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Landslide Susceptibility Zonation Study and Mapping on NH66 from Mahad to Mangoan Using QGIS

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Abstract—A landslide can be detetermined as the evolution of a mass of rock, debris or earth down a slope. As analysis of stability of slope is utmost importance because of vacillation of the entire soil mass and which may lead to fatality and great economic prejudice. Slope stability survey may help in future undesirable incidences and distruption in a large and important projects of civil engineering such as dams, highways and tunnels etc. Now a day there are various alternate methods used by engineers to develop land slide zonation maps for slope stability analysis, some of them are quite meticulous and while some are extravagant. Here the aim of project is to prepare land slide susceptibility zonation map of NH -66 from Mahad to Mangaon (27km) using Qgis.

Keywords— landslide, vacillation, slope stability, meticulous, QGIS,

I. INTRODUCTION.

A landslide can be defined as the movement of mass of rock, debris,or earth down a slope. Landslide can have several causes, including geological, morphological, physical and human but only one trigger include intense rainfall, rapid snowmelt, waterlevel change, volcanic eruption and earthquick shaking Also, other kinds of phenomena like pyroclastic grain crushing, due to suction variation, may include landslides in volcanic area. In addition, landslides represents one of the primary and serious risk factor in mountainous area where human impact is high, so potential landslide-prone risk map includes zonation showing temporal probability(likelihood) of a lindslide occuring throughout an area. On the contrary, the basic concept for landslide susceptibility involves the spatial distribution of landslide prone area without any temporal implication. Tools for handling and analysing of spatial data may ease the application of quantitative techniques in landslide hazard assessment and mapping. The increasing use of GIS techniques since has led to the developement of methods that could address these problems.

AIM:

To identify and locate landslide hazard zonation and mapping in the stretch of NH- 66 from Mahad to Mangoan.

OBJECTIVE:

To identify and prepare the map of landslide prone area of the stretch of NH66 from Mahad to Mangoan. Due to the high intensity of rainfall, this stretch is prone to landslide, causing significant damage to the road and daily routine of the people. Most of the landslide or the mass moment is occured due to the heavy rainfall and cutting along the road side.

II. STUDY AREA.

A) Description Of Study Area:

The study area of the project is Mangaon to Mahad highway via NH66 highway which is situated in Raigad district of Maharashtra. Mahad is located in India at the longitude of $73^0$42’00” and latitude of $18^0$08’00”. Mangaon is located at longitude of $73^0$28’00” and latitude of $18^0$24’00”. Total driving distance from Mangaon to Mahad is 27 km and 516 meters. Time required for travelling is 27 minutes.

B) Physiography:

Figure 1: Location of study area.

The highway spot which is located in Raigad has three physiographic regions that are:

1) Coastal zone
2) Central zone consisting of fertile land
3) Hilly areas in eastern part covered with forest.

This hilly range is characterised by roughness and unevenness in topography with line of peaks. . The Sahyadri (Western Ghats) hills are present in the east and several transverse numbers of subsidiary hills are in westwards direction. The western part of district consists of basalt and some of laterite. However there are recent deposits found comprising of beach sand and alluvium along cost and river mouth.

The district can be divided into 6 parts :

1) Sahyadri Hills.
2) Konkan Forested Hills.
3) Sudhagad Plateau.
4) Ulhas Basin.
5) Kal- Savitri Valley.
6) Raigad Coast

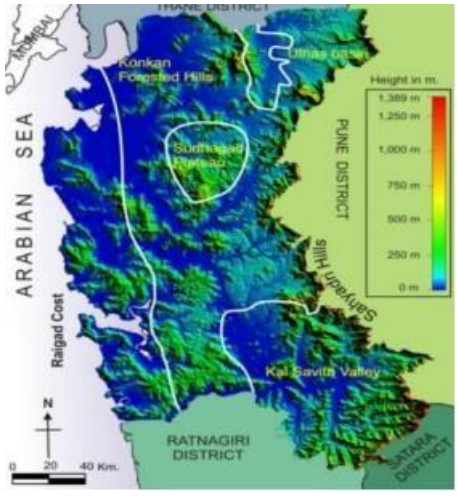

Figure 2. Physiographic Map of Raigad District.

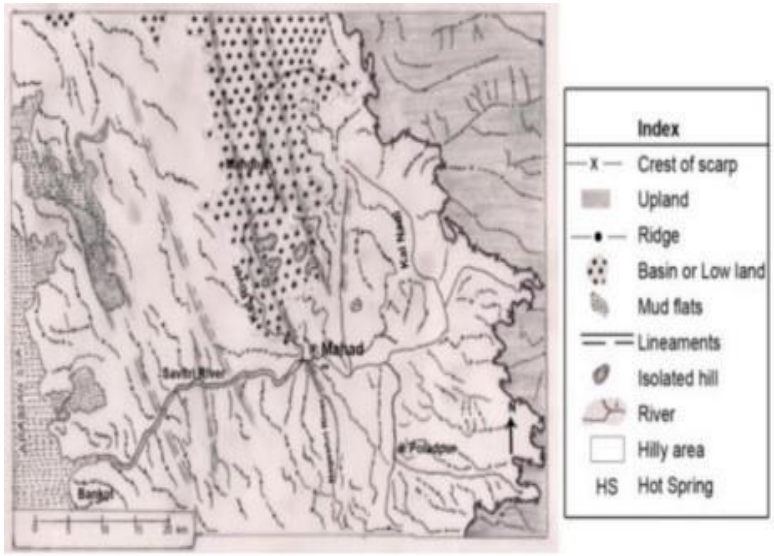

Figure 3. Geomorphic Map of area near Mahad.

C) Climate of Area:

Area around study spot has generally moist and humid climate. As the study area is in costal region so the temperature variation seen is not much large. The rainfall is from June to September and in this period mostly the road transportation is prone to landslides as due to loosening of soil. Winter is from November to January and temperature rises from February till May due to summer season.

D) Rainfall:

The phenomenon of landslides occurs mostly in monsoon period. The mean rainfall for Raigad is 3028.9 mm. The rainfall increases from the coast towards the Sahyadri hills on the east side of the district. The rainfall is heavy in district and the variations are from year to year. The following table shows the annual rainfall from years 2003 to 2012 of mangaon and mahad.

Taluka	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
Mangaon	3453.7	3762.1	3787.5	3660.2	3763.0	3183.0	3987.0	3666.0	3358.0	2194.0	3481.45
Mahad	2583.9	3332.1	4358.1	3624.0	5892.0	3299.0	3760.0	3356.0	3784.0	2512.0	3650.11

Table 1. Annual Rainfall Data (mm)

E) Geology of Area:

The project study area is the hard rock range which is the part of Deccan Volcanic Province. The area is formed by basalt rock which lays in horizontal directions according to lava flows which occurred in Cretaceous to Eocene period. Some parts of these major basalt rocks are intruded by a number of dykes. Mainly basalt of AA type flow and vesicular basalt of pahoehoe flow are found in this area. Red bole beds were also found along the road sections and well sections. Laterite is also found in some parts along west side where river flows. Rivers flowing in western region with their tributaries having steep slope navigate Mahad–Mangaon area. However deposits of Beach Sand and Alluvium occur along the coast and in the river mouth.

III. METHODOLOGY:

Landslide zone maps are generated using thematic information. This information contains data related to landslides occurred which took place in past, vegetation growth of area, water flow conditions, slope of the area with respect to horizontal surface and also information gathered using satellite data and Topo-sheet. GIS gives powerful tools which helps to do analysis of gathered data. The methodology is classified into three steps:

1) Input data which we have gathered for the preparation of thematic maps
2) Weighted Overlay Analysis using tools
3) Landslide Zone Map formation

A) Preprocessing:

To make the evaluation as comparable as possible the project is performed as an experiment. This means that the same input will be used and the goal is to produce the same map and series of maps in all of the chosen programs. Preprocessing is necessary so that our data will generate same inputs as required. It is not possible to set our data on same coordinates so preprocessing becomes our priority. Tool used for this purpose is called Feature Manipulation Engine (FEM). All programs can handle shape-file format and therefore there is no need for manipulation of the delivered formats.

Raster data:

Raster can be called matrix of cells or pixels. These cells have rows and columns and each cell represent information, such as temperature, etc. Raster are digital aerial photographs, imagery from satellites, digital pictures, or even scanned maps. Thematic data also known as discrete represents features such as land-use or soils data. Continuous data represents phenomena such as temperature, elevation, or spectral data such as satellite images and aerial photographs. Thematic and continuous raster may be displayed as data layers along with other geographic data. Picture raster are also used but they generally need attributes in tables. By displaying with our geographic data they can be used to show additional information of our map features.

Vector data – Points:

Sometimes there are discrete data points which have no dimensions and are unable to measure according to length and area with this dataset. In such case point data is used. They are used to show specific places or points such as bridge, any city, school, any place of interest, etc.

Vector data - lines:

Sometimes in our dataset there are linear features such as rivers, rails, streets ,etc. In such case line data is used. Mostly different features are symbolized differently. For example roads may be shown by solid black lines and rivers with solid blue lines. Combinations of symbols like solid lines, dashed lines, thin lines can be used to differentiate as per our convenience.

Vector data – Polygons:

Geographical features which are of two dimensions and are of large area of interest are shown using polygon tool. Area and perimeter can be easily measured using this tool. Color schemes, patterns, color gradation are used to differentiate symbols of this feature. Large boundary of city, lake, forest, etc can be shown using this tool.

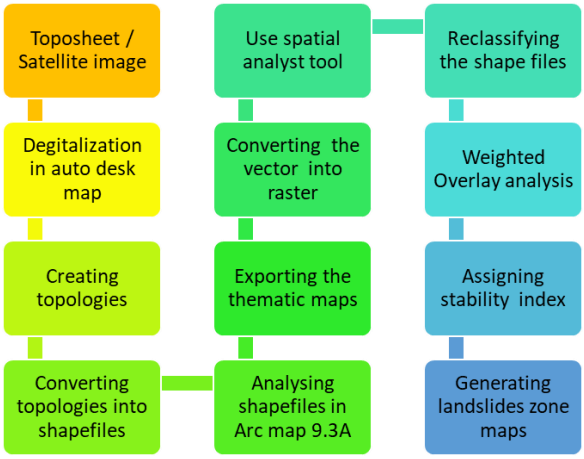

Figure 4. Methodology Used In QGIS

IV. MATERIALS USED:

Following materials were used inorder to develop a Landslides Zone map of the areas from Mahad to Mangoan on National Highway 66, Raigad District, Maharashtra State, India.

- Toposheet of the survey of India E43H8 of scale1:50,000.
- Ongoing satellite image with goals of 1meter.
- AutoDesk Map for Digitizing theFeatures.
- Q GIS for building up maps

V. FIELD INVESTIGATION FOR LANDSLIDE DETECTION:

Figure 5. Site A.

Name of work	Site survey
Location	The site A is 18 km from Mangaon and 11km from Mahad on national highway17, near to the tol phata bus stop, comes under Dasgaon tq. Mangaon 402103 Maharashtra.
Latitude	18°06’0.71” N
Longitude	70°20'18.8"E.
Elevation	22.215 M
Vegetation	Dense vegetation at top/shrubs & tress
Are trees tilted	No
Texture of rock	Weathered rock
Type of rock	Basalt
Type of soil	Laterite
Nature of soil	Sandy soil
Slope angle	34°19’
Slope distance	32.120 M
Height of toe of slide from road level	0 M
Causes of slides	Nil
Nature of damage	Nil
Type of slide	Sandy soil/Debris flow(if occurs)

Table 2. Results From Site A

Figure 6. Site B.

Name of work	Site survey
Location	It is 23 km from Mangaon and 4.6 km from Mahad on national highway 66, opposite side of hotel Neelkamal on bank of Savitri river comes under Kemburli tal. Mahad 402301 Maharashtra.
Latitude	18°05’08.1”N
Longitude	73°23’21.9”E
Elevation	38.272 M
Vegetation	Dense vegetation at top/shrubs & tress
Are trees tilted	No
Texture of rock	Weathered rock
Type of rock	Basalt
Type of soil	Laterite
Nature of soil	Sandy soil
Slope angle	38°31’41”
Slope distance	44.792 M
Height of toe of slide from road level	1 M
Causes of slides	Nil
Nature of damage	Nil
Type of slide	Debris flow(if occurs)

Table 3. Results From Site B.

Figure 7. Site C

Name of work	Site survey
Location	It is 23 km from Mangaon and 4.6 km from Mahad on national highway 66, opposite side of hotel Neelkamal on bank of Savitri river comes under Kemburli tal. Mahad 402301 Maharashtra.
Latitude	18°5.46’05”N
Longitude	73°21’14.8”E
Elevation	68.438 M
Vegetation	Dense vegetation only at top(shrubs & tress)
Are trees tilted	No
Texture of rock	Hard compacted rock
Type of rock	Basalt
Type of soil	Laterite
Nature of soil	Sandy soil
Slope angle	37°37’47"
Slope distance	61.3 M
Height of toe of slide from road level	1 M
Causes of slides	Nil
Nature of damage	Nil
Type of slide	Rockfall or Debis flow(if occurs)

Table 4. Results From Site C.

VI. RESULTS:

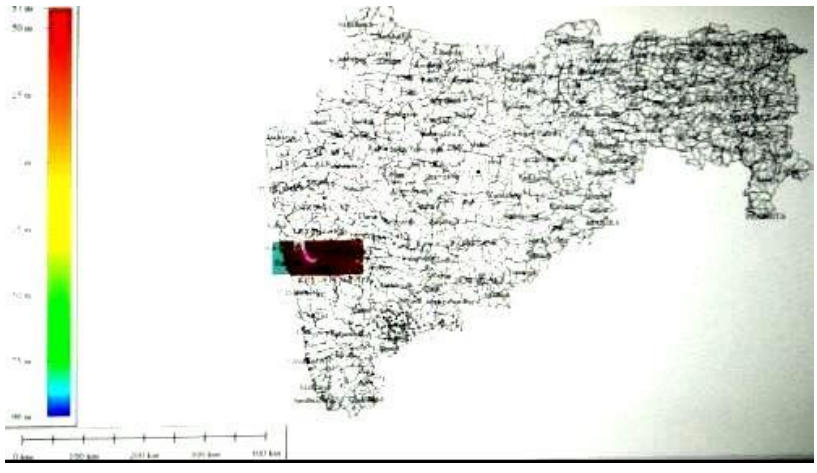

Figure 8. Working Area (Mahad To Mangoan

A) Slope map:

Slant is a significant factor in the investigation of Landslides. As the slant builds the likelihood of the event of avalanches likewise increments. The incline map is gotten from SOI Toposheet by GDEM strategy.

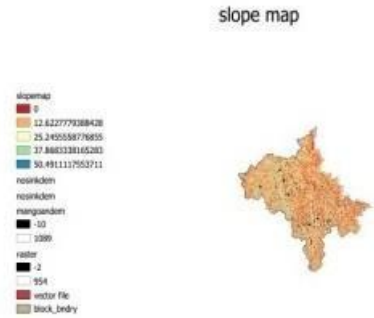

Figure 9. Slope Map.

B) Aspect Map:

Aspect is the Compass course that faces the slant. Perspective impacts vegetation. Boundary of angle, for example, presentation to daylight, drying winds, precipitation and discontinuities may control the event of avalanches.

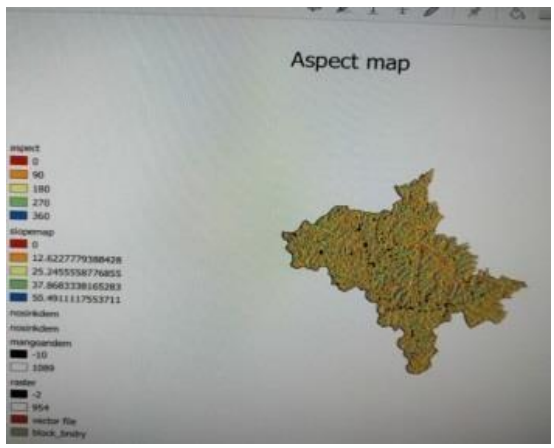

Figure 10. Aspect Map.

C) Landuse Map:

Vegetation cover is an important factor which influences the occurrence and movement of the rainfall which triggers the landslides. Light Vegetation is found as the major landuse in the watershed.

Figure 11. Landuse Map.

VII) OUTPUT:

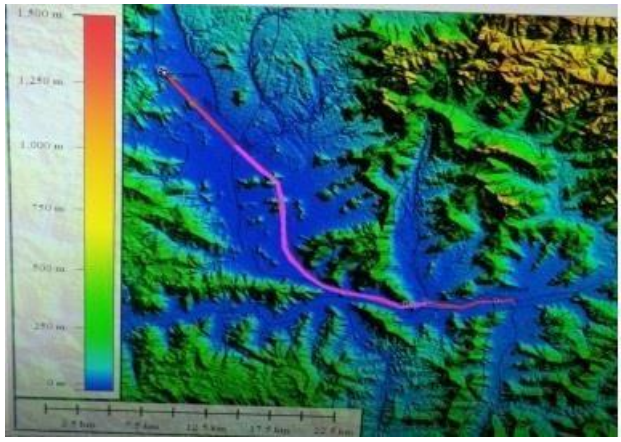

Figure 12. Slope Shader Map.

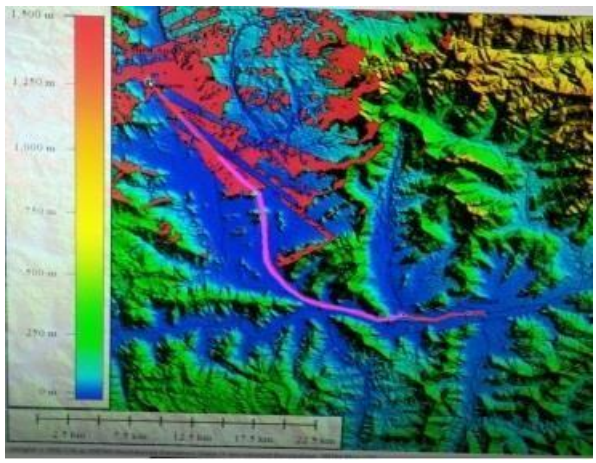

Figure 13. View Shader Map.

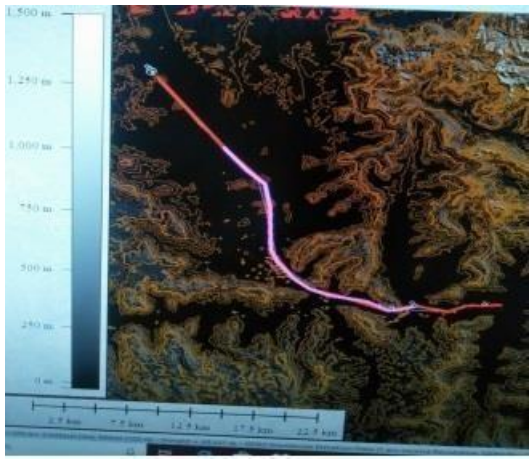

Figure 14. Contour Map

CONCLUSION

It has vastly facilitated in identifying the landslide prone area with the help of QGIS. Maintain the stability of slopes is a great obstacle in our study area. Landslides are more frequent to occur during extreme climatic conditions, deforestation, road cutting , decrease in lateral support and type of soil available. Using GIS involving polymerism techniques a set of landslide susceptibility maps are prepared. Although landslide is a natural disaster in our study area but it may happen due to several human factors in concern with rainfall. The NH66 is characterized variety of mass movements, active faults, slope gradient. In our study area site A comes under low susceptibility zone here resisting movement is greater than sliding movement which clearly shows site A is safe and the minimum chances of landslides. Site B comes under moderate susceptibility zone here sliding movement is greater than the resisting movement which indicates the hazard of landslide at site B is more. Whereas site C comes under high susceptibility zone. At site C the Sharp excavation for NH66 is made.

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