulnerability to inundation. This evaluation highlights the imperative nature of implementing thorough flood risk management tactics and mitigation initiatives to protect both properties and residents within the study locale.

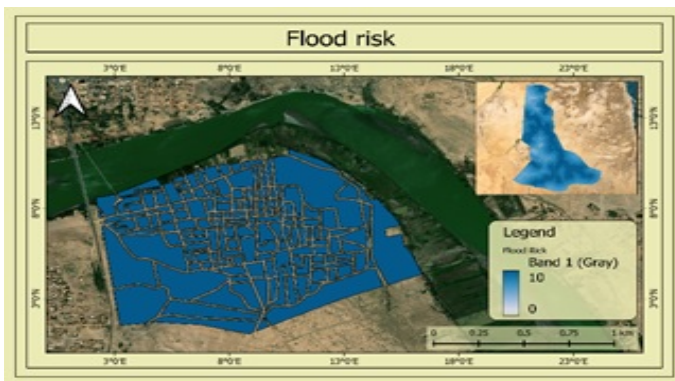


Fig. 14. Flood Risk map

The analysis undertaken in this investigation unveils that every parcel situated within the study vicinity manifests a notable propensity towards flooding, as evidenced by each parcel being designated a flood risk rating of 10 on a scale spanning from 0 to 10. This evaluation was predicated upon merging diverse datasets, encompassing rainfall, Digital Elevation Model (DEM), slope, and stream data, employing a weighted methodology. The resultant flood risk map offers an extensive delineation of flood-vulnerable regions, accentuating the imperative nature of implementing preemptive flood risk mitigation strategies.

IV. CONCLUSION

This study emphasizes the urgent requirement for focused flood risk management measures as a result of consistent and elevated flood susceptibility ratings across different parcels. By employing ArcGIS Pro 3.0.2 and including datasets such as rainfall, DEM, slope, and stream data, our approach enhanced the accuracy of flood risk assessment. The key findings highlight the need for improving infrastructure, revising land-use

planning, and implementing early warning systems to reduce the negative effects of floods and increase the resilience of the area. The study recommends that policymakers and urban planners adopt stringent zoning regulations, revise building codes, invest in flood protection infrastructure, and promote community flood preparedness education. Specific recommendations include:

- 1) Zoning Regulations: Implement strict zoning laws to prevent construction in high-risk floodplain areas and establish buffer zones along riverbanks.
- 2) Building Codes: Enforce elevated structures in flood-prone areas and mandate the use of flood-resistant materials and advanced drainage systems.
- 3) Flood Protection Infrastructure: Invest in levees, improved drainage systems, and retention basins to manage and reduce flood risks.
- 4) Community Education Initiatives: Launch flood awareness programs, engage local communities, and conduct resilience-building workshops.

Future research should refine flood risk models, incorporate additional datasets, and assess the long-term effectiveness of flood mitigation measures. Overall, this research advances flood risk management knowledge, emphasizing proactive measures and collaborative efforts to protect communities from flooding. Implementing the study's recommendations and maintaining a commitment to research and adaptation will enhance our ability to manage flood risks effectively.

REFERENCES

- [1] H. Madurika and G. Hemakumara, "Gis based analysis for suitability location finding in the residential development areas of greater matara region," *International Journal Of Scientific and Technology Research*, vol. 6, pp. 96–105, 2017.
- [2] K. X. Tang and N. M. Waters, "The internet, gis and public participation in transportation planning," *Progress in Planning*, vol. 64, no. 1, pp. 7–62, 2005.
- [3] M. A. Oyinloye, I. O. Olamiju, and O. O. Popoola, "Urban renewal strategies in developing nations: A focus on makoko, lagos state, nigeria," *Journal of Geography and Regional Planning*, vol. 10, no. 8, pp. 229–241, 2017.
- [4] L. Zhou, Y. Wu, T. Woodfin, R. Zhu, and T. Chen, "An approach to evaluate comprehensive plan and identify priority lands for future land use development to conserve more ecological values," *Sustainability*, vol. 10, no. 1, p. 126, 2018.
- [5] H. Jeong, R. A. Karim, H. L. Sieverding, and J. J. Stone, "An application of gis-linked biofuel supply chain optimization model for various transportation network scenarios in northern great plains (ngp), usa," *BioEnergy Research*, vol. 14, pp. 612–622, 2021.
- [6] H. Wang *et al.*, "A gis-based framework for supporting sustainable land use planning in urban renewal projects," 2013.
- [7] H. Huang, Q. Li, and Y. Zhang, "Urban residential land suitability analysis combining remote sensing and social sensing data: A case study in beijing, china," *Sustainability*, vol. 11, no. 8, p. 2255, 2019.
- [8] J. Chen, "Gis-based multi-criteria analysis for land use suitability assessment in city of regina," *Environmental Systems Research*, vol. 3, pp. 1–10, 2014.
- [9] Z. S. Pourtaghi and H. R. Pourghasemi, "Gis-based groundwater spring potential assessment and mapping in the birjand township, southern khurasan province, iran," *Hydrogeol J*, vol. 22, no. 3, pp. 643–662, 2014.
- [10] D. Gonzalez-Aguilera, E. Crespo-Matellan, D. Hernández-López, and P. Rodríguez-Gonzálvez, "Automated urban analysis based on lidar-derived building models," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 51, no. 3, pp. 1844–1851, 2012.
- [11] J. He, X. Huang, and G. Xi, "Measuring urban metrics of creativity using a grid-based geographically weighted regression model," *Journal of Urban Planning and Development*, vol. 144, no. 2, pp. 05018008–1, 2018.

- [12] S. Liu, H. Wang, Y. Hu, M. Zhang, Y. Zhu, Z. Wang, D. Li, M. Yang, and F. Wang, "Land use and land cover mapping in china using multimodal fine-grained dual network," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 61, pp. 1–19, 2023.
- [13] J. Sieber and M. Pons, "Assessment of urban ecosystem services using ecosystem services reviews and gis-based tools," *Procedia Engineering*, vol. 115, pp. 53–60, 2015.
- [14] J. Dong, D. Zhuang, X. Xu, and L. Ying, "Integrated evaluation of urban development suitability based on remote sensing and gis techniques—a case study in jingjinji area, china," *Sensors*, vol. 8, no. 9, pp. 5975–5986, 2008.
- [15] L. Liang, Z. Chen, S. Chen, and X. Zheng, "Evaluation of site suitability for photovoltaic power plants in the beijing–tianjin–hebei region of china using a combined weighting method," *Land*, vol. 13, no. 1, p. 40, 2023.
- [16] L. Li, J. Yang, and J. Wu, "A method of watershed delineation for flat terrain using sentinel-2a imagery and dem: A case study of the taihu basin," *ISPRS International Journal of Geo-Information*, vol. 8, no. 12, p. 528, 2019.
- [17] M. Jafari, H. Majedi, S. M. Monavari, A. A. Alesheikh, and M. Kheirkhah Zarkesh, "Dynamic simulation of urban expansion based on cellular automata and logistic regression model: Case study of the hyrcanian region of iran," *Sustainability*, vol. 8, no. 8, p. 810, 2016.
- [18] R. Liu, Y. Zhu, Y. Luo, and X. Liu, "Construction urban infrastructure based on core techniques of digital photogrammetry and remote sensing," in *2009 International Forum on Information Technology and Applications*, vol. 1, pp. 536–539, IEEE, 2009.
- [19] M. Francioni, R. Salvini, D. Stead, and S. Litrico, "A case study integrating remote sensing and distinct element analysis to quarry slope stability assessment in the monte altissimo area, italy," *Engineering Geology*, vol. 183, pp. 290–302, 2014.
- [20] H. Bai, Z. Li, H. Guo, H. Chen, and P. Luo, "Urban green space planning based on remote sensing and geographic information systems," *Remote Sensing*, vol. 14, no. 17, p. 4213, 2022.
- [21] H. Bi, W.-L. Shang, Y. Chen, K. Wang, Q. Yu, and Y. Sui, "Gis aided sustainable urban road management with a unifying queueing and neural network model," *Applied Energy*, vol. 291, p. 116818, 2021.
- [22] J. R. Nelson and T. H. Grubeshic, "The use of lidar versus unmanned aerial systems (uas) to assess rooftop solar energy potential," *Sustainable Cities and Society*, vol. 61, p. 102353, 2020.
- [23] B. Feizizadeh, H. A. Gheshlaghi, and D. T. Bui, "An integrated approach of gis and hybrid intelligence techniques applied for flood risk modeling," *Journal of Environmental Planning and Management*, vol. 64, no. 3, pp. 485–516, 2021.
- [24] E. Gioti, C. Riga, K. Kalogeropoulos, and C. Chalkias, "A gis-based flash flood runoff model using high resolution dem and meteorological data," *EARSeL eProceedings*, vol. 12, no. 1, pp. 33–43, 2013.
- [25] F. Radwan, A. Alazba, and A. Mossad, "Flood risk assessment and mapping using ahp in arid and semiarid regions," *Acta Geophysica*, vol. 67, pp. 215–229, 2019.
- [26] C. Agonafir, *A Citizen-Science Approach for Urban Flood Risk Analysis Using Data Science and Machine Learning*. PhD thesis, The City College of New York, 2022.
- [27] M. C. Aydin and E. Sevgi Birincioğlu, "Flood risk analysis using gis-based analytical hierarchy process: a case study of bitlis province," *Applied Water Science*, vol. 12, no. 6, p. 122, 2022.
- [28] S. Ali, J. Elfaki, M. Adam, M. Dafalla, H. Ahmed, and M. Ali, "Assessment of heavy metals contamination in the Nile river water and adjacent sediments: A case study from Khartoum city and Nile river state, Sudan," *Eurasian Journal of Soil Science*, vol. 6, no. 3, pp. 285–294, 2017.
- [29] N. N. Kourgialas and G. P. Karatzas, "Flood management and a gis modelling method to assess flood-hazard areas—a case study," *Hydrological Sciences Journal—Journal des Sciences Hydrologiques*, vol. 56, no. 2, pp. 212–225, 2011.



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