Analysis of Landslide Prone Area of Shahuwadi Tehsil using Geo-informatics

A DISSERTATION OF RESEARCH WORK

FOR THE PG-DIPLOMA GEOINFORMATICS

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

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DECLARATION

I hereby declare that the project entitled "**ANALYSIS OF LANDSLIDE PRONE AREA OF SHAHUWADI TEHSIL USING GEO-INFORMATICS.**" Is an original work done by me. The findings in this report based on the data collected by researcher. This work has not been submitted for any other degree of this or any other University. Whenever reference have been made to previous works of others, it has been clearly indicated as such and included in the Bibliography.

Signature of candidate

Pushpa Ramnath Kanawade

....

Place : Kolhapur

Date: 11/06/2023

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PLACE: KOLHAPUR

DATE: 11/06/2023

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1.1 INTRODUCTION

Landslides are one of the most frequent natural occurrences in mountainous regions, with the Himalayan range being one of them, according to Chakraborty and Pradhan (2012). The word "landslip" refers to a wide range of mechanisms that result in the sliding down a slope and spreading outward of slope-forming material, such as rocks, soil, artificial fills, or a combination of all of these. The potential zone that is susceptible to slope collapse may be located by using Landslip Hazard Zonation (LHZ) mapping, hence decreasing vulnerability."

A landslip hazard zone is defined as "the division of the land area into homogenous domains and their ranking based on the degree of real hazard caused by movements of mass" (Varnes 1984). The construction of LHZ mapping is required for planning landslip risk areas and disaster management (Kanwal et al. 2017). For the purpose of identifying and predicting probable sliding zones, LHZ mapping is essential (van Westen et al. 2008).

Slope, precipitation, LULC, elevation, soil type, drainage potential, development of transit networks, lineaments, and additional anthropological factors. Remote sensing and GIS have been used to extract specific details about the preparatory factors, such as slope angle, slope aspect, geological condition, drainage information, road alignment, lithological structure (faults and thrust), and land use, which influence and initiate landslides along the western Kolhapur district.

In order to reduce the risk associated with landslip hazards, it is essential to create landslip susceptibility maps and conduct hazard analyses and risk assessments using contemporary and cutting-edge techniques like high-resolution satellite data, digital elevation models (DEM), and geographic information systems (GIS). (Spiker and Gori 2000; Chacon et al. 2006) The area.

This project provides a landslip susceptibility analysis for the region of western Kolhapur district in an effort to reduce potential landslip damages. The research area was selected because it was one of the worst-affected by landslides over the previous four rainy seasons. This study aimed to map areas susceptible to landslides and pinpoint dangerous regions where future landslides are likely to occur.

1.2 ORIGIN OF THE RESEARCH PROBLEM

The research area was chosen because it has been the most severely hit by landslides during the past four wet seasons. This study aimed to map areas susceptible to landslides and pinpoint dangerous regions where future landslides are likely to occur.

1.3 REVIEV OF LITERATURE

Landslides are among the most hazardous and common natural hazards in the world. They have been taking place in the mountainous regions since the beginning of time. The first scientific studies of landslides were conducted only in the early 18th century. Debris flows, earth spreads, and rock slides are three separate forms of landslides that were acknowledged by (Dana, J. D., 1862) categorisation without identifying the landslides. In light of the fact that the term "landslide" was first used in a written text in 1838, Dana's classification of landslides may have been the first. Growing awareness of the social and economic repercussions of landslides, particularly those in hilly regions brought on by human activity, has resulted in an upsurge in interest in the study of landslides in recent years.Using cartographic, aerial, and field data. Using cartographic, air photo, and field research, Brunsden et al., 1976 investigated the forms and evolution of fairy dell, an active landslide complex along the Dorset coast.

The main landslip mechanisms examined by the authors were Rotational landsliding and Block disruption. The erosion rates of the landslides were shown on a series of maps and in geological cross sections. It was demonstrated that the evolutionary sequence of the active landslides may be used to better understand geomorphological and underlying aspects by comparing the geographic pattern of the active landslide to a dormant landslide in an inland site.

T. Kanukabo et al. examined natural hazard mapping in 1980. They contend that understanding the relationship between disaster occurrence and terrain characteristics is essential for studying the three major types of catastrophe—earthquake, mass movement, and flood. According to the findings, a lot of research has been done on the relationship between land types and disasters. They have also stressed the need for more tools and regulations to be developed for the accurate mapping of the connection between land information and natural disasters.

In 1982, Hanz Keinholz and associates looked at the application of aerial photographs for mapping natural dangers throughout the Colorado Mountains. Rockfall, debris flow, landslides, and flood threats were identified using air photos and classified into observable, inferred, and potential categories based on different standards. The hazards associated with mountains were then mapped using these.

In 2002, Lydia, Elena, Espizua, et al. carried out a landslip hazard and risk zonation mapping for the Rio Grande basin in Argentina. Length, breadth, slope, geomorphology, orientation, geology, lithology, curvature, and hydrology were among the prerequisites for a landslip. Two maps were produced using field maps and the interpretation of aerial photographs. maps of vulnerability and landslip types. Rockfall, slide, flow, and intricate landslides are the four types of landslides. Risk hazards were divided into three categories: High, Moderate, and Low.

Wu et al. 2002 focused on the zonation of landslip hazards using an integrated information model based on field research and landslip data. According to the findings, areas were divided into destructive, disastrous, slightly disastrous, probably disastrous, and non-disastrous areas. Western Van et al., 2003 examined the development of the Tessina landslip using direct field surveying and aerial picture interpretation. Several multi-temporal maps of the Tessina landslip were analysed to construct comprehensive geomorphological maps. The author got to the conclusion that numerous elevation data sets for distinct time periods were required in order to calculate the volume of the removed materials.

Hervas et al. (2003) demonstrated a novel method for mapping landslip occurrences and monitoring ground surface changes using optical remote sensing data. Multitemporal panchromatic images were used to demonstrate the model utilising digital change reduction and thresholding techniques. They have come to the conclusion that more frequent observations are needed to monitor the growth of ground dynamics.

In 2006, Neaupane, K. M., et al. presented the Analytical Network Process (ANP) model for landslip susceptibility analysis. The area for the research is in the eastern part of Nepal, in the lower Himalayas. Numerous causal factors were taken into account as parameters for the susceptibility analysis, including slope angle, slope aspect, land use, geology, and landuse. Using weights ranging from 0 to 1, areas were categorised into Low risk, moderate risk, and High risk categories.

In 2008, Dahal, R. K., et al. created a forecast model for rainfall-induced landslides across the south-western peripheral hills of the Kathmandu valley, Nepal, using the weight of evidence technique. the parameters for the slope, height, aspect, relief, and flow accumulation. Geology, how the land is used, and how far drainage and roads are Data on soil type, depth, and instances of extremely heavy rainfall were used to construct maps showing the susceptibility of landslides. Using historical rainfall-triggered landslip data, the conclusions were 88% accurately validated.

In 2011, Lodhi, Mahtab, A. investigated the post-earthquake landslip evaluation for the October 5, 2005, occurrence throughout the western Himalayas. The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) data was used to identify landslides. Principle Component Analysis (PCA), Normalised Difference Vegetative Index (NDVI), and Iterative Self-Organizing Data Analysis Technique (ISODATA) are only a few of the image processing techniques that were used. The data's accuracy was determined with 77% accuracy using visual interpretation landslip data from high resolution satellite photography (IKONOS). The results indicated that the bulk of landslides occurred in the tectonically active region of the Western Himalayas.

Roback Kevin et al. mapped the size, position, and motion of the landslides in Nepal caused by the Gorkha earthquake in 2008. High resolution satellite images were used to identify more than 25,000 landslides in central Nepal's severely submerged Himalayan slopes. The results were consistent with prior landslides caused by earthquakes that happened all around the world. Yan et al. 2019; Yang and others 2019 Yan studied the mapping of landslip susceptibility using the AHP and the cloud-based Normalised Frequency Ratio model. They concluded that both the AHP and the Normalised Frequency Model may enhance the accuracy of the results in comparison to other statistical models. Yang created a model for the Duwen Highway Basin in the Chinese province of Sichuan.

2009 study by S. Gaikwad, P. G. Chandak, M. B. Kumthekar, and others. Disasters frequently occur in Uttarakhand's Garhwal Himalaya, which is well-known for its large landslides and severe flooding. There has been a lot of focus on landslip threat zonation mapping and mitigation tactics so far.

1.4 SIGNIFICANCE OF THE STUDY

For many years, humans have tried to change the natural world in ways that would be advantageous to themselves. In some ways, they have been somewhat successful in harnessing Mother Nature. In the past, humans had little understanding of nature and how it functioned, but as time passed, more imaginative technologies were developed, the population increased, and land became increasingly scarce. The main objective of the study is to look at the geotechnical features of a landslip that occurred nearby in the western Kolhapur area. Initial site assessments, soil sample collection, sample testing, interpretation of test results based on scientific ideas, and slope stability testing are all part of the project. By employing remote sensing and GIS technology, the effects of the natural environment, ecosystem, and human-induced changes in the landslip mapping are analyzed, and it is necessary to protect this environment. The Kolhapur district's landslide-prone zones will be identified with the aid of this study. Finding landslide-prone locations can help with mitigation.

1.5 Objective:

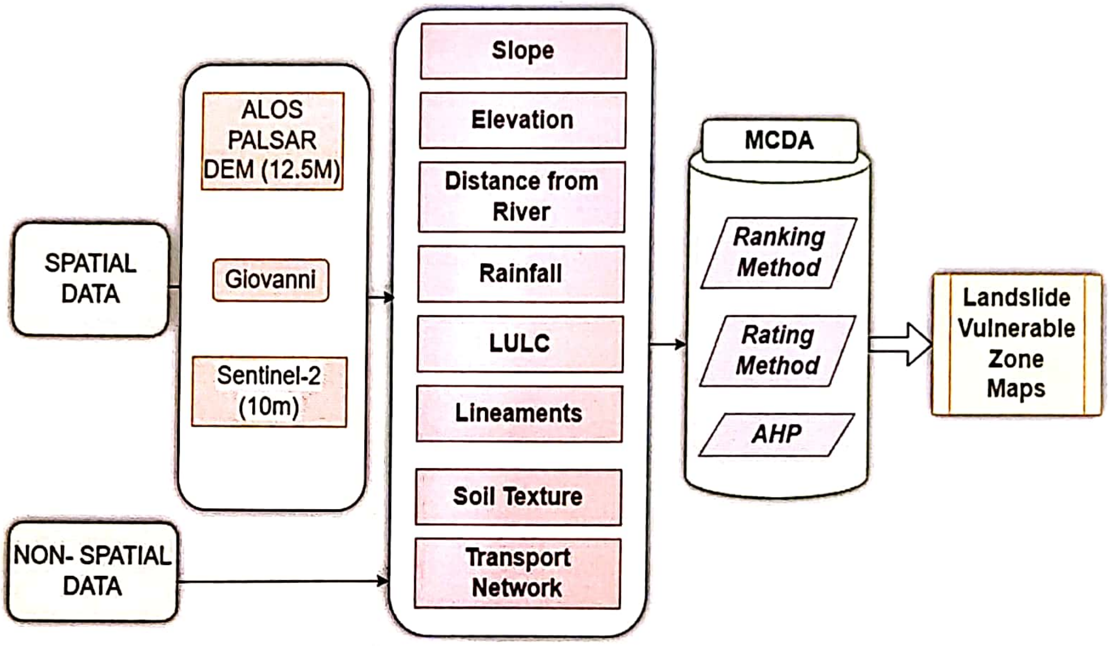
1) To study the landslide analysis and risk management of the study area using RS and GIS.
2) To identify Landslide vulnerability in study area.

1.6 Database:

1. DEM: SRTM - Resolution 30m
2. Land Use Land Cover,2021: ESRI Services
3. Road Map: Diva-GIS
4. Rainfall past occurrence data: Giovanni portal (GPM IMERG)

In any geographical study, choosing and creating the right theme layer is essential. The primary data sources for the current investigation were satellite data products and their derivatives. The majority of the layers were created using ASTER GDEM and LANDSAT ETM+ data. Primary layers and secondary layers have been produced utilising these data sources. Secondary layers are those created with the use of some other collateral data, such as an existing lithology map, Google photos, historical records, and literature reviews. Primary layers are those created directly from a data set using GIS tools.

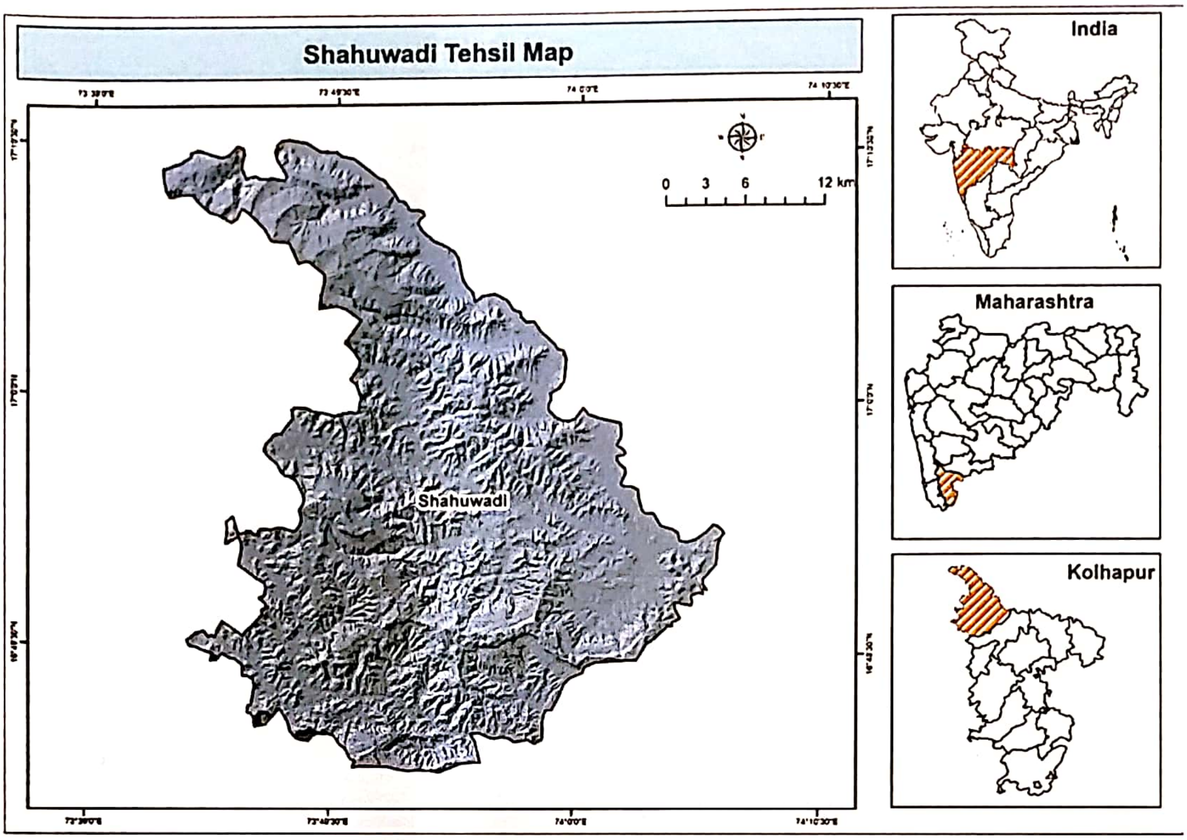
1.7 METHODOLOGY



1.8 STAUDY AREA

The Kolhapur District of Maharashtra contains the Town and Tehsil of Shahuwadi. Shahuwadi Block (CD) has the sub-district code 04283 according to census 2011 data. The Shahuwadi tehsil has a total area of 1,025 km2, consisting of 1,023.33 km2 of rural land and 1.94 km2 of urban land. There are 1,85,661 people living in Shahuwadi Tehsil, of which 5,339 live in urban areas and 1,80,322 in rural ones. The population density in Shahuwadi is 181.1 people per square kilometre. The sub-district has roughly 39,975 homes, including 1,138 urban homes and 38,837 rural homes. In terms of literacy, 72.18% of the male population and 56.78% of the female population in Shahuwadi Tehsil are literate. In Shahuwadi Tehsil, there are roughly 145 villages.

Map No. 1 Location Map: Shahuwadi Tehsil



Source: Diva-GIS

2 Result and discussion:

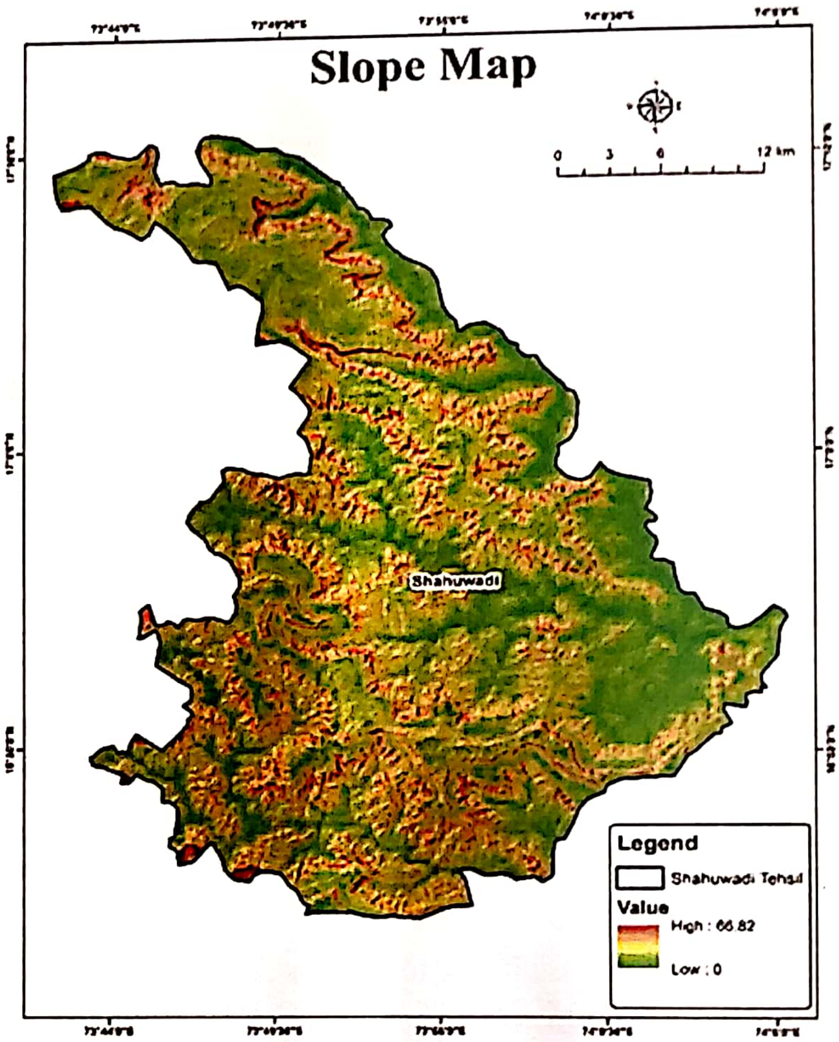
2.1 Digital Elevation Model

For the DEM extraction for this study area, an ASTER DEM with a 30 meter spatial resolution was used. Thematic layers were created using this DEM with the aid of ArcGIS Pro software tool extensions.

2.2 Slope Map

Using the spatial analyst tool in ArcGIS Pro, slope was calculated as the highest rate of change in elevation over each DEM cell and its eight neighbors. Slope ranges are divided into groups using the Young's slope classification method, as depicted on the map.

Map. No. 2 Shahuwadi Tehsil : Slope



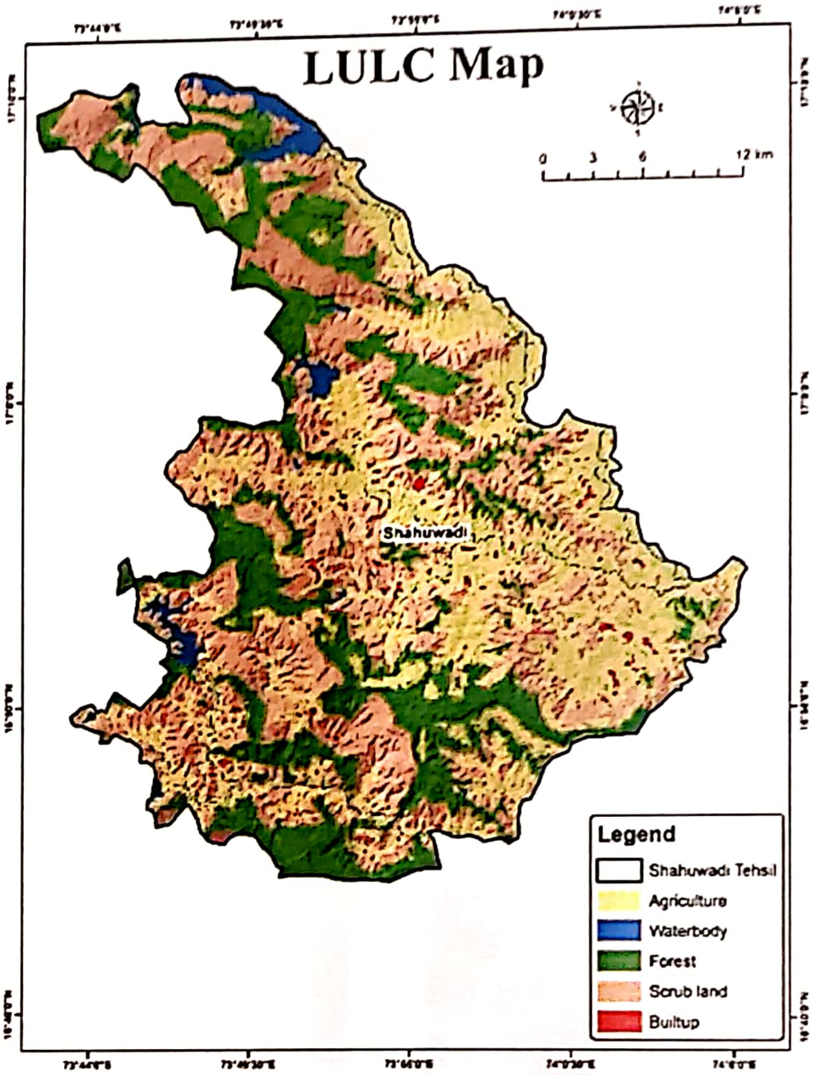
Source: Bhuvan website

2.3 Land Use Land Cover:

Sr. No.	Category	Area in hec.
1	Agriculture	32485.3
2	Waterbody	3327.07
3	Forest	27670.2
4	Scrubland/ Barren land	37368.7
5	Built-up land	1135.32

Table No. 1

Map. No. 3 Shahuwadi Tehsil : Land Use Land Cover



Source: Bhuvan website

2.4 Weighted Categories:

Reclassification is based on the rank given by considering the conditions that will trigger the landslide possibility. In the given study area, the ranking has already been assigned with the help of experts as the following table. Mostly the classification is done according to the risk associated with the factor. If necessary reclassify the layer to assign the value to five classes.1for low risk, 2for moderate risk,3 for high risk,4for very high risk, and 5the extreme risk.

Shahuwadi Tehsil: Weighted Categories

LandslideTriggeringFactor	Value	Classification	Weightage
Slope(indegrees)	<5	1	**35**
	5-15	2	
	15-30	3	
	30-45	4	
	>45	5	
Rainfall(in mm)	<1500	1	**25**
	1500-1700	2	
	1700-2000	3	
	2000-2500	4	
	>2500	5	
LandUseandLandCover	Forest	1	**20**
	Waterbodies	4	
	AgriculturalLand	3	
	BarrenLand	2	
	Built-upArea	5	
DistanceFrom River (meters)	<100	5	**10**
	100-250	4	
	250-500	3	
	500-1000	2	
	>1000	1	
DistanceFrom Road(meters)	<25	5	**10**
	25-50	4	
	50-75	3	
	75-100	2	
	>100	1	

Table No. 2

2.5 Landslide Zonation Map:

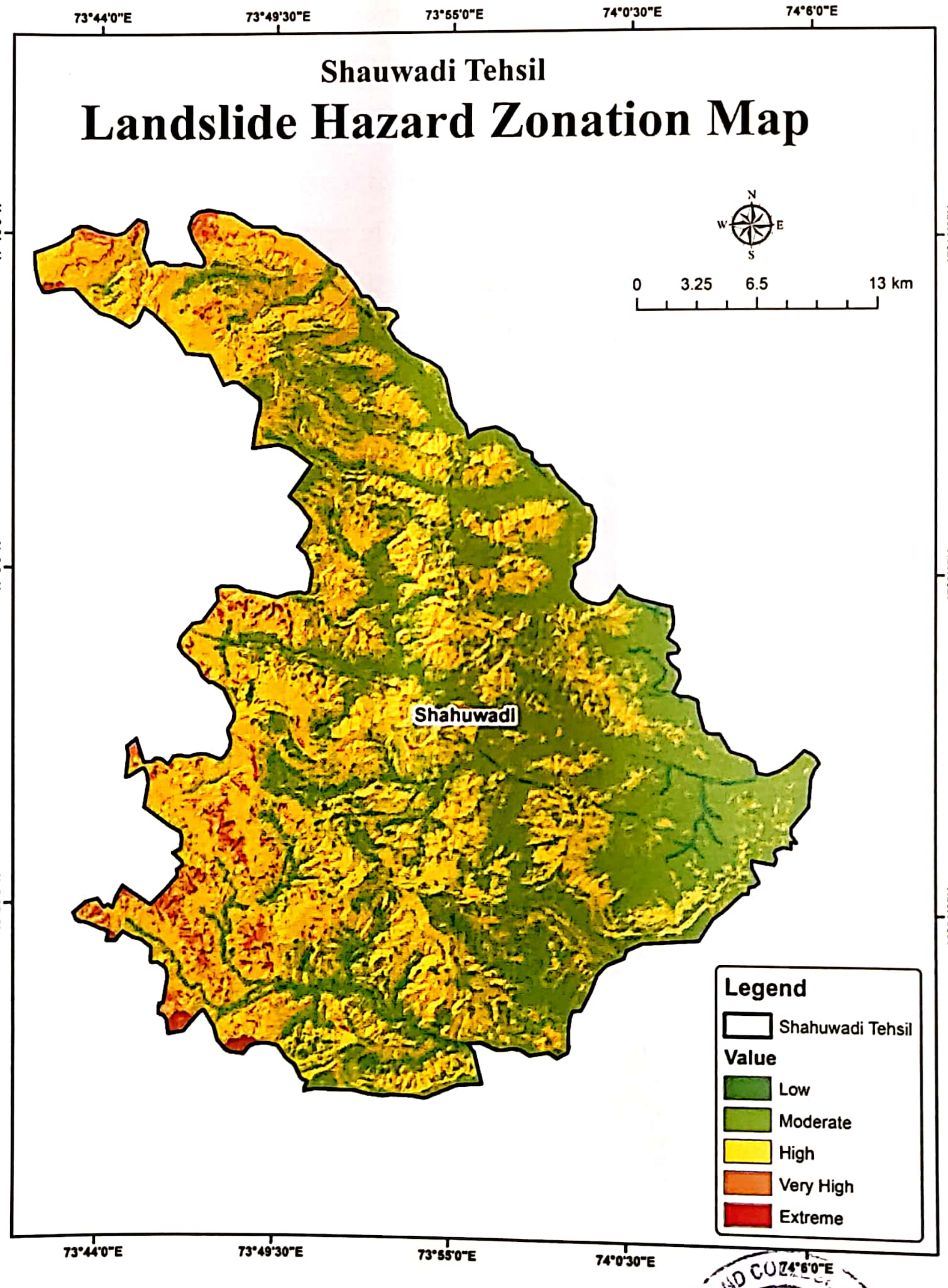
Sr. No.	Zone	Area in hec.
1	Low	877.86
2	Moderate	41796.9
3	High	52681.9
4	Very High	3720.33
5	Extreme	1.44

Table No. 3

The research region spans a total area of 99078.43 square hectors. Area of minimal danger, 877.86 sq. hec., accentuated by low land and the Sahayadri mountain range's foothills. Its 41796.9 sq hec of confined space is designated as a moderate risk region. The majority of the area (52%) showed high risk areas with significant rainfall.

It has 52681.9 hec. and was produced because of the region's height and steep slopes. A very high risk area currently occupies 3720.33 hectors of land overall. Due to the 1.44 hector area's extremely hilly terrain, valleys, steep slopes, and stony and rocky ground, it is considered an extremely risky environment. region totaling 56403.67 hectors was also marked as a landslip danger region.

Map. No. 4 Shahuwadi Tehsil: Landslide Hazard Map



Source: Arc GIS

3.1 Conclusion:

In the Shahuwadi tehsil, about 55 percent of the territory is above the high-risk zone. Heavy rainfall and other anthropogenic factors have enhanced the risk. The main problems in hilly areas are unstable slopes. It was determined that in soft structurally damaged and high relief portions of the hilly regions like Shahuwadi tehsil, the excavation for a road is the primary cause of a landslip. In most cases, stabilizing the slope will require the application of multiple techniques rather than just one.

By adding up all the information values, the final map was calculated. It was successful in creating the map of landslip susceptibility. Positive information values for any parameter class in the output of statistical analysis may be interpreted that the parameter class has high influence on landslide hazard.

3.2 Recommendations:

In order to avoid road-induced landslides, it is necessary to establish an economical method of designing the road section without any excavation in slide hazard zones. Through this case study, it was discovered that remote sensing, together with the other geoinformatics tools, is particularly useful in danger zonation mapping.

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