LANDSLIDE SLOPE STABILITY ANALYSIS FOR COONOOR REGION IN NILGIRI DISTRICT

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ABSTRACT

Deep weathering, residual material and short term high intensity rainfall are the main factors for instability in laterite hill slopes of humid tropical monsoon region. In recent years, they have gained more attention from both the administrators and public due to the increased frequency with which they occur and death toll they claim.

In relation to these issues, this paper reviews the most effective methods suitable to predict the triggering action of the phenomenon. Predicting landslide hazard on a regional scale, namely the assessment of actual and potential mass movement over large area is carried out using Remote Sensing and GIS. A numerical weight age to the causative factors of slope instability such as slope, drainage density, land use, are assigned as per earlier workers for the purpose of Landslide Hazard Zonation. The study reveals that the slope stability analysis is incomplete without systematic micro level geological and geotechnical mapping.

The area selected for the study is Western Ghats, which is a prominent orographic feature that runs parallel to the south west coast of India. The uniqueness of the terrain is contributed by lithology, climatic factors, vegetation, geomorphology and several man induced factors, in contrast to the stability problems of the sub Himalayan mountains. The comprehensive landslide susceptibility analysis in Nilgiris District of Tamilnadu State (scale 1:50000) identified that 17.30% comes under critical and highly unstable category. Slope instability problems along road cut laterite slopes is frequent and seem to compound when landslides involve multi-tier failures involving debris flow, rock fall, landslide directly hitting the highways , agriculture in adjoining valleys, culverts, bridges and

travelling public. Therefore limiting equilibrium analysis is used to find the Safety Factor of laterite slopes where favourable geological conditions exist. A high degree of match is found between observed and predicted.

INTRODUCTION

Humans have to face the impact of natural hazards from time immemorial. Natural hazards such as earthquakes, landslides, avalanches, floods, cyclones, droughts, and volcanic eruptions of varying magnitudes has frequently been the cause of calamities. According to statistics, natural hazards are believed to account for up to 4 % of the total annual deaths worldwide, besides causing enormous economic losses and uprooting habitation. It has also been observed that casualties resulting from natural hazards are not evenly distributed throughout the world, but are more concentrated in developing countries, partly due to their higher population densities and lack of preparedness. Landslides form a significant component of the natural disasters that affect most of the hilly regions round the globe. It can cause extensive damage to life and property in mountainous terrains during and after heavy rainfall. Steep terrain and high frequency of rainfall make landslide occurrence frequent on natural terrain.

"Landslide" is a general term to describe down-slope movement of soil, rock, and organic matter under the influence of gravity. In hilly regions like Nilgiris, Tamil nadu, India, landslides constitute one of the major hazards that cause losses to lives and property. Landslides in Nilgiris are dominantly influence by Rainfall, slope, Road cutting, Land use misuse and many other factors. A landslide is primarily the result of a shear failure along the boundary of the moving soil or rock mass. Water in fact has been implicated as the main controlling factor in most slides. Landslide is the downward movement of a part of a slope, debris or soil, along a sliding surface where shear failure occurs. Landslides and mass movements are phenomena that occur in the process of geomorphologic transformation. The main types of landslides are Falling, Subsiding, Sliding and Flowing. Although by definition the term landslide is used only for mass movements occurring along a well-defined sliding surface, it has been used as the most general term for all mass movements, including those that involve little or no sliding.

DATA PRODUCT UTILIZED

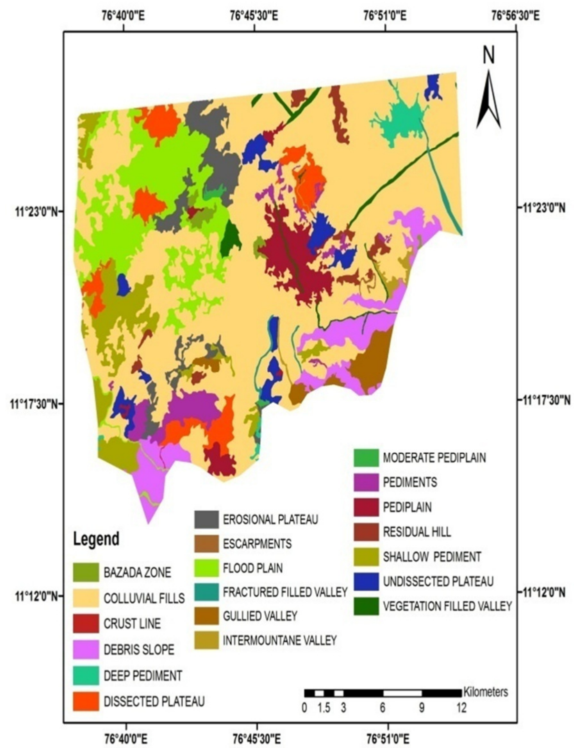
S.No	Data	Source
1	Base and Drainage map	Survey of India (SOI) toposheet on 1:50000
2	Geomorphology and Lineament	Satellite Imagery IRS-P6-LISS III-2009
3	Slope	SOI toposheet contour
4	Soil and Soil depth map	National Bureau of soil survey and land use planning, Nagpur and Department of Agriculture, Tamil nadu
5	Rainfall	State meteorological department
6	Land use/land cover	IRS-P6- LISS III (2009) satellite imagery
7	Geology map	Geological Survey of India, 1995
8	Previous Landslide occurrence	Point theme (GPS coordinates)

SCOPE

- Mapping and data preparation for Coonoor.
- Soil Sample collection from inventory of 5 landslides and Geotechnical Analysis in Soil laboratory
- Prediction modeling for Coonoor Area using following approaches

Slope Stability model using limit equilibrium method (Geo-slope Slope\W method)

GEOMORPHOLOGY MAP



Nilgiris district is a mountainous district of Tamil Nadu with many hill ranges and broad valleys with slopping towards plain. The prominent geomorphic units identified in the district through interpretation of satellite imagery are Crust line, debris slope, colluvial fills, gullied valley, vegetation filled valley, intermountain valley, bazada zone, escarpments, pediments, deep pediments, shallow pediments, undissected plateau, dissected plateau, erosional plateau, flood plain, pediplain, moderate pediplain, residual hill.

The Nilgiris hills rise abruptly from the plains (300 m above MSL) to an average elevation of 1370 m above MSL. Some of the prominent peaks are the Doddabetta (2634 m), the highest peak in TamilNadu, Kolari (2625 m), Mukurthi (2554 m), Kudikadu (2590 m), Devabetta (2552 m), the conical grass covered Bear hill (2531 m) and Nilgiris peak.

SLOPE STABILITY ANALYSIS THROUGH LIMIT EQUILIBRIUM METHOD

Geoslope slope\W adopts Modern limit equilibrium to deal with complex stratigraphy, highly irregular pore-water pressure condition, variety of linear and nonlinear shear strength models, virtually any kind of slip surface share, concentrated load and structural reinforcement. Analysis provides a factor of safety, defined as a ratio of available shear resistance to that required for equilibrium.

This approach includes the finite difference and finite element methods that discretize the whole mass to finite number of elements with the help of generated mesh. Currently the factor of safety is the most common criterion for slope design, and there is wide experience in its application to all types of geological conditions, for both soil and rock.

Furthermore, there are generally accepted factor of safety values for slopes excavated for different purposes, which promotes the preparation of reasonably consistent designs.

Laboratory investigation of Soil Sample that has been collected from site and deriving shear strength, soil density, Friction angle are critical source for Geoslope Slopw|W. The analysis of collected data and test results will serve to identify the deficiencies in slope stability for high embankment and suggest for overcoming the deficiencies. Geotechnical analysis were carried out for the soil samples collected from landslide sites to derive above said factors to substantiate the model provided by both Geoslope and SIN Map. Following details derived on geotechnical analysis.

Slope stability analysis for Aravangadu

Slope stabitily analysis for Kundha

Slope stability analysis for Oranalli

Slope stabiolity analysis for Thumbanatti

Slope stability analysis for Archanakal

RESULT AND DISCUSSION

The landslide hazards zonation factor weights scheme is a numerical system which depends on the relevant factor. Knowledge based Ranks and weights for terrain parameters assigned to thematic layers to generate a landslide hazard zonation map through GIS overlay analysis. The relevant factor for landslide hazards zonation mapping were included for land use/land cover, geomorphology, geology, soil, soil depth, slope, drainage density, lineament density and rainfall. The stability of an area depends on the combined effects of the factors indicated above. The maximum landslide hazards zonation factor weights for different categories are determined on the basis of their estimated significance in causing instability.

A landslide hazard zonation map indicates relatively vulnerable zones such as low, medium, high and very high for landslide occurrence. Several themes and their classes are chosen Rank and weights were assigned according to their potential to cause a landslide. The important factors responsible for the landslide areas were assigned numerical values (rank) on 1 to 4 scales in the order of priority. Weights were assigned to the layers of the factors on sum of 100, where higher weight indicates a greater susceptibility to landslide occurrence. The details of ranks and weights for themes and their classes are presented. The raster based LHZ model was developed and the results evaluated with this model and the final raster LHZ map.

CONCLUSION

- Identification of landslide hazard zone for coonoor region.
- This study has been carried out by collecting soil sample at 5 location from that region.
- Collected soil samples were tested and their results were applied at

bishop limit equilibrium method, which was used to calculate FOS.

- In Archanakkal zone we get FOS in less than 1, so we decided to provide retaining wall at the Archanakkal zone for the reducing landslide hazards.
- We have successfully completed by this project to design the retaining wall at Archanakkal zone.

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