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Need and Urgency of Landslide Risk Planning for Nilgiri District, Tamil Nadu State, India

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ABSTRACT

Landslide is one of the major natural hazards that are commonly experienced in hilly terrains all over the world. Landslides are affect at least 15 per cent of the land area of India—an area which exceeds 0.49 million km2. In India the incidence of landslides in Himalayas and other hill ranges is an annual and recurring phenomenon. There is a variation in the degree of landslide incidences in various hill ranges. For example, the landslide incidences are high to very high in Himalayas, high in Northeastern hill ranges, high to moderate in Western Ghats & Nilgiris and low in the hill ranges of Eastern Ghats & Vindhyas. The landslide hazard zonation atlas of India published by Building Materials and Technology Promotion Council (BMTPC), Government of India reveals that the Nilgiris district of Tamil Nadu state is one of the severe to very high landslide hazard prone areas of India.

Unprecedented rains triggered about a hundred landslides within an area of 250sq.kms in the district during 1978. Nearly 200 landslides were recorded during 1979 and causing loss of life and severe damage to property. Though the Nilgiri and other mountainous areas are known to be susceptible to landslides, occurrences of such magnitude were unknown earlier. A total of 28 landslides of medium to large size occurred on 14 November, 2006 along NH-67 between Kallar and Pudukkadu villages and along Mountain Railway track between Adderley and Barliyar stations. In the recent times casualities and damage due to landslides have increased in the Nilgiri Hills. More than 110 landslides were reported within five days from 10 to 15 November, 2009, and taken away about 80 human lives, also the vast damage reported on houses, roads and railway lines. This taught the lesson for the need and urgency of landslide planning in Nlgiris among the scientific community and planners.

Key Words: Landslide, Slope failure, Hazard zonation, Landslide planning and Risk mapping,

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1.0 Introduction

In order to reduce the enormous destructive potential of landslides and to minimise the consequential losses, it is necessary that the hazard must first be recognised, the risk analysed and an appropriate strategy developed at the national level to mitigate its impact (NDMA, 2009). Increasing demands from different sections of society as well as the need to bring into the main stream the isolated communities in the remote hill areas, have resulted in an increase of all types of construction activities in these areas. In order to maintain the tempo of developmental activities and mitigate losses due to landslides, there is need for developing appropriate framework for landslide hazard management.

Hazard zonation map comprises of a map demarcating the stretches or areas of varying degrees of anticipated slope stability or instability. The map has an inbuilt element of forecasting and is hence of probabilistic nature. Depending upon the methodology adopted and the comprehensiveness of the input data used, a landslide hazard zonation map be able to provide the aspects of location of occurrence time of occurrence -type of landslide extent of the slope area likely to be affected and rate of mass-movement of the slope mass (Rajarathnam and Ganapathy, 2006).

Landslide hazard is one of the most significant hazards that affect different parts of India every year during the rainy season. It has been observed that 21 States and Union Territory of Pudducherry, located in hilly tracts of Himalayas, N.E. India, Nilgiris, Eastern Ghats, and Western Ghats, are affected by this hazard every year and suffer heavy losses in terms of life, infrastructure and property (Sharda,Y.P, 2008). Though the Nilgiri and other mountainous areas are known to be susceptible to landslides, occurrences of such magnitude were unknown earlier (Thanavelu and Chandrasekaran, 2008).

Most of the topographic maps of hilly terrain of Nilgiris which are used as base maps for carrying out various studies including landslide investigation and mapping are available in small scale of 1:50,000 and a very few in 1:25,000. Small scale maps typically represent extensive areas, but they offer only a gross perspective on details. The potential for accuracy drops as the area mapped grows larger and the scale grows smaller. Such scaled maps are not suitable for in-depth and accurate landslide investigations and instrumented monitoring. A large-scale map, which shows a limited amount of space and provides a considerable amount of detailed information about that space can only be used for detailed landslide investigations, mapping and monitoring.

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The present paper provide information that leads to the reduction of losses from landslides and increase public safety through improved understanding of landslide hazards--requires developing the information, scientific understanding and capabilities needed to issue accurate warnings, advisories, or notifications of landslide hazards

2.0 Materials and Methods

Nilgiri is hilly district with an area of 2500 sq. kms and is situated in the northwestern part of Tamil Nadu state. It is bordered by the states of Karnataka in the north, Kerala in the west and south and by the districts Erode and Coimbatore of Tamil Nadu in the north east respectively. Ootacamund (udagamandalam) is the district head quarters (Figure 1). The total population of the district is 762141 as per the Census 2001.

2.1 Geology

The charnockite group of rocks with the enclaves of Satyamangalam Schist Complex exposes in the Nilgiri district. This group represented by chamcokite and pyroxene granulite and covers a major part of the district in the southern part, which is popularly known as "Nilgiri Massif". The Bhavani Group (Peninsular Gneissic complex) comprises fissile hornblende biotite gneiss and occurs in the northern part of the district. The Satyamangalam Schist Complex is represented by quartz-sericite / mica schist, ultramafics and banded magnetite quartzite. The Nilgiri Massif is capped by aluminous laterite at a number of places indicating the deep zone of weathering (GSI, 2000).

Most of the parts of the district rocks are deeply weathered and the soil thickness is found to be upto 40m with lithomarge is a common feature in the district. The low gradient of slope in Ootacamund, promotes stagnation of surface water as bogs and swamps (GSI, 2000).

2.2 Geomorphology

The Nilgiri hills rise abruptly from the surrounding plains to an elevation of 1370m amsl and it is surrounded by the Coimbatore plains in the southeast, Bhavani plains in the northeast, Moyar valley in the north and Gudalur Plateau in the northwest. The prominent hills are Ooty hills, Dodabetta, Kodaibetta, Bhavani Betta and Devabetta. Dodabetta is the highest peak in Tamil Nadu (GSI, 2000). Moyar is a prominent river in the district and flows in an easterly direction,

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along the northern boundary of the district. The drainage is dendritic to radial at places with prominent rapids, cascades and water falls.

Figure 1. Map showing the location of the study area in the Landslide Hazard Zonation Map of India

The erosional surfaces such as Dodabetta, Ootacamund, Coonoor and Moyar are recorded in the district. All these erosional surfaces are capped by residual laterite. All Dodabetta surface includes landform such as high peaks, structural hills, rocky escarpments with or without soil cover around which prominent radial drainage is developed. The Ootacamund and Coonoor surfaces include gentle mounds, with soil cover, stream meanderings and gentle smoothening of the hills. The latter abuts against the former at many places, with break in slope.

2.3 Rainfall

The District usually receives rain both during South West Monsoon and North East Monsoon. The entire Gudalur Pandalaur and Kundah taluks and portion of Udhagamandalam Taluk receive rain by the South West Monsoon and some portion of Udhagamandalam Taluk and the entire Coonoor and Kotagiri taluks are benefited by the rain of North East Monsoon. There are 16

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rainfall Registering stations in the district. The normal average rainfall in this region varies from place to place and is somewhere between 1500 mm – 3000 mm.

2.4 Risk Based Approach

The risk-based approach recognises that a different planning approach is needed for an area that has not been developed and for an area that has been developed or subdivided, or where there exists an expectation to build. Each local authority will need to determine the definition of a greenfield site for their own city/ district. The three stages (Risk Analysis, risk Evaluation, risk Treatment) for the Risk based planning approach is suitable for the Nilgiris district where the landslide hazard is Very high to Severe.

2.4.1 Spatial Distribution and Severity of Landslides

The spatial distribution of landslides in Nilgiri district is presented in the Figure 2.

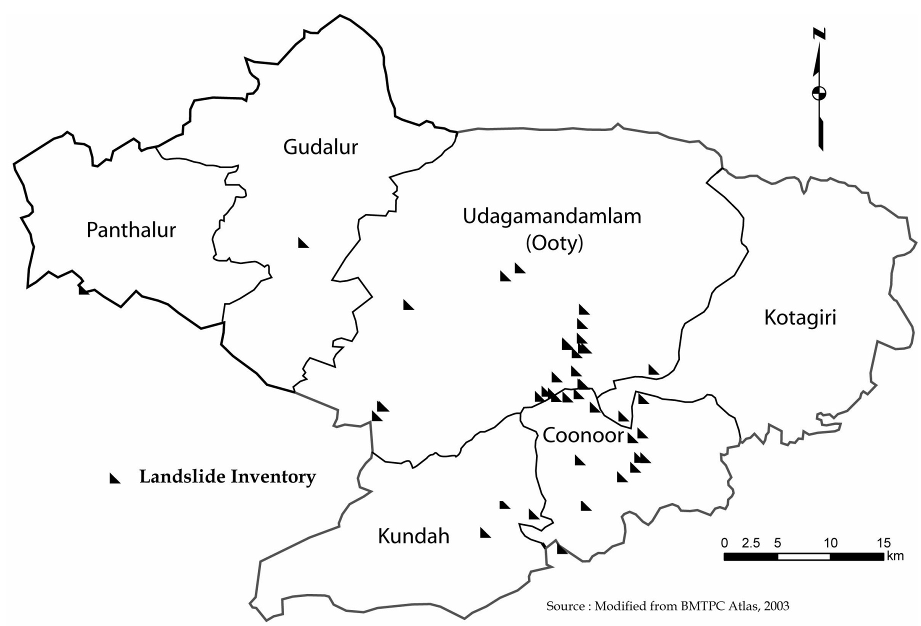

Figure 2. Landslide Inventory map of map of Nilgiris

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2.4.2 Some of the major Landslides of Nilgiris

23rd October 1865: Worst Storm on record occurred around Ooty and Coonoor. Coonoor Railway station was covered with water up to five feet deep. In Ooty Lake rose up to top of willow bound and threatened to breach it.

November 1891: Storm caused many landslips on the Coonoor Ghat, and did great damage to the Kotagiri - Metuppalayam road.

December 1902: Twenty one inches of rain (three times the average amount) fell in that month in Coonoor, and at Kotagiri 24 inches (six times the average amount) was received, of which 8.45 inches fell in a single night. The Coonoor railway was blocked for a month the old and new Coonoor railway was blocked for a month the old and new Coonoor ghat roads for nearly as long; and all the traffic of the eastern side of the plateau was thrown upon the Kotagiri ghat, which was itself in a perilous condition -slips having occurred throughout and being serious in six places out of its twenty one miles length.

4th October 1905: 6.8 inches of rain fell at Coonoor in three hours and the Coonoor river and its effluents came down in heavy and sudden floods, the former sweeping right over the parapet of the bridge near the railway-station. The families of the station staff had to be rescued by breaking open the back windows of their quarters with crowbars.

5th November 1978: 323mm of rain was recorded at Ooty of which 243 MM was during the night-between 5.00 pm of 4th and 8.00 am of 5th. Many people were killed in Ooty on account of houses collapses, landslides and drowning. Reports were also received regarding the causalities due to landslides and floods in Kookalthorai; Madithorai; Adashola and Kallatti areas of Uthagamandalam Taluk and Manthada of Coonoor Taluk.

November 1979: Heavy rainfall started from 12th November 1979 and the highest rain fall was 114.5mm at Kodanad. On 13th it was 149.4mm at Coonoor and 169.9mm at Kodanad. On the 15th night heavy landslide had occurred at Doddacombai, on 16th night there was heavy rain at Coonoor resulting in washing away of one woman and 2 Children. The rainfall recorded at Coonoor and Kodanad was 145.2 mm and 142.2 mm respectively. On 19th there was heavy landslide of 100 yards in width and about 1.00 km in length in Selas of Ketti Village of Coonoor Taluk resulting in filling up of a Valley of 30’ - 50'. The heaviest rainfall of the day was 187.6mm at Coonoor. On 20.11.1979 also, there was heavy rain of 102.2mm at Coonoor and a

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heavy landslide at Selas in which a house was completely buried in the debris along with 2 women and 3 children. The rainfall recorded on that day at Kotagiri, Kodanad and Kundah was 90.4 mm, 99.8 mm and 78.0 mm respectively. There was heavy rainfall of 71.0 mm at Devala on 21st. On 28.11.79 also there was heavy rain of 144.2 mm at Coonoor.

25th October 1990: The North East Monsoon was heavy and there was a 'cloud burst'. More than 35 families were buried alive in a place called Geddai.

November 1993: There was another 'cloud burst' on 11-11-1993 in the upper reach of Marappalam of Coonoor Taluk, about 18 huts situated below the road and washing away Coonoor MTP ghat Road for about 1 ½ k.m. The Road traffic was suspended for more than a fort night. 12 persons lost their live and 15 persons missing. It is laid that 21 passengers were washed away with two buses. An important highway, sheared stretched of rail road for about 300 m.

11th December 1998: Due to continuous rain fall, one big boulder weighing about 20m tonnes fell an the Coonoor Mettupalayam main road and the road was closed for traffic, the rock was blasted and earth slips were removed and traffic was resumed from 14-12-98.

December 2001: Due to continuous rainfall, two massive land slides occurred near pudukadu on the Coonoor-Mettupalayam high way damaging two bridges resulting in the complete closure of traffic. In addition a closer damage was also caused to the railway track between Coonoor - Mettupalayam. Bridge no 55 near hill grove railway station was completely damaged and Bridge No 56 was also damaged.

November 2006: Consequent upon continuous heavy rains in the Nilgiri Hills, numerous landslides were reported to have occurred at the early hours on 14.11.2006 killing one and injuring three persons and disrupting traffic in NH - 67 and blocking of Mountain Rail track between Mettupalayam and Coonoor (nilgiris.nic.in).

2.5 Damage caused by November 2009 Landslides

Heavy rains triggered a series of landslides in Ooty, Coonoor and Kotagiri regions of the Niligiris, killing 42 people within 48 hours. Most of the people were killed after the landslides slammed into their houses. Seven of a family died at Acchanakal hamlet near Ooty. The slides and uprooted trees also cut off access to Nilgiris via Mettupalayam. The approach road to Ooty

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from Tamil Nadu via Mettupalayam has been severely damaged. After 1978, this is the biggest rain-related disaster in the district. However, smaller landslides and fallen trees are also blocking parts of the road. Houses and communication infrastructure came down, and roads and rail lines fell apart. The extent of damage caused to infrastructure is without precedent.

About 1890 houses fully or partially damaged due to the landside and the total estimated losses are worth about Rs.300 crore by a government report (The Hindu, 2009).

3.0 Macro-Landslide Hazard Zonation

The earliest landslide studies in the country were carried out by the GSI. This includes the study of the Nainital landslide by Sir R.D. Oldham in 1880 and C.S. Middlemiss in 1890, and the study of the Gohana landslide in 1893 in the erstwhile Uttar Pradesh Himalayan region that resulted in the formation of a 350m high landslide dam across the Birehiganga (Bhandari R.K , 2006). The first attempt on National level Landslide Hazard zonation was made by Krishnaswamy in 1980. The first attempt on regional zonation of northeast India was made by Majumdar in 1980. The next major attempt on regional zonation was jointly made by GSI and State Geology Mines in the year 1982 for the Nilgiri Hills. The Building Materials Technology Promotion Council of the Government of India published small scale landslide hazard map of India in 1:6 million scale. The Landslide Hazard Zonation Map of India presented in the Landslide Atlas 2003 is based on a systematic study of the literature, the information available on intensity and spatial distribution of landslides, preparation and processing of thematic maps in small scale 1:6 million on a GIS platform. The maps produced in the Atlas have limitations. This atlas gives a regional picture on the different hazard category in Nilgiris. The author of this atlas is advised to the reader that the small scale landslide hazard maps only provide a mega view of landslide hazard distribution across our country. For projection of the most probable landslide damage scenarios, landslide hazard maps need to be produced preferably at a scale of 1:10,000 or 1:25,000. Only then the development planners, architects and engineers are able to do reliable risk analyses in real life situations. For large scale hazard maps to be produced there is need for large scale base maps, preferably the digital version. (Bhandari, R.K, 2003).

A detailed macro zonation map for the part of Nilgiri district was produced by D.N. Seshagiri et al (1982). Thanavelu and Chandrasekeran (2008) suggested it is necessary to carry out a comprehensive meso/micro zonation studies applying the methods in vogue for the entire stretch of the slope from Kallar to Coonoor areas. Jaiswal and Van Westen (2009), conducted a study

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on Probabilistic landslide initiation hazard assessment along a transportation corridor in the Nilgiri.

The scale of landslide hazard zonation mapping depends upon the nature of study requirements, availability of base map and resources. The earlier works has brought out the usefulness of the small scale mapping to various users and also emphasise the requirement of systematic large scale landslide hazard mapping to get more reliable information for risk assessment or implementation of suitable mitigation measures.

4.0 Need for Landslide Risk Maps

Strengthening of buildings and infrastructure should lead to reduction in Vulnerability. The vulnerability of buildings as well as infrastructure in a landslide however is most in cases nearly 100 percent, regardless of the quality of construction. Hence the vulnerability of the structures cannot be reduced. This option therefore is not highly relevant to landslide prone areas (UNDRO, 1991).

The planning principles of a landslide riak studies are: 1) gather accurate hazard information; 2) plan to avoid hazards before development and subdivision occurs; 3) take a risk-based approach in areas likely to be developed or subdivided; and 4) communicate the risk of hazards (Andrew Leventhal & Geoff Withycombe , 2009 and Wendy Saunders& Phil Glassey , 2009).

Landslide Hazard and Risk Mapping (LHRM) is multivariate and complex problem in mountainous environment. Landslide Hazard mapping has been significantly developed over past decades but framework for risk mapping are rarely available (Sharma V.K). The process of landslide risk estimation integrates the hazard levels with specific element or set of elements at risk. He considered three sets of elements viz, Risk to life (Grade-1), Social risk such as lifeline features (Grade-2) and Infrastructure like road, bridges etc. (Grade-3). Sine this is a qualitative approach the out put map will be greatly helpful to the regional users, Community users and as well as the private users.

The Risk map will answer the questions of a) which areas of the district are, or are likely to be under pressure for development, b) what infrastructure already exists near a landslide hazard (buildings, network utilities etc.) and the value of that infrastructure; c) what level of risk the community is prepared to accept or not accept (in practice, it is easier to define what the community will not accept using community reactions to past events as a guide); d)

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consideration of the feasibility (effectiveness versus cost) of possible engineering solutions or other risk reducing mitigation works.

5.0 Discussions and Conclusions

Before the losses from landslides can be reduced, the hazard must first be recognised and the risk assessed appropriately. A landslide hazard assessment, which is commonly in the form of a map, provides people with a practical and cost-effective way to recognise areas where landslides exist or could occur.

So far landslide hazard zonation mapping for the study area has been attempted for the district only based on Landslide Susceptibility Index (LSI) considering factors like lithology, slope angle, distance from major thrust/faults, land use pattern and drainage density in relation to frequency of existing landslides. These approaches are qualitative and some of then are quantification. Risk analysis involves assessing the hazard as well as considering the consequences if people and property are affected by these hazards. This paper provided an overview of the risk management processes on landslides.

The district is categorized under Severe to Very High landslide hazard prone areas. This indicates the area is well known for the danger of landslides, and for the perennial threat to life and property. Restriction on all new constructions and adoption of improved land use and management practices deserve to be encouraged. Investments on landslide remediation measures, on public education and on early warning systems are strongly indicated.

One of the most difficult problems concerning landslide hazards in place like Nilgiris is dealing with existing urban areas where buildings are constructed on or close to a landslide. The ideal approach in this situation is to avoid further development in high-risk landslide prone areas, limit existing-use rights to rebuild, and limit the use of buildings. The most realistic approach is to avoid further development and use of buildings (building type) is consistent with the level of risk posed and the district plan maps clearly show landslide hazard zones.

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6.0 References

1. Andrew Leventhal and Geoff Withycombe (2009), Landslide risk management for Australia, The Australian Journal of Emergency Management, Vol. 24 No. 1, February 2009.
2. Bhandari R.K. (2006), The Indian Landslide Scenario, Strategic Issues and Action Points, (A Key Note address – Technical Session on Landslides) First India Disaster Management Congress, New Delhi, 29-30 November 2006.
3. BMTPC (2003), Landslide Hazard Zonation Atlas of India, Published by Building Materials and technology Promotion Council, Government of India and Anna University, Chennai , p.125.
4. GSI (2000), District Resource Map Series: Nilgiri District Tamil Nadu, published by Geological Survey of India-xplanatory Note.
5. http://nilgiris.nic.in/disaster.htm
6. Jaiswal, P and Van Westen C.J (2009), Probabilistic landslide initiation hazard assessment along a transportation corridor in the Nilgiri area, India, Geophysical Research Abstracts, Vol. 11, EGU2009-2854, 2009, EGU General Assesmbly 2009.
7. Krishnaswamy, V.S (1980), Geological aspects of landslides with particular reference to Himalayan region, Proceedings International Symposium on Landslides in India, Volume 2.
8. Mazumdar, N (1980), Distribution and intensity of landslide process in North eastern India, Proceedings International Symposium on Landslides, New Delhi, Voilume I.
9. NDMA (2009), National Disaster Management Guidelines: Management of Landslides And Snow Avalanches, National Disaster Management Authority, Government of India, June 2009.
10. Rajarathnam S and Ganapathy G.P. (2006). Landslide Hazard Zonation of India, a GIS Approach, Proceedings of the First India Disaster Management Congress, New Delhi, 29-30 November 2006.
11. Seshagiri, D.N., Badrinarayanan, S., Upendran, R., Lakshmikantham, C.B. and Srinivasan, V. (1982). The Nilgiris landslide - Miscellaneous publication no. 57. Geological Survey of India.

Research Article ISSN 0976 – 4380

12. Sharda, Y.P (2008), Landslide studies in India, Glimpses of Geoscience Research In India, The Indian report to IUGS 2004-2008. Indian National Science Academy, Silver jublie Volume, pp 98 -101.

13. Sharma, V.K. (2008), Landslide hazard and risk mapping procedures: case study from parts of Ravi catchment, Himachal Pradesh, Journal of Engineering Geology, Vol. XXXV, Nos. 1-4, pp291-302.

14. Thanavelu C and Chandrasekaran, (2008), Geotechnical Assessment of November 2006 landslides in the Nilgiris Tamil Nadu, Abstract Volume: Proceedings of the National Seminar on Challenges in Engineering Geology, 03rd to 05th December 2008, Hyderabad.

15. The Hindhu (2009), Scale of damage in Nilgiris huge, relief work apace, http://www.thehindu.com/2009/11/12/stories/2009111258110100.htm

16. UNDRO (1991), Mitigating Natural Disasters, Phenomena, Effects and Options, A manual for Policy Makers and Planners, A publication within the framework of the International Decade for Natural Disaster Reduction (IDNDR), 1990 -1999, New York, 1991

17. Wendy Saunders and Phil Glassey (2009), Taking a risk-based approach for landslide planning: An outline of the New Zealand landslide guidelines, The Australian Journal of Emergency Management, Vol. 24 No. 1, February 2009