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Research Article

Analysis and Prediction of Landslide using Drone Image and GIS Techniques- Case Study Aranayaka Area

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Abstract Occurrence of Landslides has become a major impact considering the damage a landslide can do in a quick time. Among the natural hazards the country is exposed up to now, severe landslides are the upcoming major issue since it can affect to the lives of people too. In this case study from Aranayaka area, a method is developed to analyses and identify landslide prone areas. The methodology of the research includes collecting terrain data, building a model using geographic information system (GIS), satellite image processing, preparation of a landslide susceptibility potential map and giving recommendations on the landslide hazards. Among the factors that influence a landslide such as drainage, bedrock condition, slope angle range, land forms and etc. (published by National Building Research Organization), the foremost controllable and mostly varying factor. In this research, landslide prone areas are identified using the land use data. Identification of landslide hazards plays an important role in disaster management and risk controlling since a severe landslide can affect several aspects such as human lives, agricultural aspects, economic activities and transportation. This paper includes the background of the entire research that has developed up to current situation. This method can be used around the world as well as in the country.
Keywords *Land Slide; GIS; Drone image; Satellite Image; Disaster Management*

1. Introduction

Landslides occur mainly during monsoon and inter-monsoon seasons are the most pressing natural disaster in the Central Highland of Sri Lanka. 42% of the total populations of the country in 10 administrative districts consider being prone to land slide (Somarathne, 2015).

Geological, topographical map and plant cover maps, satellite images and the information about rainfall information processing in GIS environment and many parameters such as lithology, slope, slope aspect, annual rainfall, land use, distance to waterway, distance to the fault, and distance to road were used for some of previous studies (Shahabi et al., 2012).

National building research organization (NBRO), Sri Lanka has published six factors inducing landslides as (I) bedrock geology, (II) hydrology & drainage, (III) surface overburden, (IV) slope angle range, (V) land use, and (VI) land forms. Among these factors, hydrology & drainage and land use are recognized as major factors since those need to be monitored time to time and update landslide susceptibility map (Pushpakumara et al., 2013 and Donnarumma, 2013).

A reliable prediction of a natural disaster leads to the safety of lives comfort. According to the facts recorded, 60% of the major disasters have happened in Asia-pacific region. Hence Asia-Pacific region is considered as the most disaster prone area in the world (Report on Disaster management Asia, 2019). The research includes an analysis and prediction of landslides using remote sensing and GIS techniques in Aranayake area.

Each inducing factor has been weighted considering the weightages published by NBRO. Because of the lack of a high quality satellite image of the considered area high quality drone image is used as main data source and digitized using GIS software to extract the land uses. The land uses are categorized as low, medium and high hazardous and by taking intersection with other causative factors, the landslide susceptibility map is generated (Karsli et al., 2008).

2. Data and Methodology

Figure 1 includes the selected area in Aranayake including the area of previous landslide and also considering the different land use patterns.

A socio-economic analysis was done to gather people's intention about the weather condition of the area after the landslide, economic growth of the area after the landslide, what were the main land uses of the area and whether they think those land uses was a main reason for the landslide.

Figure 1: *High Quality Drone Image*

Since there was no incident of a landslide in this area, no one noticed any clue of a landslide during the rain. Some people have been aware of an incident due to the heavy rain but not evacuated from the area because there was no evacuation plan. According to the survey, people have avoided the permanent evacuation because of the misleading behavior of the officials. This report strongly recommends that it is very urgent to practice successful emergency evacuation plan and informing the warning of a landslide as early as possible.

Weighted maps for causative factors other than land use are shown in Figure 2a, Figure 2b, Figure 2c, Figure 2d and Figure 2e. All the factors have been given a certain weight according to their influence for occurring of landslides as shown in Table 1.

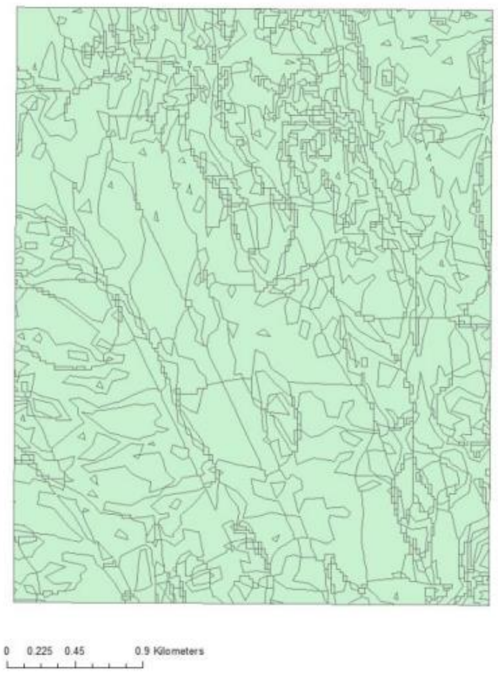

Figure 2a: *Bed Rock Geology*

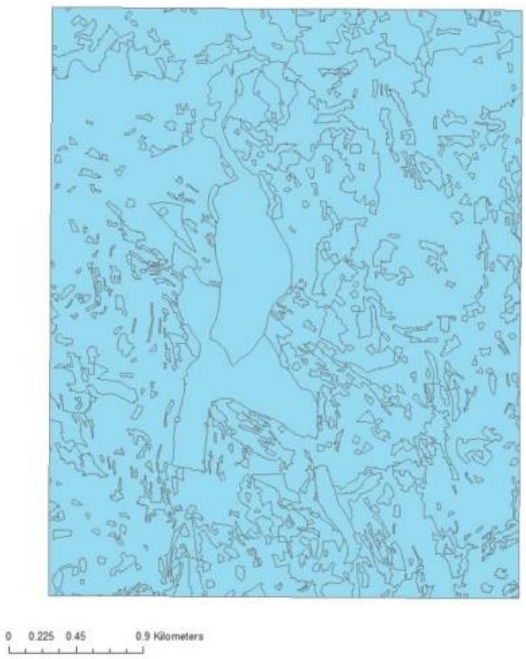

Figure 2b: *Hydrology and Drainage*

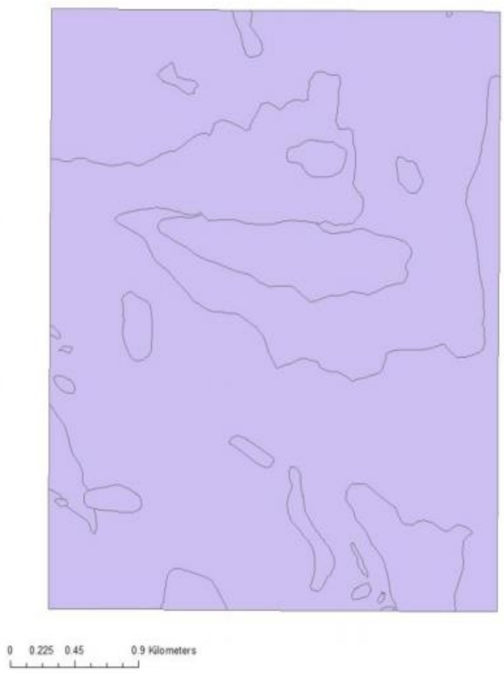

Figure 2c: *Overburden*

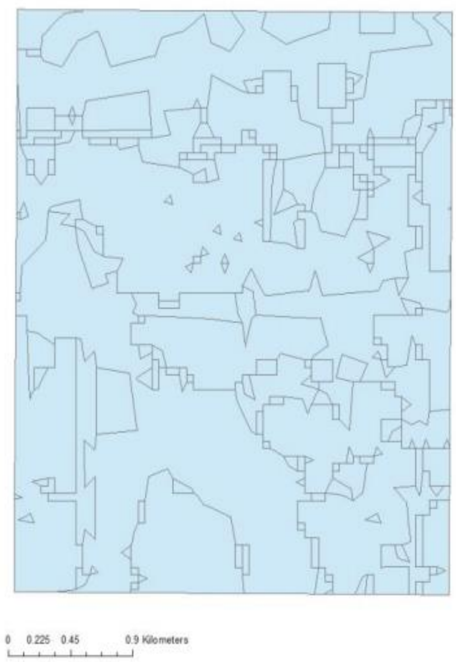

Figure 2d: *Land Forms*

The previous methodology was to get a panchromatic and a multispectral IKNOS images and analyses them using spatial analysis tool in ArcGIS software to obtain a true color image to recognize the land use patterns (Hari et al., 2018). But due to unavailability of satellite images, the method was slightly changed. The data available was a high quality drone image of the considered area. So that the image was digitized manually and obtained the distribution of land uses such as Water bodies, Paddy, Rubber, Scrubs, Building, Coconut, Home gardens, Forest area, Grasslands and Tea in the selected area.

Figure 2e: *Slopes*

Table 1: *Weights for Causative Factors of Slope Failures*

	Slope	Maximum Weighting
1	Bedrock Geology	20
2	Hydrology & Drainage	20
3	Surface Overburden	10
4	Slope Angle range	25
5	Land use	15
6	Land forms	10
	Total	100

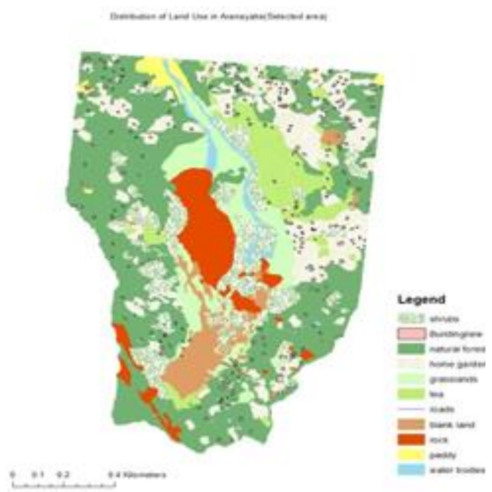

Figure 3: *Land use Map*

Table 2: *Weights for categories of land uses*

Linguistic Racing	Score	Factor Classes
Very low	3	Coconut, Forest, Well Manager
Medium	8	Paddy, Rubber, Scrub, Home Garden poor
Very High	15	Water Bodies Grasslands, Buildings

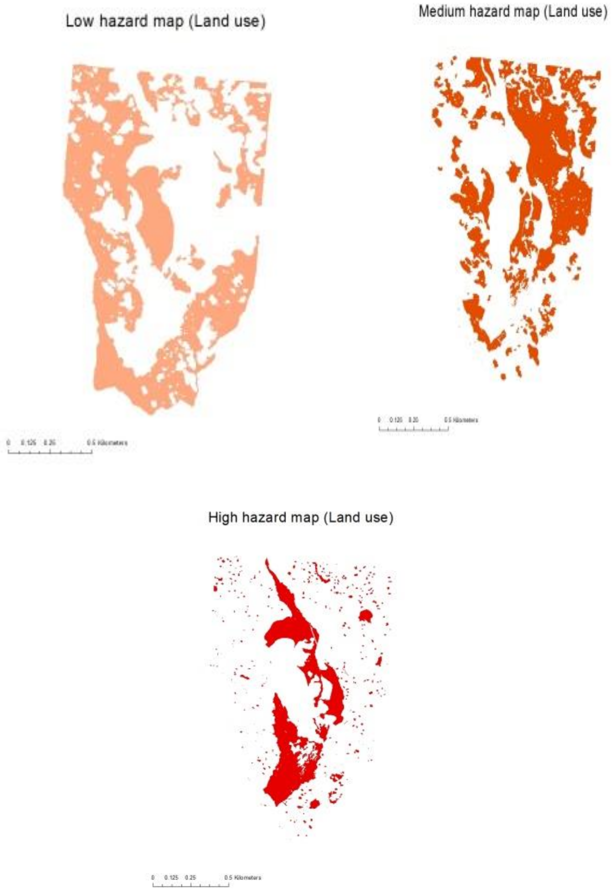

Figure 4(a): *Hazard category maps considering Tea as poorly managed*

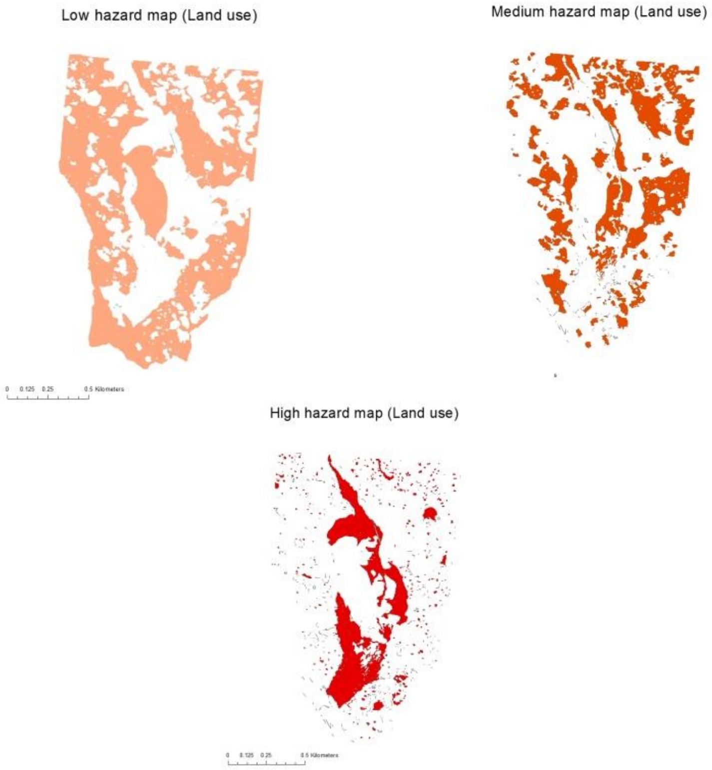

Figure 4(b): *Hazard category maps considering Tea as well managed*

The contribution of each land use for landslides is different. In the literature, NBRO has considered tea as two aspects as well managed and poorly managed. So that it was essential to consider both aspects since influence from each aspect is different from each other. According to the clarification done by NBRO, three weightages have been given for three categories. The clarification is shown in Table 2. Therefore, three maps were produced consequently for poorly managed tea and well managed tea. Each three maps are shown in Figure 4a and 4b, Figure 5a and 5b.

In case of obtaining the final intersected maps, these two maps were made intersection with other maps of landslide causative factors taken from NBRO. This was done using GIS analysis tools and these two maps can be presented to predict the landslide susceptibility according to the land use distribution of the area (Shahabi et al., 2012). Table 3 shows the arrays of weights of the hazard zonation which are defined by the National Building Research Organization.

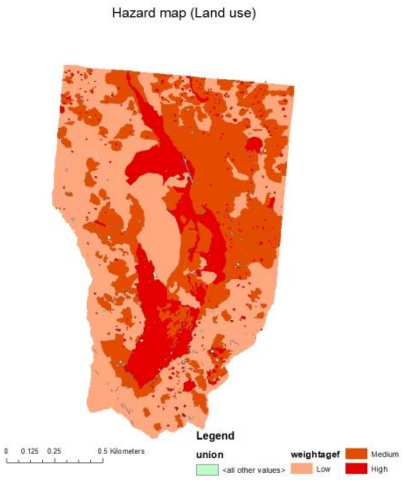

Figure 5(a): *Hazard category map considering Tea as poorly managed*

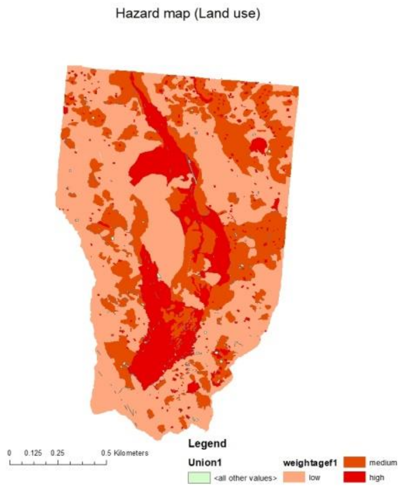

Figure 5(b): *Hazard category map considering Tea as well managed*

Table 3: *arrays of weights for the hazard zonation*

Total Score	Slope Failure Probability
>70	Higher hazards
55-70	Medium hazards
40-55	Low hazards
40>	Not likely

Conclusion

This research is proposing a methodology to analysing and predicting landslides using remote sensing and GIS techniques. And it was based on a high quality drone image of Aranayake area. But the accuracy of the research can be improved by using a high resolution satellite image. If a high resolution satellite image was available, a supervised classification and an unsupervised classification can be conducted to obtain a true colour image and a final classified map of different land uses where the land uses are classified by the software.

But due to unavailability of a satellite image to that required resolution, a high quality drone image was used to get the land use map of the selected area. This modelling method can be extended to the whole country to analyse and predict landslides based on the land use factor (Rathnayake, 2014).

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