ABSTRACT

Landslides are widely defined as ‘a collapse of the mass of soil or rock from a slope'. It is one of the natural hazards that occur perennially in hilly regions all over the world. In India landslide occurs frequently in the Himalayas, North Eastern parts, Meghalaya plateau, and the Western Ghats. The Nilgiri district situated on the Western Ghats is affected by landslides throughout the year. The increasing trends of disastrous landslides in the Nilgiri district are due to unplanned urban growth and unprecedented rainfall. To comply with urban growth, sustainable building construction and safe infrastructure development at landslide prone zones gains importance. This can be made possible by studying the land suitability at landslide susceptible zones.

The Nilgiri district is a hilly region recorded with landslides from 1978 (Seshagiri et al. 1982). It geographically lies at 76° 14’ and 77° 02’ East longitude, 11° 10’ and 11° 42’ North latitude covering an area of 2547 km^2. The district receives rainfall from both southwest and northeast monsoons, with an average annual rainfall of 1857.00 mm. It is connected with other districts through roadways and railways. During the years 1978, 1979, 1993, 2006, 2009 and 2011 the district suffered severe landslides, causing damages to property and human lives due to heavy rain (Nalina et al. 2014).

In order to generate Landslide Susceptibility Zonation (LSZ) map, first past landslide inventory data are collected from the Geotechnical Cell and Railway authority, Coonoor. The data are entered through inventory form, developed using Csat program and integrated with the Geographical Information System (GIS) to generate the landslide inventory map. About 520 landslide locations are collected and eleven landslide causative parameters are identified, namely geomorphology, geology, soil type, land use land cover,

lineament, distance to road, distance to the railway line, drainage, rainfall, slope and slope aspect. Different forms of these parameters are converted to thematic maps using GIS.

In this research, quantitative methods, namely Analytical Hierarchy Process (AHP), Spatial Multi Criteria Evaluation (SMCE), Factor Analysis (FA) and Artificial Neural Network (ANN) are used to find weights for these parameters. Using the weights Landslide Susceptibility Index (LSI) are calculated and applied to each thematic layers to prepare the LSZ map for the Nilgiri district.

The LSZ map is classified into five zones, namely Very Low, Low, Medium, High and Very high and validated analytically using Receiver Operating Curve (ROC) and also by field verification. Out of 520 landslide locations collected, 406 are used for weight calculations and the remaining 114 locations are used for validating the LSZ maps generated. The results obtained are 85%, 89%, 91% and 95% using ROC and 95.98%, 98.66%, 91.74% and 100% accuracy, using field validation for AHP, SMCE, FA and ANN methods respectively. From the results of all the four methods obtained, ANN method is found to be close to the reality. It is suitable for future prediction of landslide occurrence. From the LSZ map of ANN method, it is found that in the Nilgiri district, 39.3% of land area are identified as high and very high susceptible zones.

To study the characteristic of the soil and the existing slopes in the Nilgiri district, for safe building construction, reconnaissance survey is conducted. About 56 locations are selected to perform Standard Penetration Test (SPT) as per IS 2131 at the depth of 3m (shallow foundation) from the ground level. Two locations are found to be refusal and hence 54 locations are considered. Stratified random sampling is adopted for calculating the number of samples needed to represent the soil characteristics of the blocks in the

Nilgiri district. Both disturbed and undisturbed soil samples are collected from the boreholes. ‘N’ values are observed in the field and corrected for overburden pressure. Using GIS ‘N’ map is generated. Laboratory tests, namely field density, specific gravity, sieve analysis, atterberg limits (IS 1498, 1970) to find Plasticity Index (PI) of soil and direct shear test to find shear parameters (C and Ø values) are carried out using the disturbed samples collected.

Factor of Safety (FOS), inorder to check the stability of slopes and Safe Bearing Capacity (SBC) of soil to know the shearing capacity of soil, were determined based on shear strength of the soil. SBC and FOS maps are generated for the Nilgiri district using GIS. 75% of the district is found to fall in the moderate zone for both FOS and SBC. To validate the number of soil samples required to represent the characteristics of the soil, SBC values are used at 95% confidence level and 10% error. As a result, the normal distribution curve is obtained to envisage sufficient number of samples.

Intergrating all the parameters of landslides susceptibility for building construction, a tool has been developed named ‘NILAST’ (Nilgiri Land Suitability Tool) using Matlab. The village map, land use land cover map, LSZ map, FOS and SBC maps of the Nilgiri district are used for identification of suitable sites. The tool mainly focuses on safe construction of the residential building and retaining wall. The tool is validated with the reports of past landslides collected and are found to be 73% accurate.

The findings of the research work are concluded as follows

1. The quantitative methods AHP, SMCE, FA and ANN used in this research can be used to generate LSZ map for the Nilgiri district for the 11 parameters identified. Of all the four methods, ANN gives better result.

2. The generated LSZ map shows Udhagamandalam, and Gudalur blocks are highly susceptibile to landslides than the Coonoor and Kothagiri blocks.

3. The LSZ map generated shows major roads NH67 and SH15, and railway line from Burliyar to Udhagamandalam are highly susceptible to landslides.

4. From the SPT conducted at various locations of the Nilgiri district, the observed ‘N' values show that 90% of the Nilgiri district fall under low zone (‘N’ value between11-20).

5. The SBC map generated shows the Coonoor and Udhagamandalam blocks fall in low and very low bearing capacity zone.

6. The Coonoor, and Udhagamandalam blocks fall in unstable to quasi stable zone constituting 60% of the study area, based on FOS map generated using the shear strength of soil.

7. Land suitability tool NILAST developed for safe building construction at Nilgiri district shows out of 63 villages 17 villages are not-permitted for building construction.

This research work aims to help the local administrators, decision makers of Government and public in identifying lands suitable for safe building construction.