THE LANDSLIDE THREATS IN MAHARASHTRA: LESSONS TO BE LEARNT FROM THE MALIN LANDSLIDE

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Abstract: Malin is a small, insignificant village in Ambegaon Taluka of Pune district, Maharashtra located at an elevation of 619 metres above mean sea level, 19°9'40" N latitude and 73°41'18" E longitude. It came into light on 30th July, 2014 due to a landslide which occurred in the early morning hours which was believed to be caused by a burst of heavy rainfall and killed at least 151 residents of the village. The landslide was first noticed by a bus driver who drove by the area and saw the village had been overrun by mud and earth.

The environmental destruction that resulted in the massive landslide is believed to have many causes. Deforestation has been cited as the foremost cause. The location of Malin is on the eastern slope of a North-South trending hill and the slope can be divided into roughly four zones between 10° to 40° gradient. Forests have been traditionally known to stabilize hill slopes by holding the soil together and increasing the infiltration while cutting down the run-off of water. The Malin landslide is typically a mudflow where debris overridden with rainwater flows downhill under influence of gravity and is associated with heavy rainfall. The immediate cause of the landslide was also attributed to a low pressure trough which had developed over the Arabian sea and had caused continuous heavy rainfall for more than 24 hours before the actual event. Deforestation along with faulty agricultural practices destabilized the slope and the rainwater infiltrated to a crucial depth where the top soil layer moved under the influence of gravity. The traditional rice cultivation allowed the water to flow downhill without obstructions. But recently wheat cultivation is started which required terracing and levelling of the slopes. Therefore, the water accumulated on the slopes and infiltrated to a depth to which it caused the slope to destabilize. The construction of Dimbhe dam has also been considered to be the cause of slope instability. Stone quarrying in the region for construction activity has exposed the deeper rock beds to weathering and mass wasting. The landslide of Malin has many lessons for the future wherein such incidences can be avoided with proper planning, slope management techniques and rainfall monitoring.

Key words: Landslides, Mudflows, Slope instability, Mass wasting, Deforestation, Slope management techniques.

Introduction: Malin is a village in Ambegaon Taluka of Pune district, Maharashtra. Located at an elevation of 619 metres above mean sea level, 19°9'40" N latitude and 73°41'18" E longitude, it was practically unknown to the rest of the state till the dawn of 30th July 2014. In the early morning hours, a massive landslide buried the whole village with its residents asleep under massive debris of mud, gravel and stone.

This Landslide was declared as a National Disaster as it claimed roughly 155 lives. The National Disaster Response Force with 400 personnel, a team of trained nurses and doctors reached immediately. But continuous rains, narrow roads and debris of the mud flow made rescue operations difficult.

The Geological Survey of India undertook a survey of the region from 2nd August 2014. Dr Thigale, Satish an expert in landslide mapping and zonation has ascertained that the primary cause might have been heavy rainfall. But the major cause has been changing the slope morphology for agricultural practices and deforestation.

Objectives: The main objective of the present research paper is to study the immediate and long term causes of the landslide of Malin and to establish a connection between human interference in natural and traditional forms of development and destruction of habitats and disasters. Maharashtra has seen many instances of landslide, though, none as massive as Malin. This paper explores the probable causes and lessons that can be learnt from the same in order to avoid such a major incident from occurring again and causing immense destruction to human life and property.

Database and Methodology: The data is collected from various sources which includes both published and unpublished books and published articles. Research papers have been quoted for topographical references. The research is mainly based on literature study and analysis is carried out with the data available through articles, research papers and online journals.

Discussion: Malin is located on the eastern slope of a north-south hill. The topography of Malin is broadly uniform. The region is drained by the River Ghod and its tributaries. There are two low magnitude seismic activities recorded within the 100 km radius of Malin. The basic rock structure in the area is basalt subject to severe leaching due to heavy rainfall. Hence the area is covered mainly by lateritic rock and soils. Being a tropical region, the summers are harsh and the high temperature cause rock damage, soil erosion and cracks develop in the hillsides. Rainwater seeps through these cracks and causes subsurface flows which further erode the rock from inside.

Pinom Ering, Ramesh Kulkarni et al have studied the slopes post the landslide and found that the slope gradients can be classified in four zones.
Zone I: from the Nala bed to the road level
Zone II: From the road level to the 2nd slope break
Zone III: From the 2nd major slope break to the 3rd slope break
Zone IV: From the 3rd major slope break to the plateau incline.

Table: Slope angles at different slope zones along sections AA' and BB'

Section	Ist Zone		IInd Zone		IIIrd Zone		IVth Zone		
A-A'	20°		10°	25°	30°		18°	25°	50°
B-B'	10°	28°	10°	25°	30°	20°	25°	30°	40°

Table Source: Pinom Ering, Kulkarni et al

On the previous day of the landslide ie on 29th July, a low pressure trough developed over the Arabian Sea and caused incessant rains in the entire western Maharashtra which also covered Malin. There is no rain gauge in the immediate vicinity on Malin but the Junnar rain gauge recorder 10.8 cm rainfall on 29th July which continued even on 30th July 2014. The heavy rainfall causes the top soil layer to be saturated and also generates a subsurface flow which provides a frictionless medium for the top layer to move downhill as a mudflow. The heavy rainfall was proven to be the single, major immediate cause of the landslide.

But, geologists and experts have opined that the major cause has been the tampering of the slope for faulty agricultural practices and deforestation. The cropping pattern in this region has been traditionally rice and finger-millets. Rice is a kharif crop and requires lot of water. Finger millets are usually Rabi crops which grow with very little water which is available in the sub-surface soils. But, in the recent past, the farmers started growing wheat in this region which is a Rabi crop and requires flat land. The slopes were hence terraced and left fallow during the rainy season. That allowed for the water to accumulate on the terraces and seep into the lower layers, saturating the entire top surface with water. When a thin film of water was created in the subsurface, the mudflow occurred under gravity.

Deforestation also has been found as another important cause for slope destabilization. Forests hold on to the soils and increase percolation of water to deeper layers, thus draining the top layers and avoiding saturation. The trees also stabilize the slopes. Deforestation under the pretext of development and stone quarrying has destroyed many hillslopes in Maharashtra. Stone quarrying was also rampant in this region. The stone quarrying creates massive cracks in the rocks and crevices which increase the rate of rock weathering and mass wasting.

The Dimbhe dam is also being constructed in the region which is said to have caused slope destabilization. But direct impacts have not been proven except for the stone quarrying for the construction purposes which caused water to accumulate in the cracks and widen them further causing mass weathering.

Conclusions: Landslides are a natural phenomenon and associated with slopes. But the human activities have increased the risk of landslides in different parts of the state. The state of Maharashtra is characterized by the undulating topography of the Western Ghats comprising the Sahyadri, Mahadeo hills, Ajanta hills and their offshoots. It receives heavy orographic rainfall between the months of June to September which is characterized by a few rainy days intermittent with long dry spells. The rate of weathering is high due to high temperature and high annual rainfall.

Any activity of humans like faulty agriculture, deforestation, stone quarrying, etc., leads to slope destabilization and may lead to more such severe events and cause massive destruction of human life and property besides being damaging to natural habitats in the region affected by the disaster.

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