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REVIEW OF LANDSLIDE: A SPECIAL ATTENTION TO WESTERN GHAT OF MAHARASHTRA

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Abstract-In this paper discussed worldwide landslide (Mass Movement) and its effects on the environment are considered, special attention is given to the landslide of Konkan region particularly the ghat section (Western Ghats) of Maharashtra. Photographs of different types of landslides of Konkan region of Maharashtra are correlated with the different types of mass movements and suggestions are given to mitigate the effect of landslides.

Index Terms-*Landslides(Mass Movements), Western Ghat, Mitigate, Sahyadri Mountain, Springs, logging.*

1. INTRODUCTION:

This paper includes worldwide landslides. A mass movement process in which rock or sediments move down slopes. It affects on the environment. Landslides a amazing yet deadly element of nature, triggered by the rains of springs and winter, and the destruction of trees and hill slides. Logging, erosion, development and precipitation are some of the causes of landslides. Landslide occurs in the many parts of the country, but this study focus on the landslides in the Konkan region particularly the western Ghat of Maharashtra. Most landslides are single events, more than one third part of the cases are associated with the heavy rains. It also includes creep; slump and sheet slide, debris avalanches, earth flow and rock fall. In this study, the suggestions are discussed to mitigate (preventive measures) the effect of landslides.

1. STUDY AREA:

The Western Ghats of Maharashtra constitutes the ranges of the Sahyadrimountain. The Sahyadri ranges trend almost north-south and parallel to the west coast of India along with the entire western border of Maharashtra. The average elevation change ranges between 1000 to 1300 meters. The western ghat are broader about 15 kilometers in the north and narrower to about 30 kilometer southwards. It is now here flat, being cut up by many east-west trending ridges. Some of which reach right to the coast. The region is also traversed by several short rivers, with a steep gradient, which have their origin in the sahayadri. There are some small and narrow plateaus at different elevations in this region at places covered by Laterite. The Sahyadri form main watershed of the rivers of peninsular India. The major area of Maharashtra is covered by basaltic rock, which is called as Deccan trap. The Deccan trap form between 60 to 68 million years ago, at the end of the Cretaceous period. The bulk of volcanic eruption occurred at western Ghat. The Deccan trap is formed due to the fissure type of volcanic eruption. Konkan region is a large landslide prone area in the Maharashtra. Most roads and railway tracks of Konkan region are connected to the megacities of Maharashtra i.e. Gujarat, Karnataka and Goa. The road blockage problems occurred due to landslides. The Konkan region famous for

mango, Kaju and Kokum and coconut business.Because of road blockage due to landslides affecting on this business as well as tourism.

1.1. CAUSES OF MASS MOVEMENTS:

Landslides occur when the stability of the slopes changes from stable to unstable conditions. Natural causes of landslides are 1. Ground water (pore water) 2.Pressure acting to destabilize the slopes 3.Loss or obscene of vegetation structure, soil nutrients and structure (After wildfire) 4.Erosion of the toe of a slope by the river or ocean waves. 5. The weakness of a slope through saturation by snow melt, glaciers melting or heavy rains. 6. Earthquakes adding loads to barely stable slopes 7. The earthquake caused liquefactions destabilizing slopes 8. Volcanic eruptions 9. Landslides are aggravated by human activities 10. Human causes include deforestations, cultivation, construction which destabilizes the usually fragile slope. 11. Vibrations from machinery or traffics 12.Blasting 13.Earthwork, which impose new loads on existing slopes 14. In shallow soils the removal of deep-rooted vegetation that binds colluviums to bed rocks. 15. Construction, agricultural or forestry activities (loggings) which change amount of water, which infiltrate the soil.

1.2. TYPES OF MASS MOVEMENTS:

Creep: The most persistent of all mass movements, creep is an imperceptibly slow movement of quasi-viscous soil and rock materials. The movement is of the order of few mm or centimeter per year and brings about permanent deformation without developing discrete failure planes. In the shallower part of the sloping ground, exceedingly slow movement takes place on minute slip planes, but the real deformation occurs at grain boundaries and within the structure of clay material where, respectively interstitial and absorbed water play a contributing role by reducing the friction. In this manner, the clay friction is converted into slimy material, which serves lubricants.

1. **Slum and Sheet slide:** The event of shearing stresses and the driving forces becoming strong failure takes place along discreet plains called sleep or shear surface. If the surface of the failure is planed, the resulting movement is called sheet slides, and when broadly concave the phenomenon is described as slumping. The movement of the slumped mass is rotational without causing much impairment of solid blocks even though the modification of the landscape may be considerable as witnessed along roads and mines. The sheet slides usually 3 meters deep, affects extensive areas extending as they do even up the slope.
2. **Debris Avalanches:** The rapid movement of shallow non-cohesive or loose material down a steep slope following heavy rainfall is called debris avalanches. The debris masses from fans and cones at the foot of the slope while the scars left behind are often spoon shaped depressions. If a large amount of water is able to soak the moving material. The viscosity is considerably lowered, resulting in the debris flow spreading far and wide, In the lower part of the slope. The water soaks debris flows as a torrent, eroding and scouring the channel deeply.
3. **Earth Flow:** as a result of heavy rainfall, water soaked finer loose material lying along the upper part of a slope flows down towards the slope foot and forms fan. The fluctuations of water content within the soil are primarily responsible for these kind of mass movement of mud, clay and silt. Mud flow is commonly witnessed in the Siwalik terrain and along the western Ghat of India. A special type of earth flow is seen in the high glacial area result from thawing of ice that fills the intergranular space within clays. As the ice melts, the whole mass becomes waterlogged and unstable, leading eventually to down slope flow is called solifluction. Solifluction is in the fact, downhill creep or flow of any mass (usually regolith) involved creep, frost heave and collapse. It produces earth-banked and stone-banked lobes and terraces above the upper timberline.
4. **Rock Fall:** Abrupt and extremely fast movement of loosened rocks and pieces of jointed or fractured rocks from cliffs and steep slopes is called rock fall.

The Hydrostatic pressure of the water that finds its way into joints and fissures. The widening effect of freezing of water and the tree roots are responsible for dislodging blocks and

pieces which hurtle down the precipitous slope and bounce or richochet.

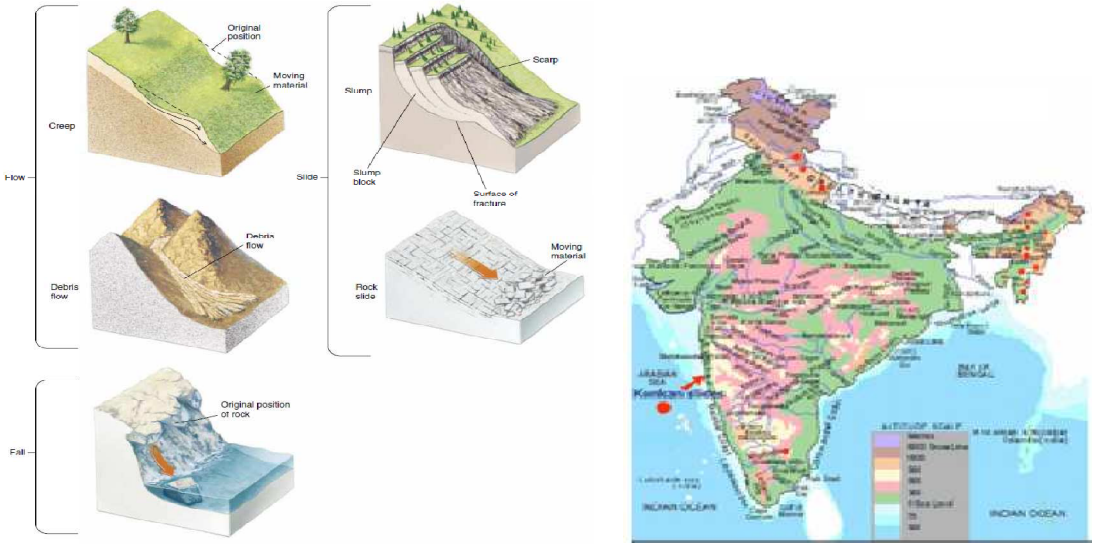

Fig. A. Creep, Slum slide and Sheet Slide, Debris Flow, Rock fall are the five categories of mass wasting in western Ghat of Maharashtra.

MAJOR LANDSLIDES IN INDIA

Date/ Year	**District/ State**	**Remarks**
10 May 2005	Itanagar, Arunachal Pradesh	Nine people were killed and loss of property resulted.
June 2005	Nogli, H.P.	Severe damage was caused to 70 to 80 meters of the road due to heavy rain flash floods.
June 2005	Rampur, H.P.	The junction of the HPSEB Rest House road and NH-22 near the Chuhabagh area of Rampur town was affected due to a landslide resulting from rainfall.
29-30 June 2005	Govindgaht, Chamoli, Uttarakhand	A cloudburst/landslide occurred in which huge quantities of debris and rock boulders were brought down along a seasonal Nala. 11 people were killed and property lost.
July 2005	Mumbai, Maharashtra	Caused death and loss of property in Mumbai. 4 dead on the Belapurkharghar road. 14 deaths at Nerul, and 100 deaths at sakinaka.
Aug. 2005	Ratnagiri District. Maharashtra	Places affected were Mandangad, Chiplun,andSangameshwartalukas. Destabilization of slopes affecting man-made features.
13 Nov. 2006	The Nilgiris, Coimbatore, T.N.	Between Burltar and Mettupalayam on NH-67, the road was washed off due to landslide.
Sept. 2006	Doda, Jammu & Kashmir	Between Ramsu and Batolte, there were many minor slope failures and landslides due to heavy rains.
7th Aug. 2006	Betul, M.P.	At km 837/22 of the Betu_Itarasi section of the central railway, rock slide occurred 5 km north of

		the Maramjhiri railway station, bringing down 100 M^3 of rock material. These resulted in the blockage of rail traffic.
7th Aug. 2006	Araku valley, Prderu, Andhra Pradesh	Massive landslide occurred in Vishakhapattanam district A.P., at several places. 18 lives were lost and damage was caused to 10 to 15 dwelling units.
7th Aug.2006	Dharla Village, Himachal Pradesh	A landslide led to the burial of entire villages. 14 houses and one primary health center
		were buried under the debris/ 60 lives were lost.
6th Sept. 2007	Village Baram/Sialdhar, Dharchula, Pithorgarh district, Uttarakhand	A landslide due to excessive rainfall resulted in 15 fatalities and loss of livestock.
14th Sept. 2008	Parampure District, Arunachal Pradesh	17 people were killed in a series of landslides preceded by heavy rainfall.

Photograph (C) Railway Bridge Collapse in Konkan Region

Photograph (D)Retaining wall collapse on railway track in konkan region

Photograph (E) landslide-on-way-to-gangotri-.preview

2. **Mitigation and Preventive measures of landslides:-**It is very difficult to prevent landslide and in fact, it is not healthy for an environment to do so, but with good

engineering techniques, it is possible to reduce the effects of hazards.

1. Some slopes, however, cannot be stabilized and development of these areas should be avoided if at all possible.
2. It has been estimated that the benefit to cost the ratio of preventing landslide ranges from 10-2000, meaning that every dollar spent in preventing landslides will save $10 to $2000. If no landslides presentational measures are taken.
3. There are three primary considerations involved if we are to minimize environmental and societal damage: Geological, structural and policy.

- **Geological:-** One of the most important and first steps to take in order to minimize landslide hazards is to identify where potential landslide can occur. This can be done by examining the geological conditions that contribute the mass wasting as well as taking Ariel photographs to identify previous slides.

1. **Land Assessment :-** To determine what areas are prone to landslides.
   a. Take Ariel photographs to look for areas of little vegetation. This is indicative of mass wasting because after being destroyed by a landslide, the growth of vegetation is slow to resume. The growth of blackberry bushes is, in fact, indicative of disturbed soil, so it is likely that a landslide, even a small one, occurred in that area in the past.
   b. Next, an investigation in the field:- Is it a steep slope? Does the slope consist loose sediments such as sand or gravel? Is development in the making the slope more bearable to erosion? Is it a wet climate?
2. **Maps:-** Produce slope stability map showing how prone various areas to landslide.
   Inventory:- Make a Landslide inventory, recording where past landslide has occurred.

- **Structural:-**After a landslide-prone area is identified the next step is identified, the next step is to minimize the damage. This can be done using setbacks and common engineering techniques regarding drainage control, unstable slope material, vegetation and shoreline armoring.

Drainage Control System

(Konkan, Maharashtra)

Stabilize slope material by polyethylene cover

(Konkan, Maharashtra)

Retaining Wall Smeshing Techniques

- Except natural slope processes to continue, so set houses and building back to from the edges bluffs to safeguard against landslide.
- **Drainage:-** Drainage control is fairly effective in reducing landslide risk seen slides can often be triggered, but the intense amount of rainfall, a drainage system can prevent to much storm water from infiltrating and saturating the ground, this can be achieved above the surface, by installing drains the perform the same functions as gutters that remove water from the roofs of houses, or by covering slopes with an impermeable layer such as soul-cement or plastic. Drains that divert water away from unstable slopes, drain control improvement can be one of the most cost efficient means of reducing the probability of landslide.
- **Stabilize slope material: -** The first option is avoiding steep slopes altogether. Grading a slope, however, can increase slope stability if carefully done. Material from the upper part of a slope can be removed and emplaced lower on the slope, thereby reducing the steepness of the slope. Another option is to cut the slope into the series of the steps which incorporate and efficient drainage system. Also applying erosion mats, plastic sheeting or other erosion control material where vegetation will not take hold may help.
- **Vegetation:-** Vegetation reduces soil erosion and increase slope stability by providing different types of root systems which can help strengthen and building the soil together, carefully selected plants can also intercepts precipitation before its hits the ground, their by reducing runoff or excessive infiltration.
- **Shoreline armoring:-** Many property owners around the Puget sound decide to use bulk heads and sea walls are to reduce the erosion, such as to, from wave action and provide support at the base of the slope. These walls can be constructed from materials like rock, timber, concrete or other materials, and drains wholes must be incorporated to reduce the chance of water building up behind the wall.
- **Retaining wall:-** A solid, well designed retaining should be made of sturdy material such as masonry, brick, stone or steel. Drainage material behind the wall help increase the stability of the wall.
- **Diverting Debris Pathways:-** The building pathway to debris is another option to prevent landslide on your property. You can create these pathways with the help of retaining walls. However, if you build walls to divert debris flow and then that flow lands on a neighbor's property, you can be liable for damage.
- **Policy:** - In order to standardize the building allowed on steep slopes and the ways of stabilization, various policies put into place.
- Building codes- These prevent developers from using unsafe structural materials.
- Tax break program- Shoreline property owners have options for preserving and protecting their homes and property.

- Shoreline management act (SMA)- One of primary goals of these act is to prevent the inherent harm in an uncoordinated and piecemeal development of the states shoreline.
- National landslide hazard program (NLHP)- The main object of NLHP to reduce the long term losses caused by improving our understanding of the causes behind slope failure and suggesting possible strategies of mitigation.

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