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# LANDSLIDE SUCEPTIBILITY ANALYSIS OF KOTHAMANGALAM-MUNNAR HIGHWAY USING GEOINFOEMATICS

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## ABSTRACT

*Landslides occur in a large variety of forms depending on the type and speed of movements, the material involved and the triggering mechanism. The research area comprises an area of 77 km road stretch Kothamangalam-Munnar highway (NH49) of Kerala and it was situated at in two districts Idukki and Ernakulam. The present study tries to identify different landslide prone areas in Kothamangalam-Munnar highway (NH49) of Kerala by using Remote Sensing and GIS. In the present study raster based weightage method was carried out for the preparation of landslide susceptibility zonation map. For the study data utilized include survey of India Topographic maps, Indian Remote Sensing Satellite data and Rainfall data from the Indian Meteorological Department. In this study a set of 6 instability factors corresponding to the causative factors for the instability were prepared using remote sensing information and topographic sheets. Different thematic layers such as slope, aspect, elevation, drainage density, landuse and rainfall were created for the preparation of landslide susceptibility zonation map. The accuracy of landslide prediction map was verified by field investigation using GPS.*

***Key words: Landslide, Geographic Information System, Remote Sensing, Disaster, Prediction***

## INTRODUCTION

Natural disasters such as landslides, earthquakes, flood, drought, cyclone, volcanic eruptions, environmental degradation etc are of global phenomenon. Most of the countries are experiencing either one or more disasters at regular interval. International Decade for Natural Disaster

Reduction, of the UN resolution (1989) aims at minimizing the loss of life, damage to property and description of economic and social activities through concerted actions. Landslide is a common and major natural hazard, often triggered by rainfall. The term landslide is used to denote the movement of mass rock, debris or earth down a slope (Zezere, 2004). Many other scientists consider landslides as "a sudden, short-lived geomorphic events that involved the rapid-to-slow descent of soil or rock in slopping terrain". Mass movements occur whenever the downward pull of gravity overcomes resisting forces. Downward pull is related to material mass and slope gradient .When this pull or shearing stress exceeds frictional resistance movement occurs. Generally steeper slopes are more prone to failure (Lee, 2006).

Landslide events are associated with various physical factors and therefore almost all methods of landslide susceptibility mapping focus on: a) the determination of the physical factors which are directly or indirectly correlated with slope instability (instability factors); b) the selection of the rating-weighting system of all instability factors and of the classes of each one of them; c) the overall estimation of the relative role of causative factors in producing landslides; and d) the final susceptibility zoning by classifying the land surface according to different hazard degrees (Kumungo,1995; Rao,1994,).

The present study tries to identify different landslide prone area by using most modern technologies like GIS and remote sensing. The spatial data in GIS data predominantly generated from remote sensing through the import of images, also through the generation of topographic maps. In the present study a grid based Geographic Information System (GIS) is used to analyse the factors responsible for landslide. Geographical Information Systems (GIS) and Remote Sensing have become integral tools for the evaluation of natural hazard phenomena (Nagarajan *et al.,* 1998; Liu *et al.,* 2004). Moreover, GIS is an excellent and useful tool for the spatial analysis of a multi-dimensional phenomenon such as landslides and for the landslide susceptibility mapping (Vaughan *et al.,* 1985; Lan *et al.,* 2004).

**MATERIALS AND METHODS**

Geo informatics and Remote Sensing can play a role in the production of a landslide inventory map and in the generation of thematic maps related to landslide occurrences. Several previous works have showed the potential of remote-sensing data both in the extraction of causal factors which are linked to landslide occurrences and finding of landslide area. Also, reports associated with landslide studies utilizing GIS and probabilistic models have been published. The majority of the previously mentioned research has already been performed while using landslide inventory

map extracted from optical satellite images and aerial photographs. Basic qualitative procedures simply use landslide index to identify areas along with related geological as well as geomorphologic features which can be susceptible to landslides. In present study Landslide susceptibility zonation mapping has carried out by using Raster Based Weightage Method by using Arc GIS Software. For this study Collecting the toposheets of 1:50000, edit them using ArCGIS9.1. The data sources for the present study are the Survey of India toposheets, Geological map prepared by GSI (1:25000), soil map, field data and Remote Sensing Data. The Survey of India Toposheets (1:50000) provided the geomorphology , location map, elevation and road density of the area. The IRS P6 LISS-III 2007 Image was used to generate landuse pattern of the study area. The drainage network of the study area is derived from the topographic sheets. Moreover the Drainage density is also derived from streams using spatial analyst of ARC GIS The total study area is then classified into three drainage density zones, low (0 - 10000), medium (10001 - 20000) and high (20001 - 40000). Road density is also calculated using the same method. Rainfall data were collected from the near by meteorological station (monthly data) and interpolated by using geostatistical analyst.

Geomorphology is also derived from the toposheets. The study area is classified into six geomorphic classes. Landuse/landcover was prepared using IRS P6 LISS -III 2007 image by the visual interpretation. It is classified into five classes. Lineament density is also calculated using spatial analyst and is classified in to three, low (0 – 6000), medium (6001 – 9000), high (9001 - 12000).

The preparation of the landslide susceptibility maps assesses the landslide potential of any area. In the present study, they are generated by giving weightage to various parameters that influences the landslide. The method for the landslide assessment used in this study is weightage factor model. The weightings assigned to each terrain parameter to reflect its importance in the occurrence of landslide together with the rating for the individual classes, which denotes the degree of hazard represent.

Landslide influencing factors such as slope, landuse, geomorphology, lineament, relative relief, drainage density, rainfall are ranked and weighted according to their assumed or expected importance in causing mass movements. For application of the WeF model, numerical values were assigned to each of the susceptibility classes of each factor. A numerical weight is attributed for each instability factor and then an overall score (susceptibility index) is determined by the use of the following multiplicative model. Overall landslide susceptibility index (LSI) =

a1 * F1 + a2 * F2 + a3 * F3 + a4 * F4 + a5 * F5.Where a1, a2… a5 are the numerical weights and F1, F2… F5 are the instability factors as thematic layers that were taken into account to the landslide susceptibility mapping.

## RESULT AND DISCUSSION

In this study final Landslide Susceptibility Zonation Map shows that Kothamangalam, Iyyankavu and Nellimattom is comes under stable areas. Unukal, Thalakad, Neryamangalam, Aaram mile, Valara, Irumbupalam, Machiplav, Kumpanpara, Anaviratti is moderately stable and moderately unstable areas. Kallar vattayar, Karadipara, Pallivasal, Mincut Colony and Munnar are comes under the category highly unstable and critical regions. The areas come under in highly unstable and critical classes have steep slopes and highest elevation points compared to other places. The vegetation in that area is most covered by plantation especially by tea plantation. These are shallow rooted plants, they can hold the materials together, and in monsoon season the rainfall in this area is very high about 1200 mm average rainfall in this area. There is no heavy vegetation to block the runoff of water with the materials, because the area have an elevation is 1800 meters, and the density of the drainage is very high in this area. These runoff moves the materials in the earth crust that causes heavy mass movement n that area. The relationship between slopes and landslides show that slopes between 20° to 30° range has the highest probability of landslide occurrence with a frequency ratio 2.36. The aspect simply shows that the North-West and north facing slopes has the highest probability with greater frequency ratio of 1.66 and 1.58 respectively. The region with convex curvature is relatively more probable than with concave curvature. The relative relief indicates that region with relative relief ranging between 50 - 75 has the highest probability with frequency ratio of 2.23. The high drainage density regions show least probability of landslide while the low drainage density regions show high probability of landslides. Moreover the landslide probability is higher in the low drainage frequency areas. The distance from road indicates that less than 250 m from the road is more probable to landslide . The distance from streams indicates that higher the distance from the streams lower the probability of landslides.

## CONCLUSION

A better assessment of area could be arrived at by using a semi quantitative approach. The Geo spatial analysis by using raster calculator and raster based weightage method provides a general picture on stability scenario along the Kothamangalam – Munnar Road. The research area

encompasses an area of 77 km and it was situated at in two districts Idukki and Ernakulam. The present study tries to identify different landslide prone areas in Kothamangalam-Munnar highway (NH49) of Kerala by using Remote Sensing and GIS. Susceptibility zonation maps according to different degrees using GIS by considering instability factors are useful in identifying landslide prone areas. Landslide cause enormous loss of life and property every year in mountainous area, in such regions landslide susceptibility zonation is necessary with a view to delineate the disaster prone areas. Landslide susceptibility analysis is an analysis undergone to predict the landslide prone areas based on the previous landslide locations. Landslide susceptibility should be primary consideration in landuse planning. The international community has acknowledged the significance of geological hazards in landuse planning by naming 1990-2000 the decade for natural hazard reduction (Pachauri *et. al.*, 1998).The landslide susceptibility map immediately conveys areas of very high and high susceptibility, which warrant special consideration by landuse planners. These areas that have not been developed should be restricted to compatible landuses such as natural preserves, parks and hiking trails. These non invasive landuses do not exasperate landslide problems by loading slopes, removing vegetation, or undercutting slopes, any combination of which could catalyze mass wasting. Moreover, these landuses do not involve expensive buildings and related infrastructure, there by reducing financial losses in the event of a landslide.

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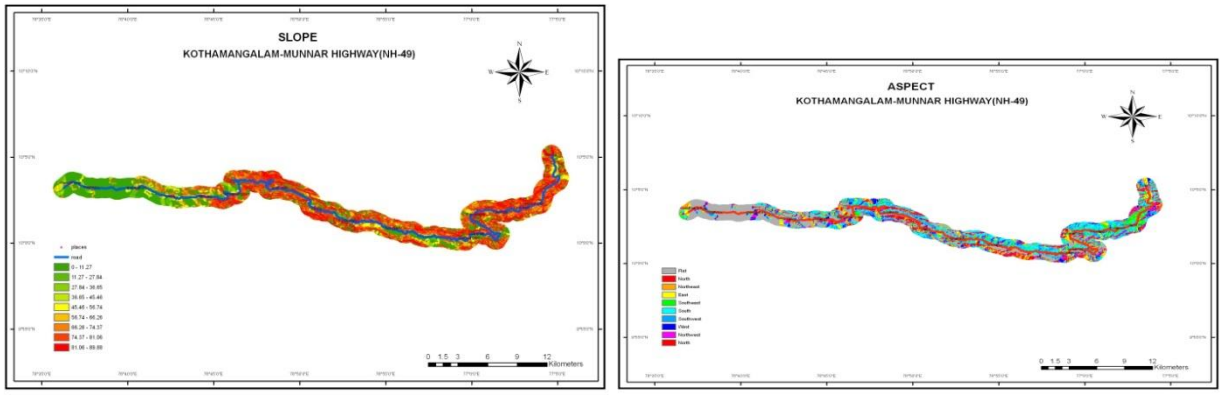
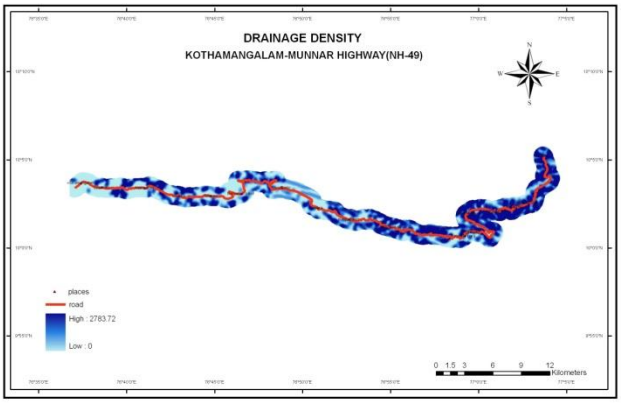
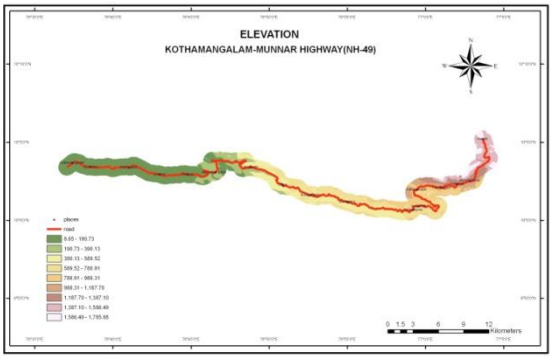
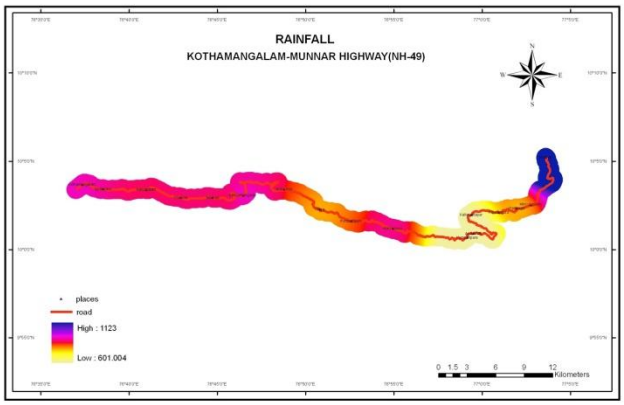
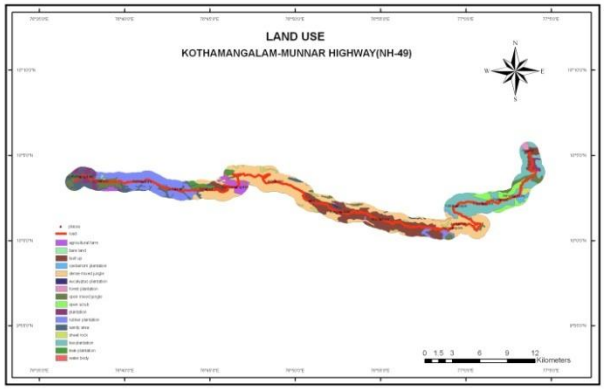
## Illustrative Figures

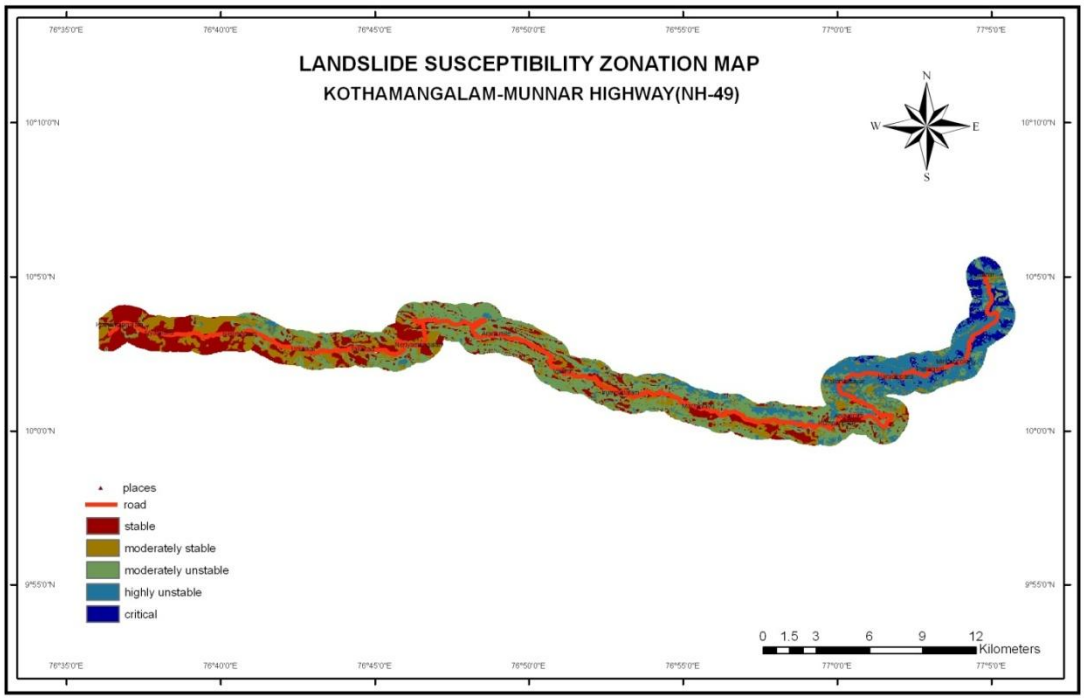



DRAINAGE DENSITY
KOTHAMANGALAM-MUNNAR HIGHWAY(NH-49)
places
road
High : 2783.72
Low : 0
Kilometers


ELEVATION
KOTHAMANGALAM-MUNNAR HIGHWAY(NH-49)
Kilometers


RAINFALL
KOTHAMANGALAM-MUNNAR HIGHWAY(NH-49)
places
road
High : 1123
Low : 601.004
Kilometers


LAND USE
KOTHAMANGALAM-MUNNAR HIGHWAY(NH-49)
Kilometers


LANDSLIDE SUSCEPTIBILITY ZONATION MAP
KOTHAMANGALAM-MUNNAR HIGHWAY(NH-49)
places
road
stable
moderately stable
moderately unstable
highly unstable
critical
Kilometers