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Landslide Susceptibility Mapping Using GIS In Tamhini Ghat Region

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Abstract - Landslide susceptibility analysis is an important aspect of geological hazard computation and management. In this study, we have used Google Earth Pro, QGIS, ArchGIS software for landslide susceptibility analysis in the Tamhini Ghat region of Pune. The study area is prone to landslides due to its topographical and geological characteristics. We have analyzed the landslide susceptibility using various terrain and geological factors by computing slope, aspect, hillshade, curvature, land cover, stream flow and flow direction. The analysis was carried out using the weighted overlay method.

***Key Words*:** GIS, Landslides Suseptbility Zontion, Thematic Maps, Weighted Overlay Analysis.

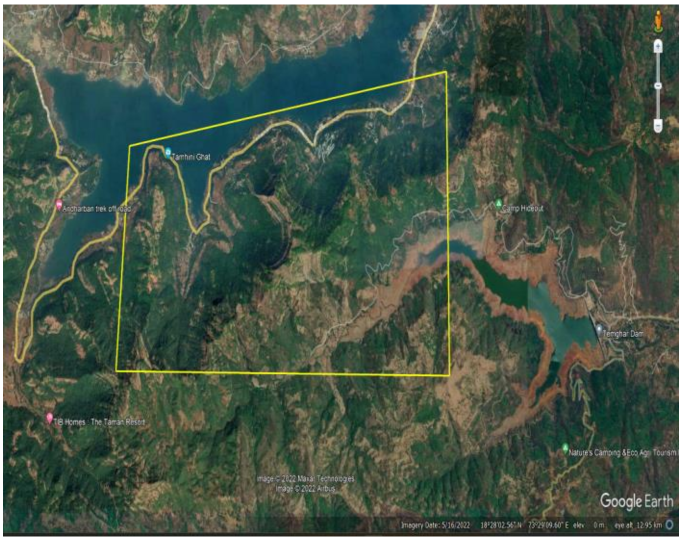
1.INTRODUCTION

A massive amount of rock, earth, or other material sliding quickly down a slope is known as a landslip or landslide. Numerous factors, such as torrential downpours, earthquakes, volcanic eruptions, and human activities like building or deforestation, can trigger them. Landslides can range in magnitude from small local occurrences to devastatingly large-scale catastrophes. The process of collapsing starts when the slope's stability is compromised, either as a result of the weakness of the substructure or the direction of an external force. When loose or unstable material slides down a hill due to gravity, soil, rocks, trees, and other debris move. Landslides have a negative effect on the environment, infrastructure, and public safety. They can ruin homes and roadways.

2. Body of Paper

2.1 Area under study :

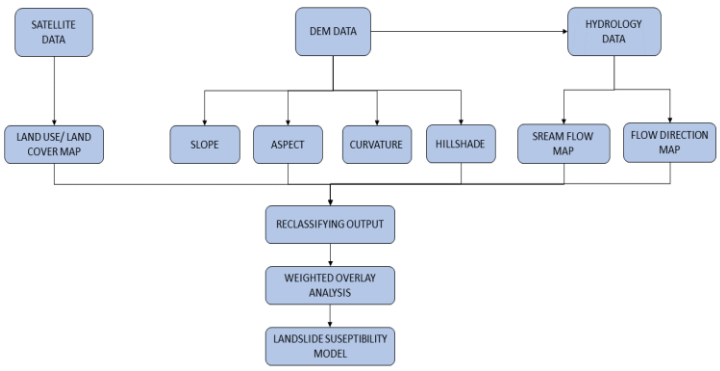
The area under study, Tamhini Ghat, is located in the Mulshi tehsil of Pune district of Maharashtra, India. The geographical coordinates of Tamhini Ghat lie between latitudes (18.4759° N, 73.4592° E). The research region has a total area of 25 km2. Mulshi and Tamhini are connected by the Tamhini ghat, which crosses the Sahyadri mountain range. The surrounding mountains are often of erratic shape, enclosing the research region. Due to the high and unpredictable rainfall in the area, the plant type is dominated by heavy vegetation and scrubs. 6,498 mm of precipitation falls annually on average during the monsoon season. Tamhini Ghat's water table is less than 2 metres deep. The study area is 600 to 814 metres above mean sea level (MSL) in altitude. the region



2.2 Materials Used:

The data used in this study were SRTM 1 Arc-Second 30m DEM satellite data, topographic maps of the Survey of India (1:25,000 and 1:50,000 scale), and land-use/Land Cover maps 10m from Arcgis website for field data collection. Data related to slope, aspect, land use, and landslides were collected for cross-checking and improving the input data layers.

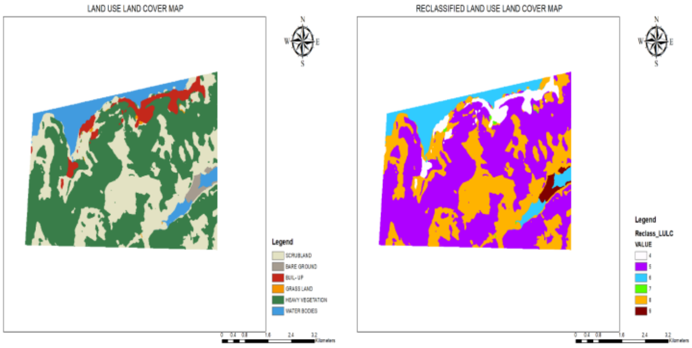
Methodology:



Due to the fact that landslides are the end result of numerous processes, spatial prediction of landslide sensitivity is challenging. It is difficult to make spatial projections of landslip vulnerability. Such research might be approached in one of two ways. Combining qualitative maps with relative weights for the components and their values is one method. classes based on expertise and experience in the subject. Another method involves using statistics to determine weights based on the correlation between various variables and existing landslides. However, if a statistical approach is applied with a small dataset and insufficient landslip data, it may produce inaccurate results. By creating a rating system based on the relative relevance of the elements influencing slope instability in the study, a method of qualitatively integrating maps was used in this investigation. Land use and land cover maps were created using satellite imagery. Using the ArchGis tool, the slope, curvature, spect, and hillshade maps were processed from the ASTER DEM. In addition, hydrological metrics from the DEM were also retrieved, including maps of stream flow and flow direction.

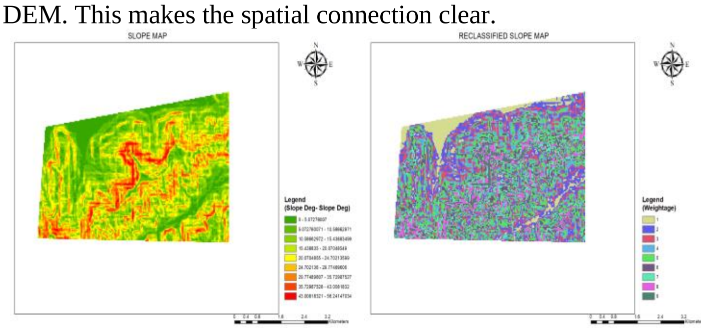
Land Used Land Cover Map:

A thematic map called a "Land Use Land Cover" (LULC) map shows the various kinds of land uses and covers within a particular geographic area. It offers useful details on the spatial patterns and distribution of different terrain features, such as forests, agricultural fields, urban areas, water bodies, wetlands, and natural reserves.



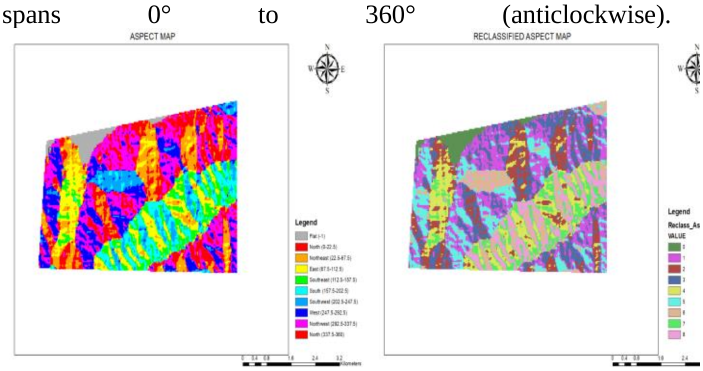
Slope Map:

Slope angle is a key factor in landslide mapping since it is directly related to landslides. As a result, the research area's slope map is segmented into nine slope categories based on the DEM. This makes the spatial connection clear.



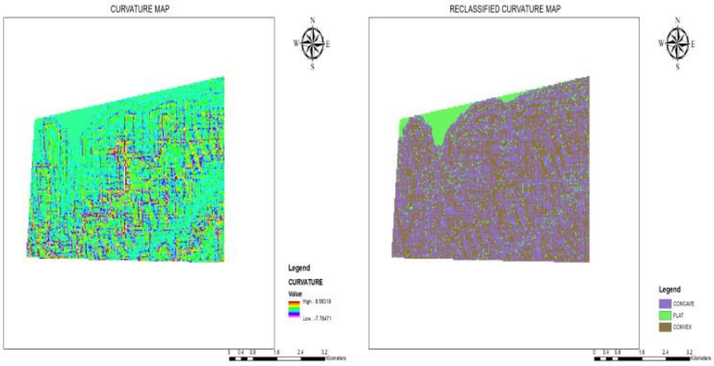
Aspect Map:

The aspect map displays the slope's orientation in degrees. The slope faces north when the aspect value is 0. In GIS, the slope side can be switched. The ground element's spatial exposure is described by an aspect map. It was calculated using DEM and spans 0° to 360° (anticlockwise).



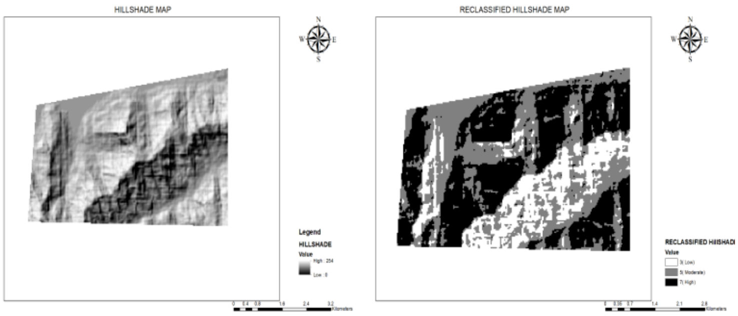
Curvature Map:

The convex/concave character of the surface in the direction perpendicular to the height was determined using ArcGIS and the elevation data (DEM). Positive values indicate a localised relief depression (concavity), negative values indicate a positive shape (convexity), and zero values indicate a flat surface.



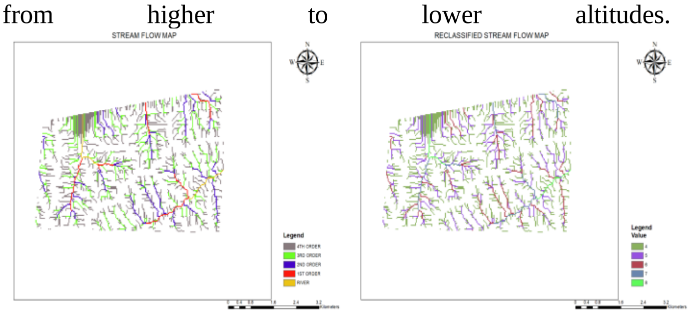
Hillshade Map:

By converting two-dimensional surfaces into three-dimensional ones, the technique known as "hill shading" can produce realistic views of the landscape. There is a fictitious lighting surface created by hill shade.The light source is positioned to the northwest.



Stream Flow Map:

A map that depicts the flow and direction of water in streams or rivers is called a stream flow map. It demonstrates how water moves through several pathways. The length of the stream reduces overall and in each order as the order of the stream rises. The stream order is variable, indicating that streams are moving from higher to lower altitudes.



Flow Direction Map:

A map known as a flow direction map depicts the course that water would naturally take as it flows downward. It shows the way that water would flow from every point on the map. Water would flow from higher elevations to lower elevations as seen

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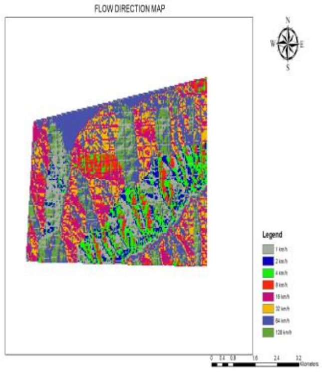
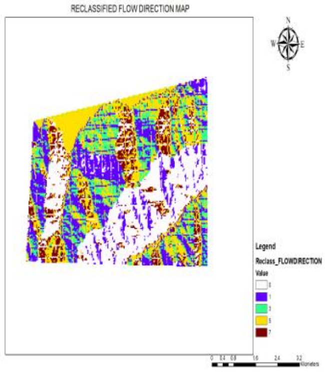
on the map.





2.3 Result and discussion-
Weightage Rating Systems:

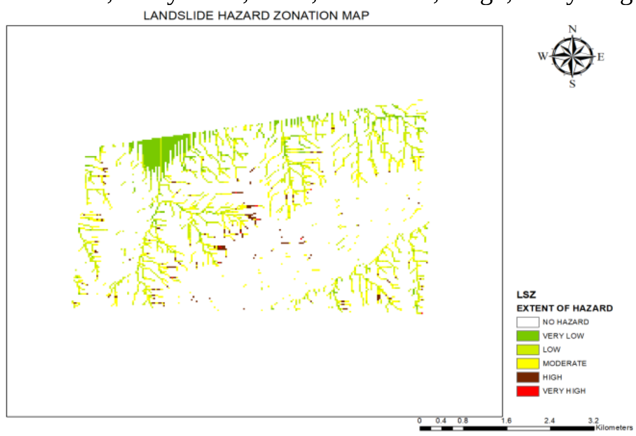
A weighted rating method is used to determine the relative value of numerous causal elements based on field information. The importance of each parameter for landslide susceptibility is rated on numerical assessment of susceptibility on a nine-point scale.

Table -1: Sample Table format

Sr No.	Features	Class	Reclassified Value	Weightage
1	Slope (Degree)	0-5	1	25%
		5-10	2	
		10-15	3	
		15-20	4	
		20-24	5	
		24-29	6	
		29-35	7	
		35-43	8	
		43-56	9	
2	Aspect Map (Degree)	Flat	0	20%
		N	3	
		NE	2	
		E	4	
		SE	7	
		S	8	
		SW	6	
		W	5	
		NW	1	
		W	5	
3	Curvature	-7.78- -0.01 (CONVEX)	3	10%
		-0.01-0 (FLAT)	5	
		0-8.56 (CONCAVE)	7	
4	Hillshade	Low	3	10%
		Moderate	5	
		High	7	
5	Land use Land Cover	Built Up	4	25%
		Heavy Vegetation	5	
		Grass Land	6	
		Built Up	7	
		Scrubland	8	
		Bare Ground	9	
6	Stream Flow	river	4	5%
		1st Order	5	
		2nd Order	6	
		3rd Order	7	
		4th Order	8	
7	Flow Direction	1 km/h	0	5%
		2 km/h	0	
		4 km/h	0	
		8 km/h	1	
		16 km/h	1	
		32 km/h	2	
		64 km/h	3	
		128 km/h	5	

Landslide Hazard Zonation Map:

Through the examination of numerous criteria, we stacked each element above the others in the research work for the landslip susceptibility site selection model. We identified the issue, which is the study area's zonation of landslip vulnerability. We divided the model into smaller models and determined that the conditional factors were the input layers. The Weighted Overlay Analysis results are broken down into six sections, each labelled No Hazard, Very Low, Low, Moderate, High, Very High.



3. CONCLUSIONS

The findings revealed that slope and aspect were the most critical factors in generating landslides in the study area. According to the magnitude of the hazard, the demonstration zones Tamhini Ghat Area under research into six LSZ categories: No Hazard, Very Low, Low, Moderate, High, and Very High. Heavy vegetation dominates the proposed study area, influencing the Hazard zone and protecting the majority of the area from landslides. No Hazard Zone applies to 29.89% of the area. 13.97% of the area is in the Very Low Susceptible Zone. 30.60% of the area is in the Low Susceptible Zone. 21.41% of the area is in the Moderate Susceptible Zone. 3.89% of the area is in the High Susceptibility Zone. 0.2% of the area is in the Very High Susceptible Zone. The current work has demonstrated that the introduction of GIS tools, together with the widespread availability of satellite pictures, has substantially aided in the detection of landslide suseptibility zonation. The quality of the available DEMs, targeted factors, and implemented models all influence the creation of the LSM. The landslide susceptibility map shows that 96% of the results are good. Because the study is not being conducted on a regional scale, we can exclude locations classified as Moderate to no hazard zone.

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