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A STUDY ON FACTORS INFLUENCING LANDSLIDES IN NILGIRIS, TAMILNADU, INDIA

Kumar.N
Research Scholar, Department of Civil Engineering,
Karpagam Academy of Higher Education, Coimbatore, Tamilnadu, India

Dr.N.Balasundaram
Professor, Department of Civil Engineering,
Karpagam Academy of Higher Education, Coimbatore, Tamilnadu, India

Dr. T. Meenambal
Professor, Department of Civil Engineering,
Government College of Engineering, Coimbatore, Tamilnadu, India

ABSTRACT

Landslides are one of the most important and major natural hazards that mankind is facing all over the world. This phenomenon is very common in the hilly regions of the Nilgiris Dt, Tamilnadu. This paper tries to analyse various factors that influences landslides in this region. This initial study marks the first attempt to find a integrated solution to arrive a suitable landslide mitigation measure.

Key words: Factor, Landslide, Nilgiris, Kattery, Rainfall, Watershed.

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1. INTRODUCTION

The landslide phenomenon is very common in the hilly terrains all over the world. In India the occurrence of landslides is an annual and recurring event in the various hill and mountain ranges. The Nilgiris district in Tamilnadu is particularly very vulnerable to landslides as it receives heavy rainfall from both South West and North East monsoons. Although it falls under seismic zone the major natural disasters that occurred from 1865 to 2009 have been landslides and floods. This has made a significant negative impact on the environment (fauna and flora) and human settlements in this region.

Landslides are very complex occurrences involving multiple factors both natural and manmade. High intensity rainfall, steep slopes, soil thickness are the natural causes. Urban developments and deforestation are man-made causes. As this district is a tourist centre, with a myriad of infrastructure developments it has faced damages of high magnitude due to slides. The landslips in this district have resulted in heavy loss to human life, livestock, damage to communication systems and agriculture.

2. DISTRICT PROFILE

2.1. Location

- The Nilgiris is situated at an elevation of 1000 to 2600 meters above MSL. Its latitudinal and longitudinal dimensions being 130 KM (Latitude: 11 ^{0} 12'' N to 11 ^{0} 37'' N) by 185 KM (Longitude: 76 ^{0} 30'' E to 76 ^{0} 55'' E).
- The Nilgiris is bounded on North by Chamranagar District of Karnataka State on the West by Wayanad, Malapuram and Paklakad Districts of Kerala State, South by Coimbatore District and Kerala State and as the East by Coimbatore District and Erode District.
- In Nilgiris District the topography is rolling and steep. About 60% of the cultivable land falls under the slopes ranging from 16 to 35%

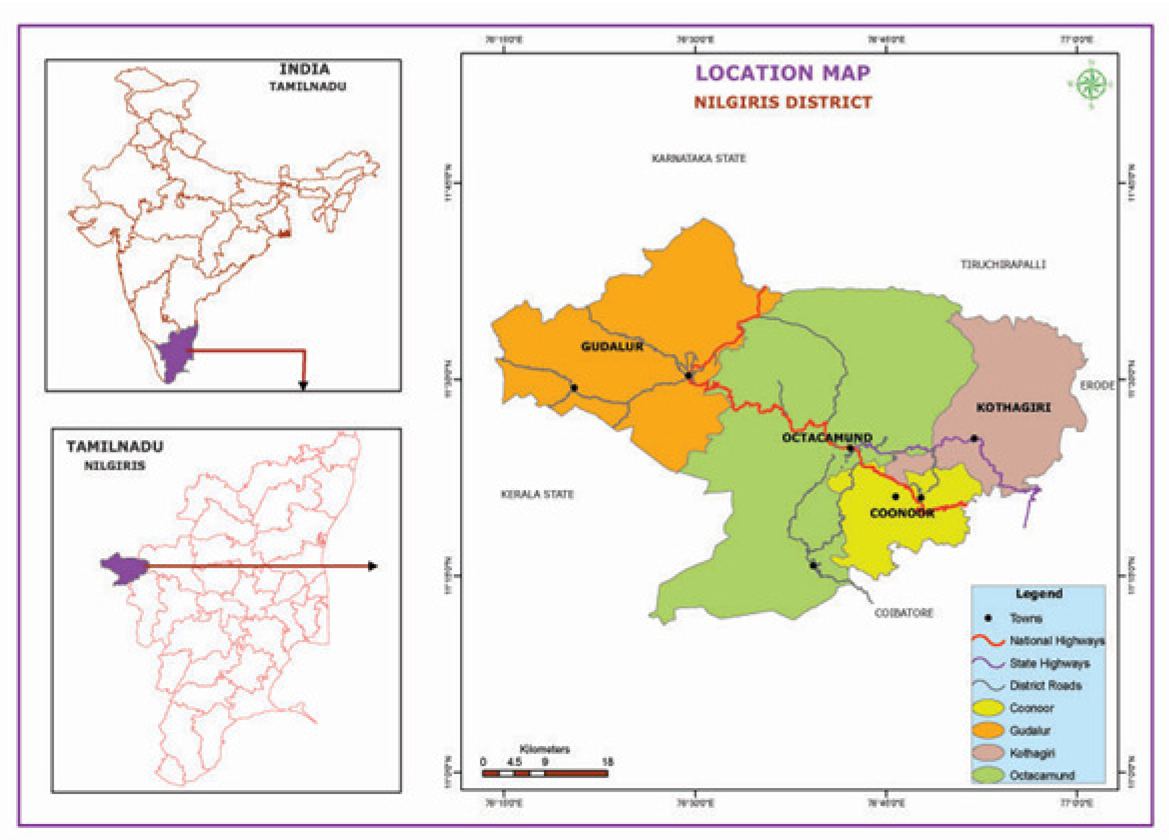

Figure 1 District Profile

In order to make precise study about the landslide influencing factors watershed based studies is taken up. Although there are 75 watersheds in the Nilgiris district, Kattery, Watershed is chosen for the study. This watershed lies in the Nilgiri Hills of the western ghats ranges.

3. AREA OF STUDY

The area taken up for study is the Kattery watershed (The Nilgiris District) situated on the Coonoor - Ooty highway with an area of 2000 hectares. It lies in the Ketty valley at an elevation of 2100mt MSL, global position latitude 11° 22" 01' N longitude 76° 44" 32' E

This Ketty valley is one of the biggest in South India and supports both annual and perennial crops. The watershed drains into the Kattery reservoir.

Kattery watershed is the apt choice of study because it has all factors related to the study. It has various agricultural practices, human inhabitation, communication systems (road & rail), large spectrum of land terrains, high intensity rainfall from both SW and NE monsoons, and finally draining into the kattery resevoir. This resevoir caters to the needs of the ordinance factory (cordite) at Aruvankadu.

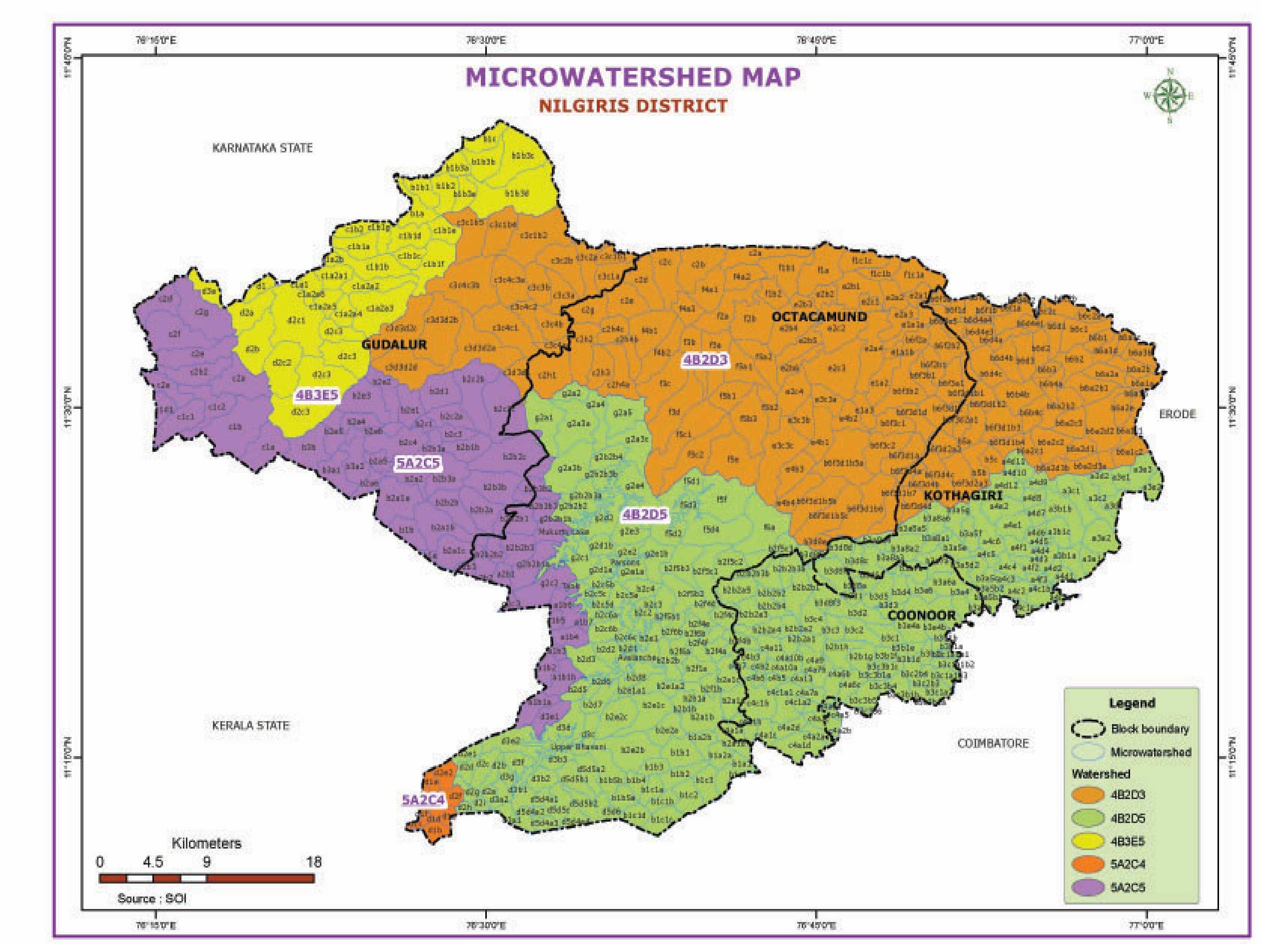

Figure 2 Nilgiris District Map

4. REVIEW OF THE PREVIOUS STUDY

4.1. Landslide Hazard Zonation by Gopal Sharma

In this study, a detailed GPR survey is carried out in conjunction with remote sensing techniques to prepare Landslide Hazard Zonation map of Katteri watershed in the Nilgiris-Tamil Nadu, India.

Thematic maps prepared for slope, Lineament density, Drainage density, Land cover/Land use, Aspect, lithomarge thickness and Geomorphology using LANDSAT, TM and ETM imagery, topographic map of l: 50,000 scale, and various other factors were analyzed in the GIS environment.

Slope - Slope is an important factor in the analysis of landslide. As the slope increases the probability of the occurrence of landslide increases because the shear stress of the soil increases.

Land use pattern - Changes in vegetation cover and cropping pattern often contribute to landslides (Glade, 2003). From various studies, it is learnt that land use pattern of thick afforestion area and deep root helps to stabilise the slopes. The areas with thick vegetation were less prone to sliding with reference to the area with mild or no vegetation. (Gokceoglu and Aksoy, 1996).

Drainage - Drainage plays a vital role in weathering and hence in turn to landslide, the coarse drainage locations are more prone than that of finer drainage i.e, more the drainage density, less is the area susceptible to landslide.

Lineament - Lineaments are the rectilinear, linear or curvilinear features of tectonic origin observed in satellite data. The landslide susceptibility is more in area of high lineament density and intersection.

Aspect - It has been analysed that in north facing slopes the landslide occurrence is comparatively low, with reference to the south facing slopes. The landslide phenomena gradually increases from north to south and then declines. (Dai and Lee, 2002).

Thickness of Lithomarge - One of the most important factors responsible for the occurrence of landslide is the thickness of the weathered overburden lying at a slope greater than angle of repose. Ground penetrating radar survey is used in present study to evaluate the thickness of these materials which are likely to slide.

Geomorphology - The area consists mainly of Charnockite, hypersthene bearing bluish grey rock.

5. MAJOR LANDSLIDES IN THE DISTRICT AND KATTERY WATERSHED

Table 1 Major Landslides in the District and Kattery Watershed

Sl. No.	Year	Nature of disaster	Reasons for disaster
1.	October 1865	Floods in Udagamandalam	Heavy Rainfall
2.	November 1891	Landslips on highway	Heavy Rainfall
3.	December 1902	Major Lanslides – blocking Coonoor railways and roads	Heavy Rainfall upto 24 inches in this month
4.	October 1905	Heavy floods in Coonoor	Rainfall upto 6.8 inches in 3 hrs.
5.	November 1978	Heavy floods, landslides, drawing etc. at Ooty	Heavy rainfall upto 323 mm of which 248mm was within 15 hrs.
6.	November 1979	Landslides and flash floods at Ketti (Kattery watershed) and Selas	Heavy rainfall upto 187.6mm per day
7.	October 1990	Major landslide at Geddai	Cloud burst with heavy rain

Sl. No.	Year	Nature of disaster	Reasons for disaster
8.	November 1993	Major landslides on Coonoor – Mettupalayam highway near Marappalam – cutting off Road and Rail transport	Cloud burst
9.	December 1998	Rock detachment upto 20 tones disrupting traffic on Coonoor – Mettupalayam Highway	Continuous Rainfall
10.	December 2001	Massive landslides on Coonoor Mettupalayam highway damaging bridges	Continuous Rainfall
11.	November 2006	Numerous landslides disrupting rail and road transport	Continuous heavy Rainfall
12.	November 2009	Series of Landslides damaging 1890 nos of houses (Achanakal)	Heavy rainfall

6. KATTERI LANDSLIDES

Katteri landslide has an axis trend of NE-SW, a length of 95 m, and slope angle of 15° 52'. There are two Geoelectrical resistivity imaging survey carried out in this area. In the first profile, the depth of pseudo-section varies from 1620 to 1638 m .The top layer constitute lithomargic clay with resistivity ranges from 51.2 to 196 Ωm up to a depth of 12 m. The intermediate layer is weathered charnockite with resistivity ranges from 196 to 1476 Ωm. The bottom layer of the pseudo-section is compact garnetiferous charnockite with resistivity ranges from 1476 to 5664 Ωm. The pseudo-section displays the thick overlying section of lateritic soil with pockets of lithomargic clay deposits.

7. RAINFALL DETAILS

Table 2 Rainfall Details

S. No	Year	South West Monsoon Jun to Sep		North East Monsoon Oct. to Dec.		Winter Season Jan. to Feb.		Hot weather Season Mar. to May	
		Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual
1	1995	1022.2	950.6	494.1	338.2	62.5	38.6	278.1	186.9
2	1996	1022.2	882.9	494.1	523	62.5	73.2	278.1	223.2
3	1997	1022.2	866.7	494.1	530.2	62.5	31.1	278.1	134.9
4	1998	1022.2	1042.6	494.1	679.4	62.5	32.6	278.1	146.5
5	1999	1022.2	610	494.1	645.9	62.5	33.9	278.1	199.9
6	2000	1022.2	928.5	494.1	386.4	62.5	46.2	278.1	207
7	2001	1022.2	799.1	494.1	385.3	62.5	14.0	278.1	287.9
8	2002	1022.2	602.9	494.1	236.7	62.5	16.2	278.1	192.6
9	2003	1060	577	367.7	471.3	62.5	20.4	278.1	203
10	2004	1060	943.7	367.7	564.8	30.8	49.2	237.2	427.9
11	2005	1060	1032.5	367.7	557.2	30.8	23.2	237.2	307.7
12	2006	1060	653.9	367.7	656.1	30.8	23.8	237.2	324.7
13	2007	1060	1142.6	367.7	515.5	30.8	35.9	237.2	178.8

S. No	Year	South West Monsoon Jun to Sep		North East Monsoon Oct. to Dec.		Winter Season Jan. to Feb.		Hot weather Season Mar. to May	
		Normal	Actual	Normal	Actual	Normal	Actual	Normal	Actual
14	2008	1060	1067.9	367.7	516.3	30.8	193.6	237.2	438.8
15	2009	1060	1265.2	367.7	893	30.8	1.7	237.2	286.5
16	2010	1060	1211.7	367.7	609.9	30.8	20.1	237.2	190.3
17	2011	759.9	915.4	478.2	509.9	49.3	67	235.3	288
18	2012	759.9	861.5	478.2	452.2	49.3	18.6	235.3	246
19	2013	759.9	841.6	478.2	375.8	49.3	17.8	235.3	246
20	2014	759.9	1031.91	478.2	685.57	49.3	27.08	235.3	269.89
21	2015	759.9	641.59	478.2	460.57	49.3	0	235.3	499.97
22	2016	759.9	538.44	478.2	65.23	49.3	499.97	235.3	103.08

8. RAINFALL DETAILS

8.1. Rainfall Details for last 10 years

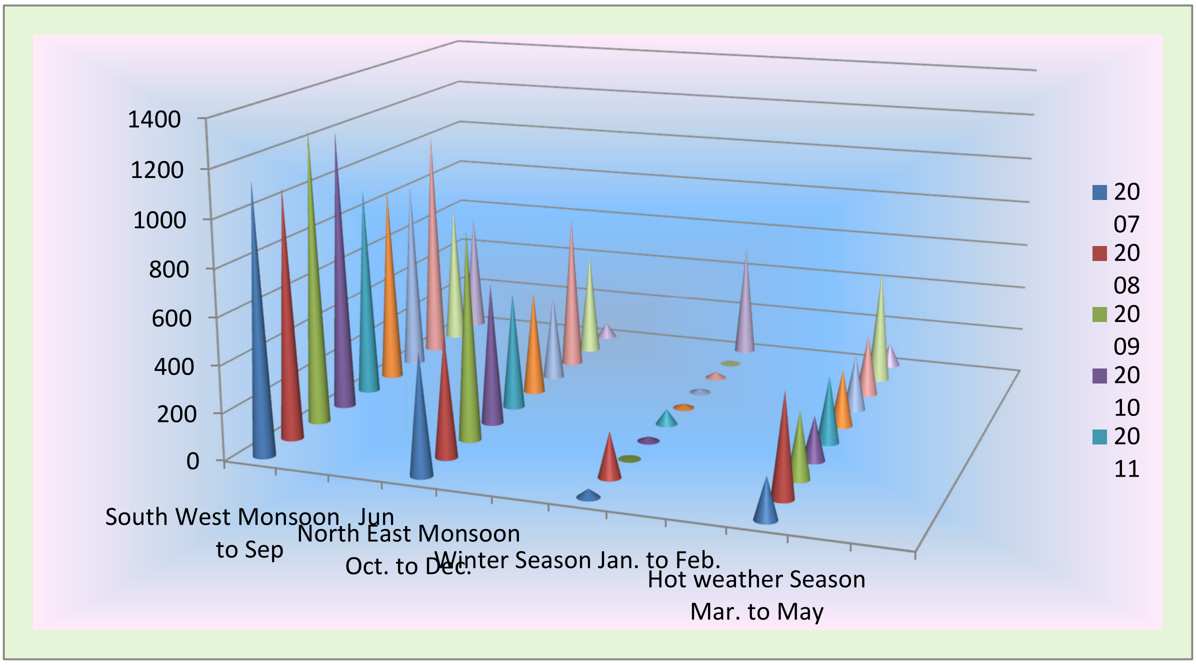

Figure 3 Rainfall Details for last 10 years

9. OBJECTIVE

The objective of this initial study is to ascertained the main factors, which induce landslides. Therefore to arrive at a more suitable mitigation and monition methodology.

10. METHODOLOGY ADOPTED

The watershed area was delineated from the cadestal maps and digitized. With the availability of datas from previous studies and datas from remote sensing satellites regarding land use, geomorphology, lithology, slope, soil, drainage pattern and rainfall related to the watershed the studied.

Various previous landslides and the reasons for their occurrence was evaluated. A detailed field visit was done in the watershed to access the previous landslides and the mitigation methods carried out.

11. CONCLUSION

- The major factors contributing to the natural disasters such as landslides and floods in Nilgiris are rainfall induced landslides.
- Land use pattern, changes in vegetative cover and cropping pattern as contributed to soil erosion and landslides.
- Areas with dense vegetation is less prone to landslides.
- More the drainage density less is the area susceptible to landslide.
- The area with very high slope is sound to be highly susceptible for landslides.

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