GIS Model for Increasing of Accuracy on Landform Map of Landslide Hazard Zonation Mapping Programme

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1 ABSTRACT

Landslide Hazard Mapping Programme (LHMP) is being conducting since 1995 by NBRO. This programme is for identification of landslide prone areas of Sri Lanka. This mapping methodology was developed with the extensive research works and 6 factors; bed rock geology, soil cover, slope arrange and category, hydrology and drainage, land use and management, and landform, are being considered for the preparation of Landslide Hazard Zonation Maps (LHZM). The landform map describes the land characteristics of particular area. This map develops through manual digitizing and interpretation of Aerial Photographs of the area. After, base maps were prepared and updated through field check. The argument was made that landform is representing from the contour system of particular area. Therefore, if there is good contour map or spot heights, the landform map can be easily developed. However, with the increase of spatial technology, GIS applications are widely useful for the preparation of maps. Therefore, analysis of different land form features based on GIS technology creates more accuracy and advantages on time consuming. This argument was tested in several areas and results were analyzed with the previously developed landform maps. This paper is describing the development of methodology, testing and calculate the effectiveness of the methodology considering the existing methodology of landform identification.

Key words: LHMP, Land form, GIS

2 INTRODUCTION

The development of the LHZM is a time consuming process which needs 4-5 months to develop 1:10,000 map. This consists of 6 factor maps and various weighted values as follows;

1. Bed rock Geology - 20
2. Soil Cover - 10
3. Slope Range and Category - 25
4. Hydrology and Drainage - 20
5. Land Use and Management - 15
6. Land From - 10[1]

Landform map is preparation based on the "World Landform Legend" which was finalized on 1987. This Landform mapping process is driven through manual digitizing of Aerial Photographs. Therefore, it takes more than 1 month to digitize the 1:10,000 map. The accuracy of this map is depending on several factors and out of that human errors are more significant issue in this process. In this process, digitizing the aerial photographs, projecting into 1:10,000 scale and again digitizing are the major steps. Therefore, three lines are created for the process. Following are the information of minimum errors in these steps;

2.1 *Digitizing the Aerial photographs*

Normally, 5-8 aerial photographs are consisted into one 1:10,000 map and approximate scale of the aerial photograph is 1:5,000. Although, 60% of aerial photographs are intersect one to another. 0.5mm pens (OHP) are used to digitizing purpose and it

[1] LHZM Presentation, R.M.S. Bandara, Head, Landslide Studies and Services Division, NBRO

was done through "theodolite "instrument. During the digitizing, 2.5 m (0.5 x 5000 mm) area on the ground is covered on to the Pen. Therefore, in this stage highest accuracy of the map is 2.5 m. (without considering human errors, aerial photograph errors)

2.2 *Projecting to 1:10,000*

These digitized maps are projected to 1:10,000 scale by using the "Projector". For this task, the digitized image should be enlarged into twice, and it is drawn with 0.5mm pen. Therefore, the error as follows;

During the enlargement, 0.5mm line enlarge: 2^2 x 0.5 mm = 2 mm

Plotting on 1:10,000 sheet error: 2 x 10,000 mm = 20 m

2.3 *Digitizing 1:10,000 maps*

In this process board digitizing is conducting to digitize the projected maps. Therefore, we can assume that the error is less in this step.

Therefore, minimum errors of these maps are 20 m. However, small error in the aerial photograph digitizing is creating massive error at the ground.

3 RATIONALE

Considering the above situation, a new methodology should be incorporate to aerial photograph digitizing process. Therefore, there are two options can be adopted for minimize of this error. One is digitizing the aerial photographs by using the remote sensing tool (ARCGIS/ IMAGINE/ EARDAS/ etc…) and other one is using digital elevation model. Digitizing the aerial photographs also have human errors because the legend of the landform create distorted mind for the digitizer. Hence, most preferred one is used digital elevation model for development of landform map for the LHMP programme. Creating a model to calculate and identification of landforms is providing the most significant solution for the above and it reduces the error into 0 (zero) m considering the present methodology. Although, it takes only few hours to finalized the map and it save more human hours and institutional wealth.

4 METHODOLOGY

The programme methodology is mainly considering the development of GIS model for analysis the landform from digital elevation model.

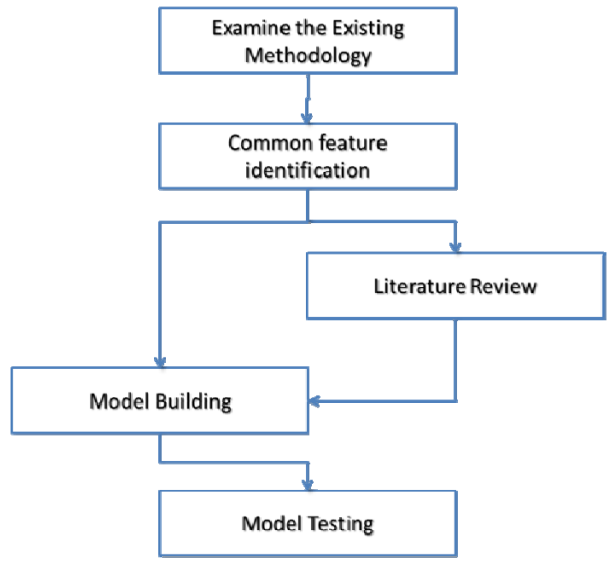

Figure 1: Methodology

Examine the existing methodology of preparation the landform map for LHMP is needed and then it helped to identify the common features of the different landforms. By using these common features, ARCGIS model was developed by using several literatures describing about various tools and scripts used for several analysis. Finally, model has tested with previous completed landform map which was developed from aerial photograph interpretation.

The existing coding system has 3 numbers that represent the landform.

Existing Land Form code = D. 3.1

Here, D represents the elevation level of the ground various from C to F. Number 3 represents the relief type of the slope which varies 1 to 3. Number 1 represents the slope type of the land which varies 1to 8.

This coding system had been changed for the development of GIS based model as follows.

New Land form code = 1.2.3.4.5.6.7

Where,

1- Elevation level (1-4)

2- Relief level (1-4)
3- Slope Category (1-7)
4- Flat land (0-1)
5- Normal, Concave, Convex slope (1-3)
6- Straight, Corrugated, Dissected (1-3)
7- Complex (0-1)

Existing landform code and new landform codes were matched by considering the characteristics of the land. For example;

2210210 = D31 (elevation between 50- 200, below 100m relief, 0-0.5% of slope, not flat, not concave or convex, not corrugated or dissected, not complex slope area)

4470331 = F56 (elevation above 1200, relief more than 200 m, 30-1000% of slope, not flat, concave slope, dissected, complex slope area)

Through this numbering system a GIS model had been developed by considering following tools and steps. 20m grid size was considered for the analysis which was selected through the highest accuracy of the manual digitizing process.

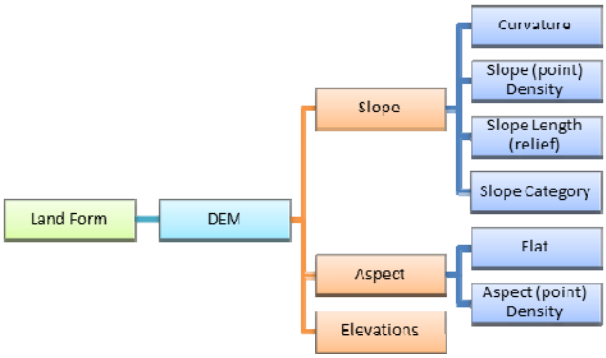

Figure 2: Process

Initially, Digital Elevation Model (DEM) was created by using contour details. After, three layers were developed; slope, aspect and elevation. Using the slope layer, four types of layers were developed and categorized. Flat area and Aspect density were identified. Finally, raster calculator was used to calculate the aggregate value.

Following map was generated after the simulation the model.

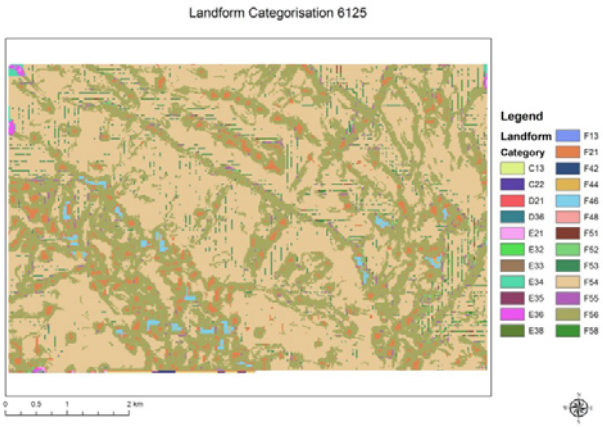

Figure 3: new Landform Map

5 MODEL TESTING

Model was tested with Landform maps which were developed previously on manual method. Figure 4 shows the overly of existing landform and new landform areas.

6 CONCLUSION & RECOMMENDATION

Landslide Hazard Zonation Mapping programme has 20 years history and within this period, the technology was significantly change. Therefore, this programme should be change according to the present technology and it will save time and money and it proceeds to increase the accuracy of the programme.

The paper is discussing the conversion of identification of landform on manual process to automated process through using of ArcGIS tool set. This has certain advantages;

1. Saving of Time and Money
2. Exactly follow the guidelines (No human errors)
3. Increase the accuracy of the programme

Therefore, it is recommended to use this methodology for map out the landform maps for the LHMP.

7 REFERENCES

Concepts and techniques of Geographic Information System, C.P. Lo and Albert K.W. Yeung, 2005, ISBN: 81-203-2230-4

Manual on filed mapping for landslide hazard zonation, R.D. Cruickshank, 1995

Landform Categorisation 6125

Legend

Landform Category

C13, C22, D21, D36, E21, E32, E33, E34, E35, E36, E38, F13, F21, F42, F44, F46, F48, F51, F52, F53, F54, F55, F56, F58, Existing Landform

0 0.5 1 2 km

N W E S