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Landslide Susceptibility Mapping Using Geographic Information System (GIS) in Kuala Balah, Jeli, Kelantan

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Abstract. A landslide is a natural occurrence that frequently results in the loss of property and life of those who live in the surrounding area. This study aims to produce a landslide susceptibility map by using Geographical Information System (GIS) approach in Kuala Balah, Jeli, Kelantan. Additionally, the geomorphology of this study area is hilly and mountainous, with several steep slopes that exposes citizens to the risk of landslides. In order to produce the landslide susceptibility map, six (6) parameters were applied such as lineament density, drainage density, slope, aspect, lithology and land use. These parameters were used to produce the thematic maps and weightage has been assigned to these thematic maps of parameters. Then, these thematic maps were reclassified and overlayed using the Weighted Overlay Method (WOM) in ArcGIS software. As a result, the study area is categorized into three landslide susceptibility zones: low, moderate, and high susceptibility zones. 5% of the study area is subject to low susceptibility to landslide, 71% of the study area is subject to moderate susceptibility to landslide, and 24% of the study area is subject to high susceptibility to landslide. Low susceptibility areas are primarily found on low land close to the town, such as Kampong Rawa, SMK Kuala Balah, and Tok Batin Forest Camp, meanwhile moderate susceptibility areas are located on valleys and low land and eventually high susceptibility areas are located on hilly and mountainous terrain area.

1. Introduction

A landslide is a natural disaster, and yearly landslides cause forty billion Ringgit Malaysia in damages and hundreds of fatalities. A landslide is the movement of rock and earth (soil) mass down the slope of a hillside under the influence of gravitation [1]. The damaging impacts of landslides are highly severe on every living creature on earth, along with the economies of the countries and nations around the world that are affected by these disaster events. In order to achieve landslide hazard assessment and risk reduction, information that is both continuous and accurate regarding the incidence of landslides and risk managements should be made independently accessible and transferred. The public and private sectors, as well as government entities and the academic researchers, should have an accurate susceptibility mapping supplied to serve as the primary source of information both on a global and a regional scale [2].

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The Weighted Overlay Method (WOM) is a method of modelling assessment method that is embedded with GIS and was extensively used in decision-making processes. In addition, the weighting of landslide susceptibility parameters was determined utilising the expert's prior study. The landslide prone area was then determined by overlaying the related parameters in ArcGIS [3]. By generating a descriptive mapping of the susceptibility to landslide using the approach that has been given, it is possible to decrease the experts' degree of error in their assessments. Therefore, the purpose of this study is to utilise a WOM that is integrated inside the environment of a Geographical Information System (GIS) in order to generate a landslide susceptibility map for Kuala Balah, which is located in the Jeli district of Kelantan. In order to generate the landslide susceptibility map, a WOM and raster calculation technique were utilised within GIS environment.

A GIS is a type of information system software that is linked with a variety of different attributes and characteristics to a specific location [4]. Depending on the end user, this system typically provides assistance with decision making and planning activities for places of interest. In addition, consumers of GIS should acknowledge that the tool will provide assistance to them in entering georeferenced data, analysing that data in a variety of ways, and producing outputs such as maps from the spatial information.

As illustrated in Figure 1, the research area is in Kuala Balah, Jeli, Kelantan. The study area was approximately 25 km^2 in size. The coordinates for the research area are 5°22'59.57"N to 5°25'42.33"N and 101°53'19.77"E to 101°56'2.11"E. This research area's elevation is approximately 860 metres above sea level. Kuala Balah is a rural region which name derives from the major river in the area, Sungai Balah.

This study aims to generate a landslide susceptibility map using WOM in ArcGIS software using parameter that affect the landslide in the study area. The GIS raster-based analysis will be conducted to create a landslide susceptibility map using Weighted Overlay Method (WOM), which is created by raster-based GIS using the parameters such as lithology, lineament density, drainage density, aspect, slope and land use.

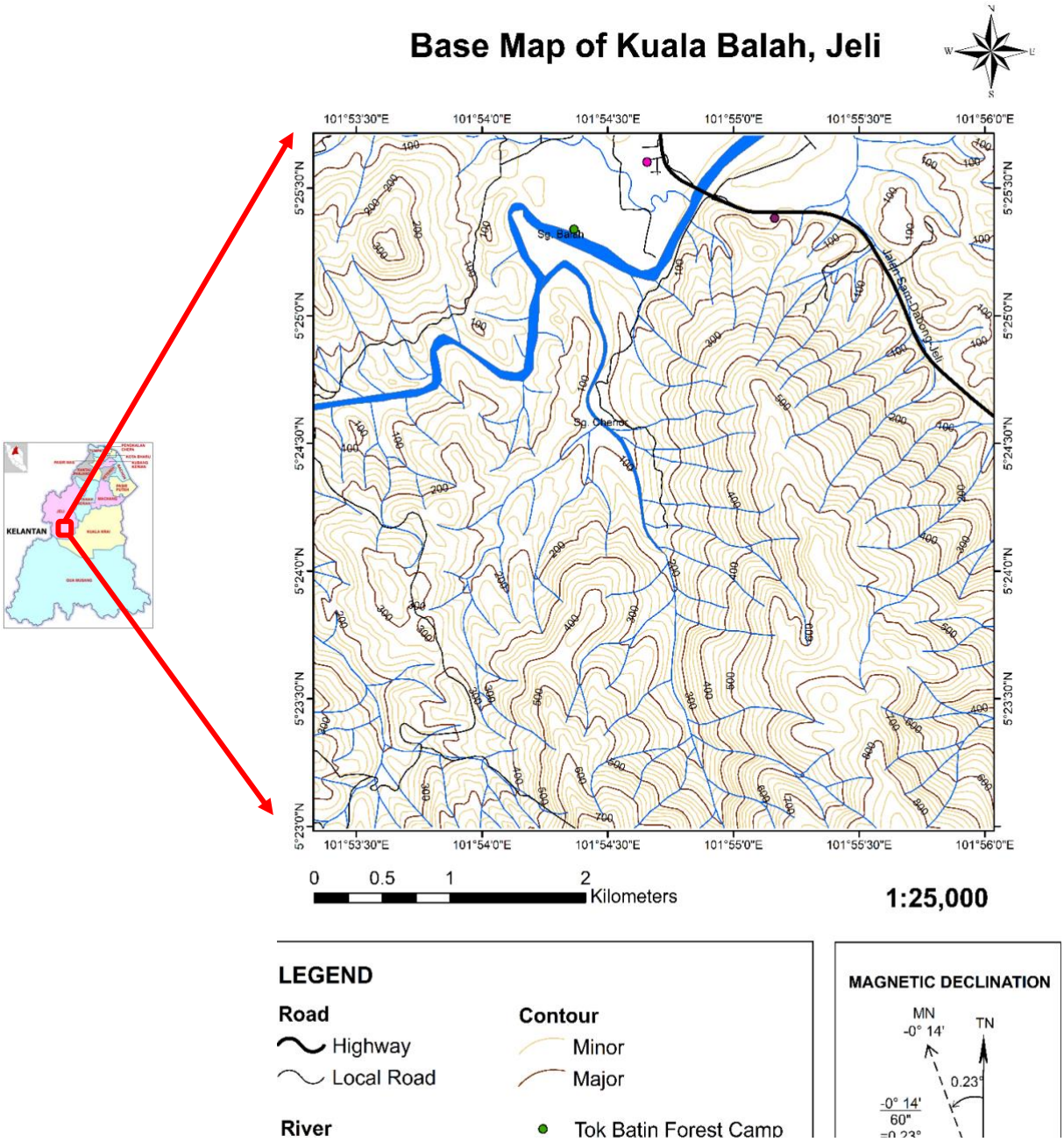

Figure 1. Location of the study area.

2. Methodology

The thematic layers of each landslide susceptibility parameter, including lithology, lineament density, drainage density, aspect, slope, and land use, have been designated in a GIS environment. The weighting factor was then assigned to each of the thematic layers. A weighting factor was employed to denote the impact on landslide susceptibility. Then, all the thematic layers were integrated using the ArcGIS Spatial Analyst tool to construct landslide susceptibility zones.

Four (4) steps comprise the study flowchart: preparation, data collection, data analysis, and conclusion finalisation (figure 2). During the preparation phase, preliminary investigations such as desktop studies and topography studies were conducted. The next step is data collection, which consists mostly of secondary data collected from a variety of agencies between year 2018 and 2021. The GIS platform was used to conceptually and geographically process all of the collected data. In the data analysis phase, a significant amount of spatial work was performed. This involves GIS processing, the creation of a thematic map with six (6) layers of parameters, weightage estimation [5], integration, and ultimately the production of a landslide susceptibility map. During the final phase, the result was interpreted, discussed, and finalised.

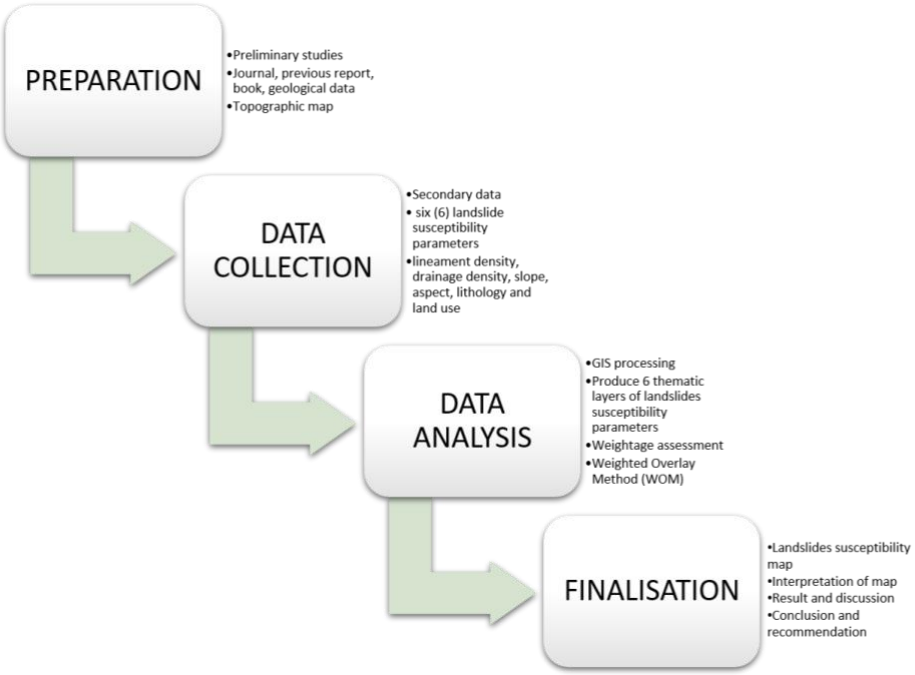

Figure 2. Research flowchart.

3. Results

In this study, all related thematic maps of six (6) parameters were classified (Figure 3 and 4) and overlaid in the spatial analyst tool using the WOM in ArcGIS. The individual parameter weights were determined by utilizing the expert's prior research [6]. The weightage score method was applied on the factors by weighting a high score of 10 to the factor that has greater influence on landslide occurrence and the one with a smaller weight with a score of 1. All these weights were assigned manually (Table 1).

Table 1. Weightage distribution for parameters

No.	Parameters	Weightage
1.	Lithology	9
2.	Lineament Density	5
3.	Drainage Density	7
4.	Aspect	10
5.	Slope	8
6.	Land Use	6

Based on the findings of the analysis (Figure 5), research area has been categorized into three (3) classes of zone of landslide susceptibility, with 71 percent of the region having moderate susceptibility to landslide, 24 percent having high susceptibility to the landslide hazard, and only 5 percent having low susceptibility to the landslides.

In general, the susceptibility and chronicity of landslides increased with an increase in drainage density and lineament density. The stability of the slope determines the frequency and severity of landslide occurrences; therefore, it is one of the most crucial parameters in the analysis of landslide susceptibility. The greater the slope's steepness, the greater the probability of instability. Due to their steeper slopes, hilly and mountainous locations have a greater danger of landslides; therefore, 24 percent the study area was influenced by a moderate susceptibility area and 71 percent of the study region was recognized as having a moderate susceptibility to landslides.

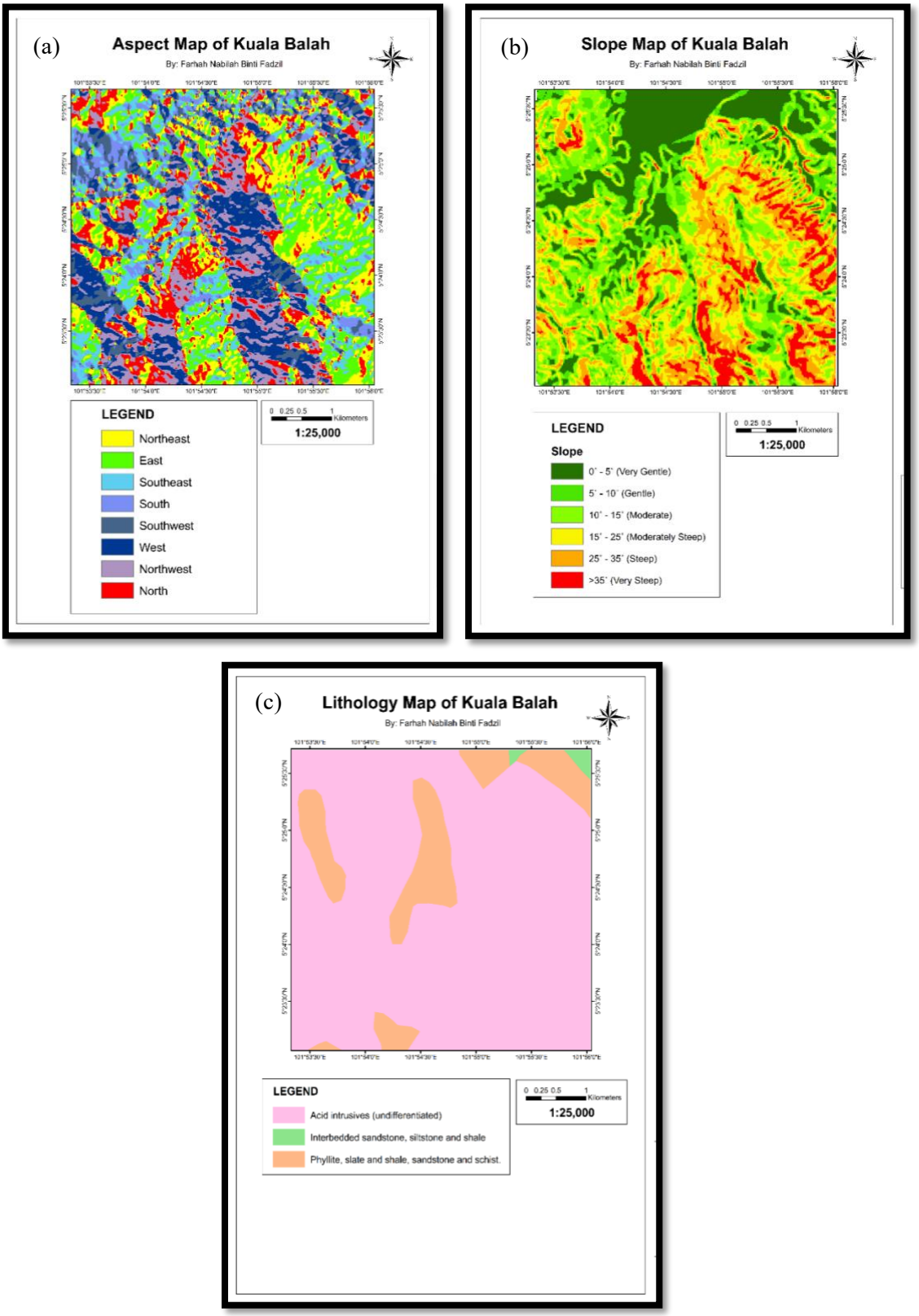

Figure 3. Aspect map (a), slope map (b) and lithology map (c) of the study area

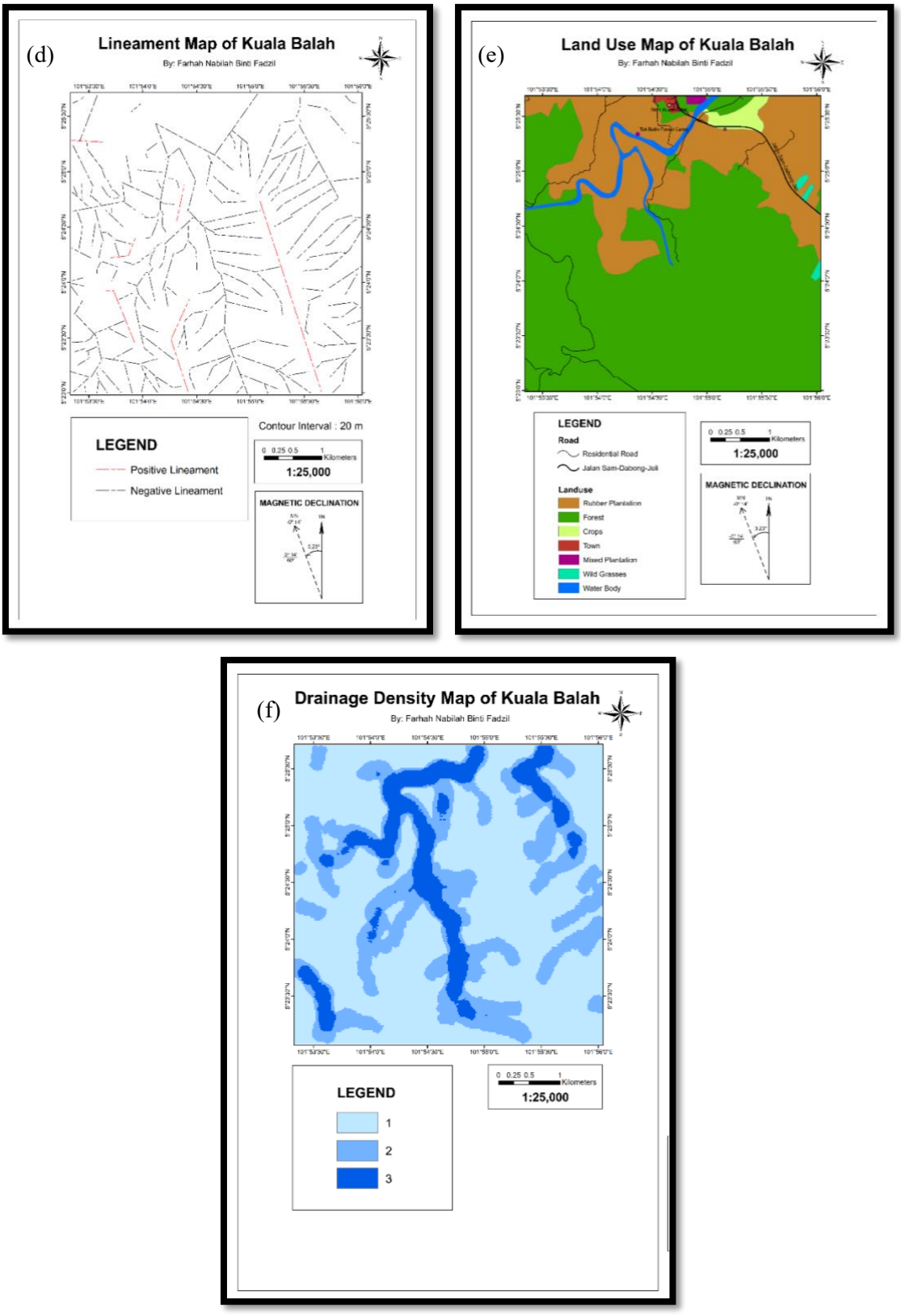

Figure 4. Lineament map (d), land use map (e) and drainage density map (f) of the study area

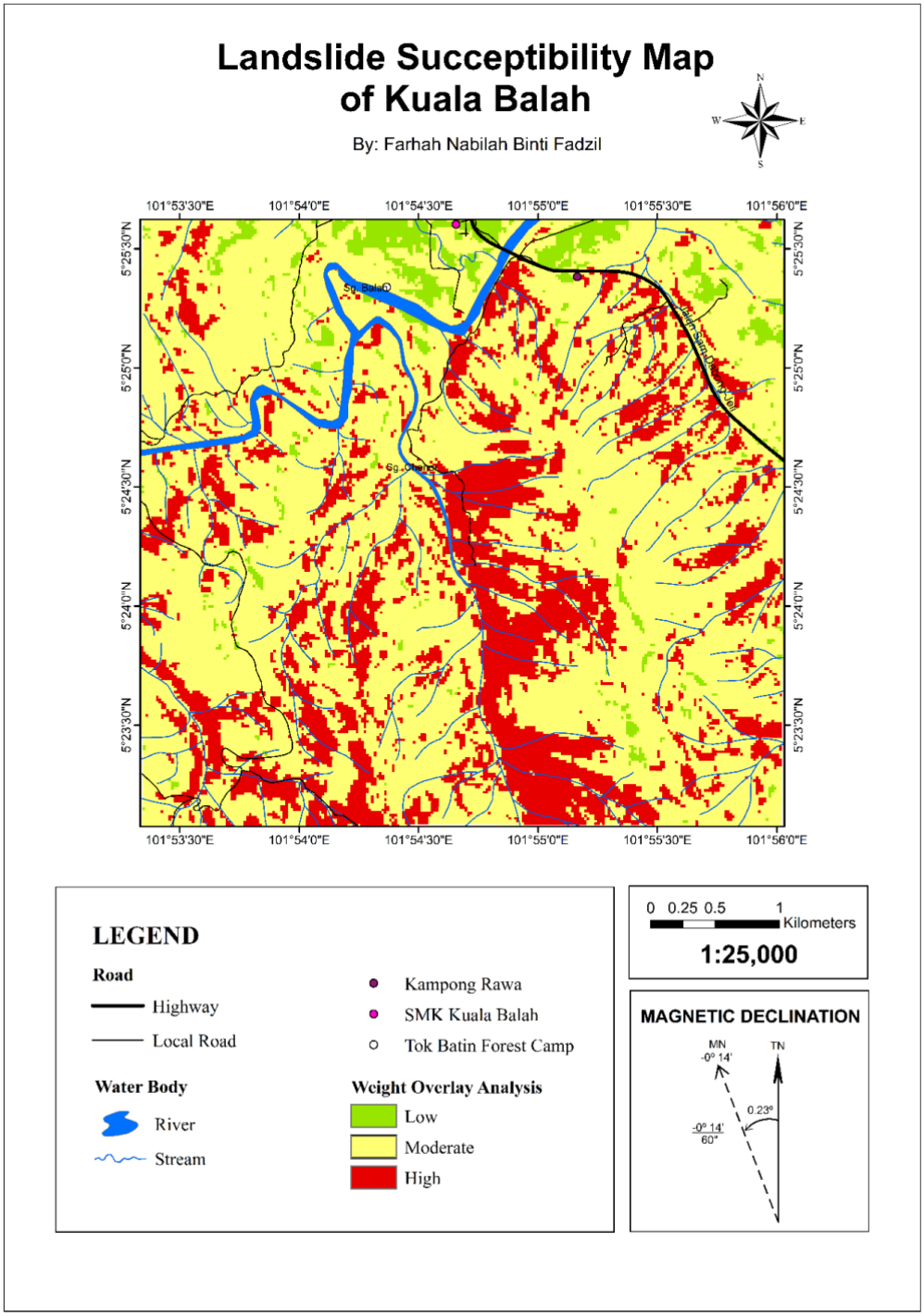

Figure 5. Landslide susceptibility map.

4. Conclusions and recommendation

The area with high and moderate landslide vulnerability consists primarily of mountainous and hilly terrain. This is because significant rainfall events typically occur at higher elevations, and the water flow transports debris, soils, and rock components to the lower portions of mountains and hills. In addition, mountainous regions have a greater drainage density, which has the same effect, particularly during rainfall. Gravity can trigger a landslide in hilly areas due to their greater degree of steepness compared to lowland areas.

Lastly, lowland areas are less susceptible to landslides due to their gentler or less steep slopes, resulting in a reduced gravity influence on the lowland compared to hilly and mountainous regions. Additionally, the area has a lower elevation than hilly and mountainous regions. Additionally, the drainage density of lowlands is less dense than that of hilly regions, making the area less susceptible to landslides.

As recommendation, since this study is based solely on secondary data, this study should conduct additional research. It is recommended that the landslide susceptibility mapping use the kinematic analysis approach for the landslide study, as it tends to be more accurate due to the data being newly collected and observed from field activities. Considering different types of characteristics may convey different findings, the data can be compared to discover which parameters had the largest influence on the landslide susceptibility of the research area.

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References

[1] Akter A, Noor M J M M, Goto M, Khanam S, Parvez A, and Rasheduzzaman M 2019 Landslide Disaster in Malaysia: An Overview. *International Journal of Innovative Research and Development*, **8**(6). https://doi.org/10.24940/ijird/2019/v8/i6/jun19058

[2] Kazmi D, Qasim S, Harahap I S H, and Vu T H 2017 Analytical study of the causes of the major landslide of Bukit Antarabangsa in 2008 using fault tree analysis. *Innovation Infrastructure Solutions 2*, 55. https://doi.org/10.1007/s41062-017-0105-4

[3] Patra P 2010 Remote Sensing and Geographical Information System *The Association for Geographical Studies* 1-28.

[4] Rodeano R, Alyvyn C M, Norbert S, and Mohd N N 2017 Landslide Susceptibility Analysis (LSA) Using Weighted Overlay Method (WOM) Along the Genting Sempah to Bentong Highway, Pahang *Malaysian Journal of Geosciences* 13-19. https://doi.org/10.26480/mjg.02.2017.13.19.

[5] Saaty T L 2002 The seven pillars of the analytic hierarchy process In: Multiple Criteria Decision Making in the New Millennium, Berlin, Heidelberg: Springer 15–37.

[6] Shaari M S 2019 Geology and Landslide Susceptibility of Patuk Area, Gunung Kidul, Yogyakarta, Indonesia, Undergraduate Final Year Project Report, Universiti Malaysia Kelantan.