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IDENTIFICATION OF LANDSLIDE SUSCEPTIBLE ZONES USING GEOGRAPHICAL INFORMATION SYSTEM

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ABSTRACT:

Landslide is one of the hazardous and critical geographical process, which damages to civil infrastructure and property as well as causes loss of life. This paper is an attempt with regard to the expansion of a landslide susceptible mapping approach by using geographical information system (GIS). In this present paper landslide prediction is done by using frequency ratio model. Also, landslide susceptible mapping is done by these techniques. The landslides map is mainly classified into four zones i.e., high, medium, low and very low. The landslide susceptibility map also used to find area observations of landslide prone areas. Landslide susceptible zone can be determined by using frequency ratio model 85% of landslide prediction get possible with frequency ratio model.

KEY WORDS:

GIS, Frequency Ratio Model, Mapping, Sinhagad Fort.

NOMENCLATURE:

GIS	Geographical Information System	LIDAR	Light Detection and Ranging
FRM	Frequency Ratio Model	SPI	Stream Power Index
LSZ	Landslide Susceptible Zones	TWI	Topographic Wetness Index
RHRSI	Rockfall Hazard Rating System for India	TRI	Topographic Roughness Index
ANN	Artificial Neutral Network	LDI	Landslide Density Index

INTRODUCTION:

Landslide is one of the most worldwide nature phenomena that causing huge damage to property and infrastructure, losses of human lives and animals almost every year. To reduce the issues of landslide susceptibility zonation (LSZ) map of that particular area. The accurate landslide zones which have been evaluated by using frequency ratio model method, that indicates more than 85% of landslide prediction accuracy. The

frequency ratio scores were calculated from the casual factors and training occurrences repeatedly.[1] The few landslide susceptibility maps were studied from the integration of casual factors that assigned frequency ratio scores.

The landslide susceptibility maps were authenticated by using each validation dataset. The frequency ratio limit for achieved susceptibility occurrence from 89.48% to 93.21%. Therefore, the landslide susceptibility accuracy is for frequency ratio model is higher than 89%. The problem of the landslide is due to topographic, excavation for construction, heavy rainfall etc. in Maharashtra Kolhapur is considered as a most vulnerable region for landslides activity.

The landslides susceptibility map study gives an idea about the stability of slope, so it can be used for future construction work and remedial measures.[2] The remedial measures are provided to avoid landslide at certain locations. Rockfall Hazard Rating System for India (RHRSI) identify the slopes on hilly areas, to find rock fall prone area, so that proper remedial measures can be proposed to mitigate loss. Rockfall Hazard Rating System for India (RHRSI) is a modified system for Indian Subcontinent and used to define strength of slopes in mountains and hilly areas.[1]

The most common software for landslides studies is ArcGIS package which is used for mapping landslides influenced area, maps factor preparation, overlay analysis and interpretation.[3]

GIS is an ideal tool for landslide modelling owing to its versality in handling a large set of data, providing an efficient environment for analysis and display of results with its powerful set of tools, for collecting, storing retrieving, transforming and displaying spatial data from the real world, with the help of remote sensing devices. We also can provide many useful and use information to combine in a GIS environment with other spatial factors influencing the occurrence of landslides.[4]

LIERATURE REVIEW:

A landslide is defined as the movement of a mass of rock, debris or earth down a slope. Landslide are a type of “mass wasting”, which denotes any down-slope movement of soil and rock under the direct influence of gravity. The term “landslide” encompasses five modes of slope movement: falls, topples, slides, spreads, and flows. These are further subdivided by the type of geologic material (bedrock, debris, or earth). [5]

Debris flows (commonly referred to as mudflows or mudslides) and rock falls are examples of common landslide types.[6]

Almost every landslide has multiple causes. Slope movement occurs when forces acting down-slope (mainly due to gravity) exceed the strength of the earth materials that compose the slope. [7]

Causes include factors that increase the effects of down-slope forces and factors that increase the effects of down-slope forces and factors that contribute to low or reduced strength. [8]

Landslides can be initiated in slops already on the verge of movement by rainfall, snowmelt, changes in water level, stream erosion, changes in ground water, earthquakes, volcanic activity, disturbance by human activities, or any combination of these factors.[9] Earthquake shaking and other factors ca also induce landslides underwater. These landslides are called submarine landslides. Submarine landslides sometimes causes tsunamis that damage coastal areas. Dattatraya J. Khamkar., 2019 presented a paper that aims towards the development of a landslide methodology by using geographical information system (GIS) and remote sensing techniques for landslide susceptibility mapping. Hyun-Joo-oh Et al., 2016 proposed the methods of investigation of the stress-strain state of the landslide slope rock, as well as the research methods of geotechnical properties of rocks that form the sliding slope. C.J. Van Westen., 2017, describe the methods to make a hazard map based on Quantitatively defined weight-values.[8]

Leulakm Shana., in his studies demonstrated that landslides are the most destructive geological hazard in the hilly regions.[9]

For systematic landslide mitigation and management, landslide evaluation and hazard zonation are required. Prasanna Venkatesh, Saranaathan., 2018, involved the study of different systematic maps like, contour, drainage, slope, aspect, curvature, DEM, DTM, drainage density, drainage intensity, geology, lineament, lineament intensity, lineament density, [10]

geomorphology, land use, weathering thickness, runoff, soil thickness and buffer maps like road, drainage lineament etc. in CNG ghat section.[11]

Laila Fayez Et al., 2018, develop a Frequency Ratio Model to access the landslide susceptibility in the study area. Landslide density was used to validate performance of the frequency ratio model. Landslide conditioning factors such as (slope angle, slope aspect, evaluation, curvature, land use, geomorphology, depth

material, slope forming material and rainfall) where considered.[3]

METHODOLOGY

The geographical information system (GIS) which is based on computer-based tool for mapping of landslide prone zones and for identify geographical phenomenon exist.[12] Landslide locations are identified by
ratio is a technique to interpreting the satellite images of the topography, soil, forest and are extracted from the spatial database. These factors are taken used with an artificial neural network (ANN) to analyze landslide susceptibility. Development of landslide susceptibility in the present study are has been carried out in five main steps: 1) Data collection, 2) preparation of landslide maps, 3) Determination of the landslide conditioning factors, 4) Application of frequency ratio model, 5) Development of landslide susceptibility mapping, 6) Validation of frequency ratio model.[3]

1)Preparation of landslide inventory map:

A landslide inventory map records the location and where known the date of occurrence and the types of mass movements that have lift discernable traces in an area. [13]

2)Landslide Conditioning Factors:

The first dataset was derived from high-resolution airborne laser scanning data (LiDAR), which contains eight landslide conditioning factors. Altitude, slope, aspect, curvature, stream power index (SPI), topographic wetness index (TWI), topographic toughness index (TRI), and sediment transport index (STI).[14]

3) Landslide susceptibility mapping:

A landslide susceptibility map identifies areas which are subject to landslide and is measured from low to high.[15]
The landslide susceptibility map takes into account where the landslide o and what causes them (slope, soil type and the impact of the flow of water in an area).[2]

4)Applications of Frequency ratio model:

Frequency ration model has been successfully applied as statistical approach for landslide susceptibility assessment in many regions all over the world. Results indicated the frequency ratio model is an effective method for the landslide susceptibility assessment of hilly areas. The mathematics representation of frequency ratio model is as follows;

$$\frac{FR = N_I^P \ / \ N}{N_I^L P \ / \ \mathbb{N}^L}$$

Where,

N_I^P =is the number of pixels study area. in each landslides conditioning factors class.
N= is the number of landslides pixels in total the study area.
$N_I^L P$= is the number of landslide pixels in each landslide conditioning factors class.
$\mathbb{N}^L$= is the number of all landslide pixels in total the study area.[6]

5)Data Collection:

Data for landslide susceptible zones from forest government office in India e.g., rainfall data, satellite image, google earth images, soil samples for testing.[1]

6) Validation of frequency ratio model:

The performance of the FR model was evaluated using the Landslide Density Index (LDI). For validation, landslide area which has not been used for the construction of model is generally considered as the future landslide area. In this study, all landslides (polygons) were divided into two parts (70% for modeling and 30% for validation). Landslide Density (LD) Index was used to validate the model which is a ratio between the percentage of landslide pixels and the percentage of class pixels in each class on landslide susceptibility map. The calculation result of LDI.[8]

STUDY AREA:

We are going to discuss the study area is Sinhagad Fort which is track down in Thoptewadi Maharashtra, India. The longitude and latitude of the Sinhagad fort is 18.3663°*N* and 73.7559°E. The height of the ort is 1312km (4304ft). the fort is completely track down in hilly area. The attribute of that fort is rugged mountains and steep slopes on which rests of the unconsolidated soil and earth, material vulnerable to failure.

The outcomes are to explore mapped data, relates GIS with remote sensing technologies, analyze spatial data, images and apps to communicate spatial data in a meaningful way to others, save losses of lives and property.

CONCLUSION:

In this article brief explanation on the term landslide has been studied. The various hazardous impact of landslides on environment where studied. Landslide's location using aerial photo and satellite image where detected. An efficient environment for analyzing and displaying results with powerful set of tools for collecting, storing, retrieving transforming and displaying spatial data from the real world.

On the basis of above research conclusion is made that the 'Identification of Landslide Susceptible Zones Using GIS' is effective method to identify landslide prone areas.

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