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# GIS-Based Mapping of Flood Vulnerable Areas in Iskandar Puteri

**Yuszaimi Jeffrey Zulkifli[1], Saifullizan Mohd Bukari[2]***

[1] *Faculty of Civil Engineering and Built Environment,*
*Universiti Tun Hussein Onn Malaysia, Batu Pahat, 86400, MALAYSIA*

*Corresponding Author: saifulz@uthm.edu.my
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**Abstract**

Flooding happens when there's more water than the river can hold, especially in curved areas. When flooding occurs in the flat area next to the river, it can cause harm like damaging homes and businesses. The flooding near the Sultan Ibrahim Stadium on Jalan J4, Jalan Gelang Patah, Iskandar Puteri is attributed to the ongoing development and construction projects near Sungai Danga, impacting the drainage system. The Department of Irrigation and Drainage (DID) reported that on December 24, 2021, the flood depth on Jalan J4 ranged from 0.1 to 0.3 meters, with heavy rainfall reaching an average of 71 mm within a one-hour period, classified as "very heavy" by DID. This requires an important understanding of the relationship between land use patterns and flood risk for effective mitigation. This project aims to produce flood risk maps using Geographic Information Systems (GIS) applications and examine the topography and land use class resulting from the data obtained. Global Positioning System (GPS) aids in gathering data for later analysis. Classifying land use using Semi-Automatic Classification Plugin (SCP) analysis and obtaining contours by raster extraction. The results of the study are maps showing flood risk based on categorized land use. This allows authorities to engage in strategic planning aimed at addressing and mitigating the flood issue.

## 1. Introduction

Floods are the risk phenomena that generates the most economic damage and fatalities among all sorts of natural disasters. On globally, these problems harm around 200 million individuals each year (Costache et al., 2022). Urban areas are at high risk of flooding due to changes in the natural environment and the presence of large populations, distribution networks, buildings and economic activities. Urban development disrupts the natural water cycle by covering natural surfaces and directing drainage into pipes. This reduces the evaporation of water from plants, the exchange of water between the surface and underground, and the infiltration process. As a result, surface water runoff significantly increases, leading to the degradation of water quality. For instance, heavy rainfall can overwhelm sewage systems, causing difficulties in draining excess water effectively (Di Salvo et al., 2018).

Geographic Information System (GIS) systems are used to acquire and refine geographic data for hydrological and stormwater models. Furthermore, a wide range of GIS tools and plugins optimized for hydrological examination useful to the evaluation of flood depth and extension are fast growing. GIS-tools can also serve as a foundation for alternative simpler techniques targeted at evaluating and combining elements associated with pluvial flood risk (Di Salvo et al., 2018). Geodatabase is a platform for storing collected data that is anything that has similar data will be stored in one database. GIS has become an effective technique for generating spatial databases of environmental information systems because it is an important and effective instrument in the collection, storage, analysis, and the development of data. GIS can help with data and information collection, storage, manipulation, transformation, and processing (Kamara, 2020).

The objective of this study is to verify the detailed data of study area, to analyze the land use classification and topography using Quantum Geographic Information System (QGIS) and lastly to produce the flood risk map. The resulting flood map serves as a valuable tool for informed decision-making, providing insights into potential flood risks and supporting effective planning and mitigation strategies. The selected location is at Jalan J4, Jalan Gelang Patah, Iskandar Puteri, near with Sultan Ibrahim Stadium due to the flash flood occur when heavy rain. The study area covers 240 hectares, including the vicinity of Jalan J4.

## 2. Methodology

The Rapid Static GPS Baseline method serves to establish precise coordinates for survey points by employing a process of recording GPS observations over time and subsequently processing the data to yield optimal accuracy. In this approach, two GPS receivers are strategically positioned at each end of the line to be measured. Rapid static surveys involve shorter observation times to gather a moderate number of points, usually lasting between 15 minutes to 2 hours. Rapid static surveys also depend on the proximity and availability of CORS or IGS stations for positional corrections.

The GPS receiver is placed stably at the point to be measured and recording data. The data collection process continues for a predetermined recording period, where the GPS receiver continues to receive signals from the satellite and calculate the position of the point. Continuously Operating Reference Stations (CORS) employ a base station permanently installed at a known location. This distinctive feature facilitates measurements at any point within the district, utilizing the fixed base station as a reference. In a CORS-based system, receivers offer flexibility and can be positioned anywhere in the local area for data collection. After collecting the data, combining it with CORS data to calculate the ranking, correcting any discrepancies to ensure accuracy in the final results.

MyRTKnet is a comprehensive infrastructure system in Malaysia managed by the Survey and Mapping Department of Malaysia (JUPEM). It comprises a network of Global Navigation Satellite System (GNSS) reference stations and Control Centers designed to provide essential GNSS data, particularly for generating accurate position information. The CORS data, essential for this purpose, is obtained by referencing the Johor Jaya station, coded as JHJY. After the receivers gather data, it gets moved to the computer from the controller and then processed using a program called Magnet Tools.

Development data for a flood risk geodatabase entail collecting and organizing the information gathered using GIS software. The data is kept in distinct layers or tables inside the geodatabase, including GPS position data and attribute data. Not only does GIS process data from GPS survey, but it also has the capability to store and analyze various other data types, such as DTM (Digital Terrain Model). DTM, specifically, is valuable for understanding the topography of an area, contributing to accurate terrain modelling and enhancing the overall precision of geospatial analyses within the GIS framework. The ability to incorporate multiple data sources ensures a more thorough and nuanced examination of geographic information, making GIS a versatile tool for comprehensive spatial analysis and decision-making processes.

Land use classification using Landsat 8 satellite and the Semi-Automatic Classification Plugin (SCP) in GIS involves systematic steps. Firstly, Landsat 8 images are downloaded and imported into GIS using SCP. Then, defined the land cover types and select pixel samples for classification training. The final classified results are utilized for information extraction like creating land use maps. The risk associated with each land use can vary significantly, contingent upon the specific type of land use. For instance, built-up areas tend to pose a notably higher risk compared to water bodies, which typically exhibit a much lower risk.

Utilizing the DTM data, an in-depth analysis is conducted to generate comprehensive topographic information, specifically in the form of polygon contours. The process involves employing a raster tool within the GIS framework to produce contours, providing a detailed representation of the topographic variations within the study area. This method not only allows for the visualization of the terrain's intricacies but also facilitates a more nuanced understanding of the geographical features. By delving into the production of contours, GIS becomes a powerful tool for accurately depicting and analyzing the diverse topographical characteristics of the landscape. Fig. 1 shows the research process carried out for the completion of this study.

In the creation of the flood risk map, integrating the intersection method with a combination of land use and contour data. This method involves overlaying and analyzing these key components to identify areas susceptible to flooding. By leveraging the intersection method, the GIS can effectively delineate zones where land use and contour data intersect, providing a comprehensive understanding of flood-prone areas. Subsequently, the flood risk level in each land use category is classified, allowing for a detailed assessment of the varying degrees of vulnerability. This method not only enhances the precision of the flood risk map but also enables a targeted and informed decision-making process for effective flood risk management and mitigation strategies.

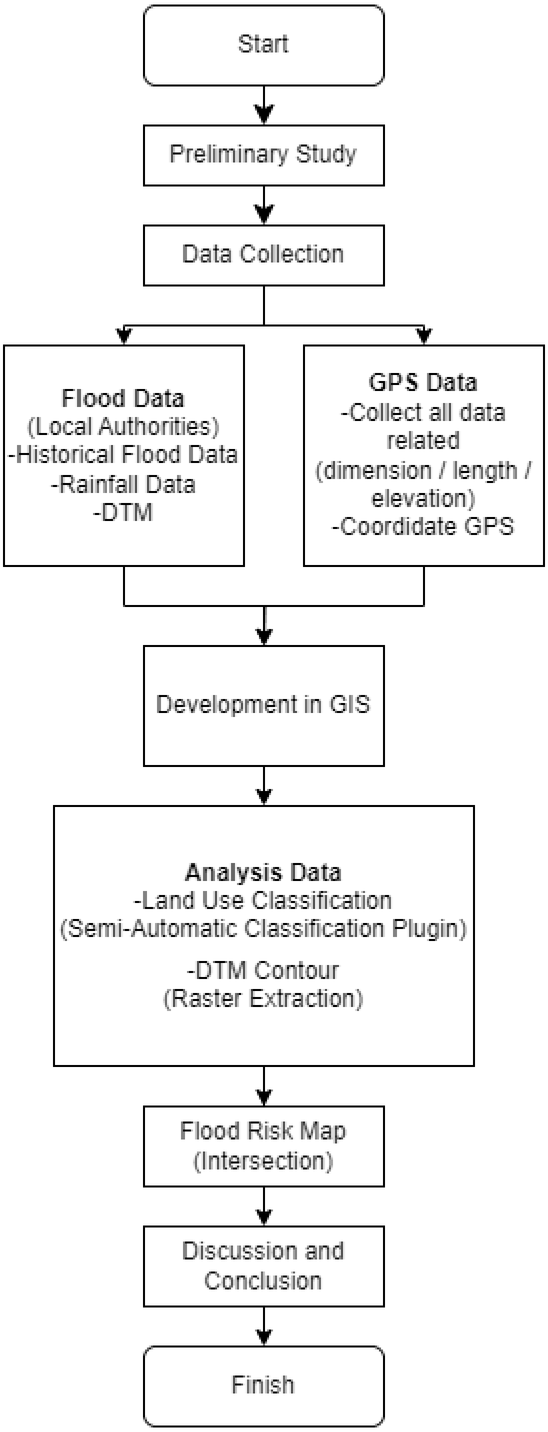


**Fig 1.** Flowchart of the study process

## 3. Result and Discussion

A number of complex assessments are required before the final map is produced in the process of developing a flood risk map. For a thorough knowledge of the variables influencing flood risk, including topography, land use, precipitation patterns, and hydrological characteristics, these early evaluations are essential. This study intends to give a thorough examination of the analytical procedures carried out to create an accurate and instructive flood risk map, providing important insights for efficient flood management and mitigation techniques. It does this by utilizing the capabilities of the QGIS software.

## 3.1 Land Use Classification

The study area is accurately delineated using land use data, thereby creating a comprehensive study area that incorporates detailed information on land use patterns. In Fig. 2, the land use classification outcome is visually presented, providing an initial overview before the subsequent classification into distinct risk levels based on the scoring system outlined in Table 1. This initial land use classification serves as a foundational step in the comprehensive assessment process, laying the groundwork for a more nuanced and detailed analysis.

**Table 1.** Land use classification

| Land use | Classification | Score |
|---|---|---|
| Vacant Land<br>Agriculture<br>Transportation | Low | 0 |
| Commercial<br>Infrastructure | Medium | 1 |
| Resident Area<br>Recreational<br>Industry | High | 2 |

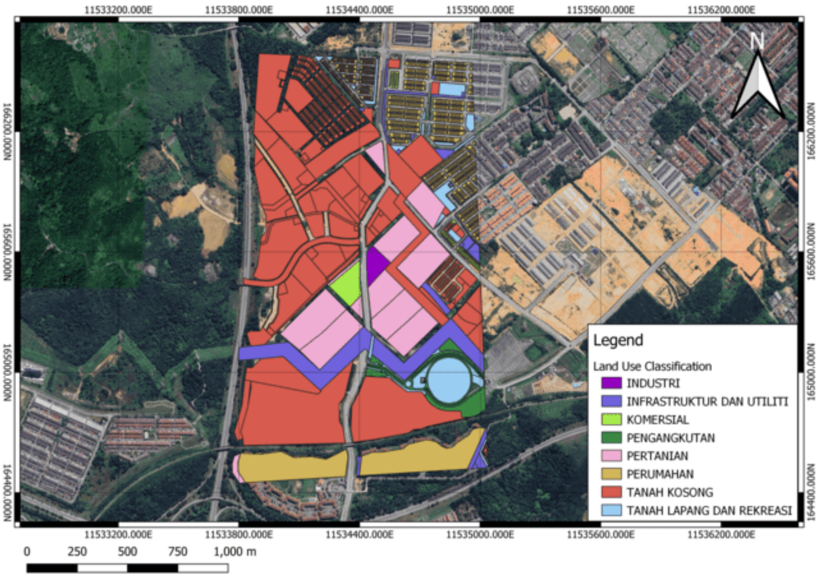


**Fig. 2.** Land Use Classification

A score of 0 in this context indicates an area devoid of human occupancy, whereas scores of 1 and 2 signify areas inhabited by people. The key distinguishing factor between scores 1 and 2 lies in their respective capacities to accommodate people. Based on Fig. 3, the production is derived from the scores generated to assess the risk of land use within the area. This provides an overview of how the population occupies the land based on the analysis of land use, thereby facilitating informed decision-making processes for urban planning, resource management, and disaster mitigation strategies.

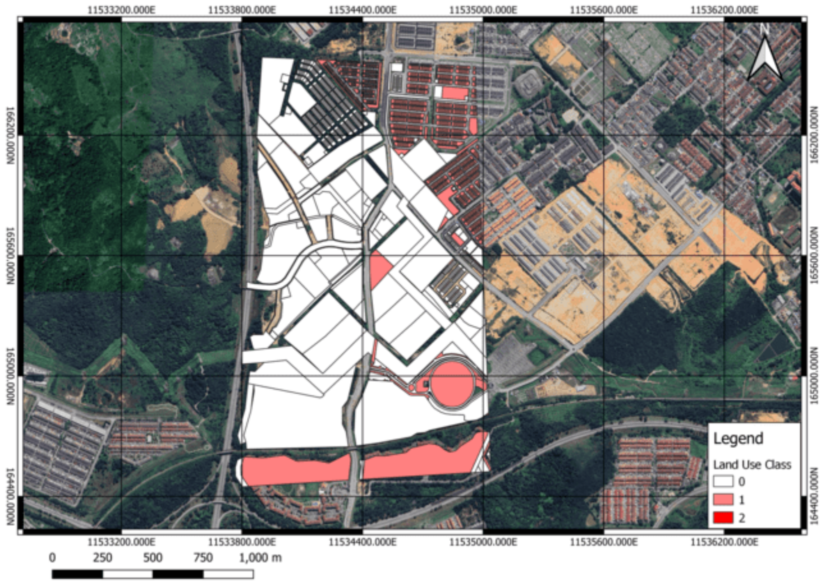


**Fig 3.** Land Use Score

## 3.2 Contour

After completing the land use mapping, the contour lines are generated by integrating the DTM with the clipped land use data. Fig. 4 shows the analytical process yields contours based on elevation, commencing from the minimum elevation of 10 and extending to the maximum elevation of 80.

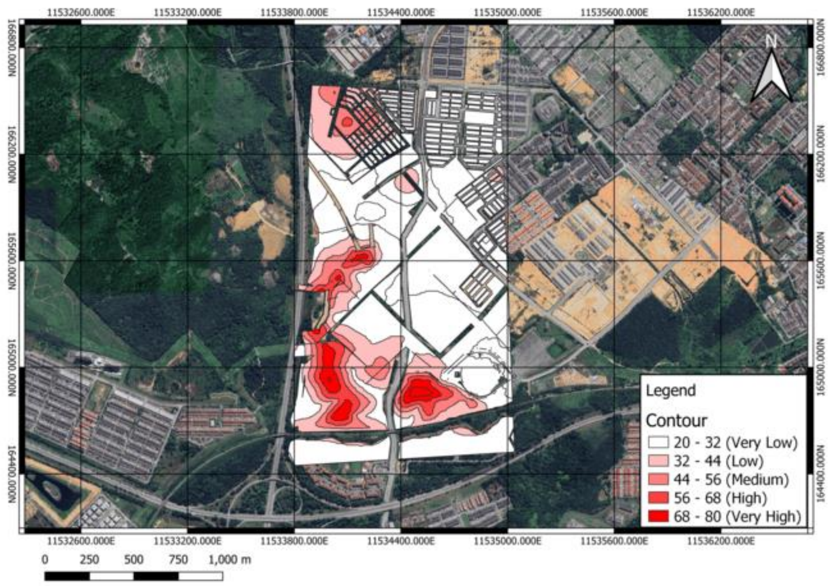


**Fig 4.** Contour Study Area

The generation of contour maps is facilitated through the utilization of raster tools, which convert elevation data into polygon contours. By employing a color-coded scheme, these contours visually represent variations in elevation within the mapped area. The color conditions applied serve to differentiate elevation levels, offering a clear visual identification of the varying topographic features across the contour-mapped area.

This detailed depiction of elevation helps in understanding the landscape's morphology and aids in decision-making processes related to infrastructure development, land use planning, natural resource management, and disaster preparedness. They enable stakeholders to identify areas prone to such events and implement appropriate measures to minimize their impact on human settlements and infrastructure.

## 3.3 Flood Risk Map

Utilizing the intersection tool in QGIS, the merger of clipped land use and polygon contours results in the creation of a comprehensive flood risk map. This map employs a color-coded scheme to visually communicate the varying degrees of flood risk in different areas. Blue colors represent safe or low-risk zones, while green indicates areas that are relatively safe but require caution. Yellow hues signify high-risk areas, and red is used to highlight the zones with the highest flood risk. This color-coded approach enhances the clarity and accessibility of the flood risk information, aiding in effective risk assessment and decision-making.

Examining Fig. 4 and Fig. 5 reveals an interesting view where certain areas exhibit low elevation contours, yet flood risk remains low. This discrepancy can be attributed to the fact that land use in the area is characterized by a low level of risk. In other words, even if the topographic features show a lower elevation, certain land use practices contribute to the reduction of vulnerability to flooding. This emphasizes the importance of considering not only elevation contours but also associated land use patterns when assessing flood risk. Such nuanced observations increase the overall accuracy of flood risk assessments, contribute to a more informed understanding of potential threats and assist in the development of targeted mitigation strategies

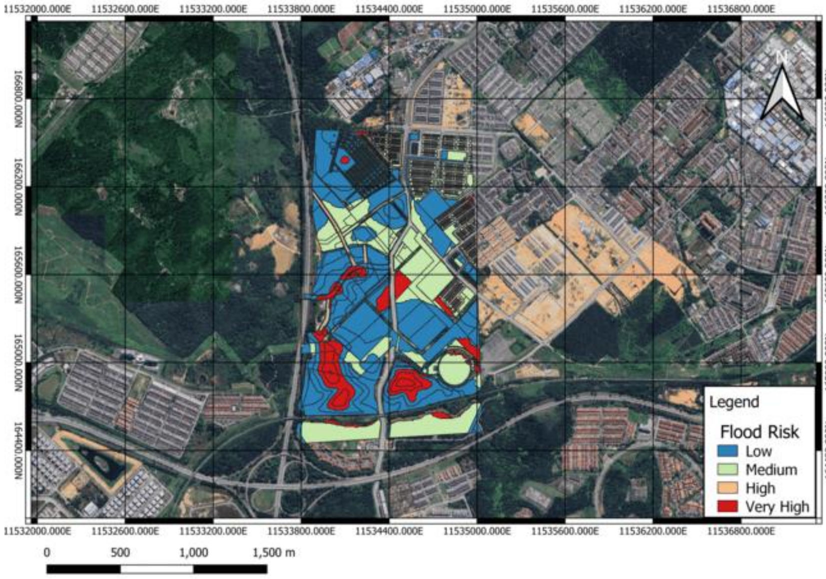


**Fig 5.** Flood Risk Map

## 4. Conclusion

Flooding events pose significant threats to both personal property and national economies. The development of flood risk maps emerges as a critical instrument in mitigating these disasters through proactive management and strategic planning. Such maps play a pivotal role in identifying vulnerable areas, enabling the implementation of preemptive measures to prevent and minimize flood occurrences. Strategic interventions, including infrastructure improvements and maintenance protocols, can be meticulously planned and executed based on insights gleaned from these flood risk maps. By facilitating informed decision-making, this approach not only mitigates the immediate impact of floods but also enhances long-term resilience and sustainable disaster management.

Utilizing acquired datasets encompassing topographical information, land use patterns, and other pertinent factors, GIS possess the capability to generate comprehensive flood maps. The analytical prowess of GIS software allows for the integration and interpretation of diverse datasets, culminating in detailed visualizations that pinpoint flood-prone areas. These resultant flood maps serve as invaluable resources for decision-makers, offering insights into potential flood risks and facilitating the formulation of effective planning and mitigation strategies.

In essence, the proposed enhancements, which involve extensive data integration and the utilization of cutting-edge software, aim to bolster the resilience of flood risk maps. By embracing these measures, the objective is to ensure that mapping outcomes are not only precise but also tailored to address the complexities and challenges of the dynamic environmental landscape.

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## References

Costache, R., Arabameri, A., Costache, I., Crăciun, A., Md Towfiqul Islam, A. R., Abba, S. I., Sahana, M., & Pham, B. T. (2022). Flood susceptibility evaluation through deep learning optimizer ensembles and GIS Techniques. Journal of Environmental Management, 316, 115316. https://doi.org/10.1016/j.jenvman.2022.115316

Department of Irrigation and Drainage. (2023, November). THE OFFICIAL WEB OF PUBLIC INFOBANJIR. (2023). https://www.water.gov.my/index.php/search/results?search=banjir

Di Salvo, C., Pennica, F., Ciotoli, G., &; Cavinato, G. P. (2018). A GIS-based procedure for preliminary mapping of Pluvial Flood Risk at metropolitan scale. Environmental Modelling & Software, 107, 64–84. https://doi.org/10.1016/j.envsoft.2018.05.020

Hussein, I. L. (2022, September 25). MBJB, MBIP Bertindak Atasi banjir kilat | berita harian. Berita Harian. https://www.bharian.com.my/berita/wilayah/2022/09/1004677/mbjb-mbip-bertindak-atasi-banjir-kilat

Kamara, S. M. (2020). Development of a geographic information systems baseline spatial Geodatabase template for evaluating potential and predicted environmental impacts for sustainable environmental impact assessment of mining in Sierra Leone. Journal of Geoscience and Environment Protection, 08(10), 262–284. https://doi.org/10.4236/gep.2020.810018

Akmal Nizam Mohammed & Farzad Ismail (2013) Study of an entropy-consistent Navier-Stokes flux, International Journal of Computational Fluid Dynamics, 27(1), 1-14, https://doi.org/10.1080/10618562.2012.752573

Musa, Z. (2021, November 3). City Council considering solutions to flash flood issue. The Star. https://www.thestar.com.my/metro/metro-news/2021/11/03/city-council-considering-solutions-to-flash-flood-issue

Osman, S. A., & Das, J. (2023). GIS-based flood risk assessment using multi-criteria decision analysis of Shebelle River basin in southern Somalia. SN Applied Sciences, 5(5). https://doi.org/10.1007/s42452-023-05360-5

Taherkhani, M., Vitousek, S., Barnard, P. L., Frazer, N., Anderson, T. R., & Fletcher, C. H. (2020). Sea-level rise exponentially increases coastal flood frequency. Scientific Reports, 10(1). https://doi.org/10.1038/s41598-020-62188-4

TOPS. (2023, October 11). Methods of GPS surveying for accurate measurements. https://www.takeoffpros.com/2019/07/31/gps-surveying-explained/