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LANDSLIDE SUSCEPTIBILITY ASSESSMENT AND HAZARD ZONATION METHODS – A REVIEW

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ABSTRACT

In Recent time one of the most destructive and most occurring disasters is landslide all across the world. Landslides are causing properties and human lives every year in hilly regions. For mitigation and management of landslide hazard zonation an appropriate systematic evaluation is necessary. Several approaches for landslide hazard zonation have been proposed over the last few decades. These approaches can be grouped into two broad classes one is qualitative and second is quantitative methods. In qualitative methods a lot of subjectivity is introduced in preparation of various thematic layers for landslide occurrence. Quantitative methods are used to minimize subjectivity in the weight assignment process; these approaches quantify the relative importance of various causative factors of landslide. In mapping landslide hazard zonation this geospatial technique can help to minimise the losses. Different scholars use different approaches for landslide hazard zonation. But there is not a solitary technique which has universally acknowledged for effective assessment of landslide hazard.

KEYWORDS: Geospatial modelling, Qualitative methods, Quantitative methods, Landslide hazard zonation.

INTRODUCTION

Landslides are one of the most frequent and damaging natural tragedies that have concerned numerous rugged mountainous provinces through the sphere. As of late, various serious debacles have made the worldwide local area mindful of the massive misfortunes of living souls and properties. Albeit a singular slope failure is, by and large, not so tremendous or decimating as a quake, a volcanic ejection or a flood, yet, being significantly more regular and wide spread throughout the long term, landslides have caused extensive loss of property and life. In numerous nations, economic misfortunes because of landslides are great and clearly are developing as advancement ventures into unsteady slope regions under the strain of growing populaces.This devastating disaster have not let escape the most fragile ecosystem of the world i.e. the Indian Himalayan Region, impacting the key sectors such as the agriculture, transportation & communication and also frequently prompting loss of lives. The global landslides information, shares that most of the landslides in the Indian Himalayan Region are rainfall elicited, which constitute 15 % of the world's rainfall triggered landslides (Dikshit et al., 2020). There are many variables that cause the vulnerability of slants, yet the major controlling elements rainfalls, earth tremor and anthropogenic exercises. Because of shortage of plane region, they don't have other choice than to lay out their homes in sloppy regions. For development of all amenities in hostile locales they are not considering factors like deforestation, disintegration slope face unsettling influence, seepage design, water assets aggravation, precipitation, climate and seismic exercises that are critical for plan of houses, street and other life line amenity (Sarkar&Anbalagan, 2008).The 4.98 % natural disasters that happened globe wide from 1990 to 2005 were epitomized by landslides. This drift is projected to persist in future due to amplified deforestation, augmented unplanned urbanization and development, intensified provincial precipitation in landslide susceptible areas due to changing global climate patterns (Kanungo et al., 2006). Construction of road along the mountainous terrain is recurrently increases the incidence of landslides. Almost every year, frequent block of roads and loss of lives in the Ghat region of mountainous terrain are all due to landslides. Development of road network in the most unscientific, unplanned manner, lack of engineering inputs, neglecting the fragile geology of the area puts the region under great danger (Karande, 2021). The landslide dangers, overall can't be totally forestalled, however, the power and seriousness of their effects can be limited assuming that the issue is perceived before the development activity or deforestation starts. Henceforth, there is a critical requirement for recognizable unstable slopes/ slants, which can be satisfied via landslide hazard zonation mapping. The landslide hazard zonation (LHZ) of an area targets distinguishing the landslide expected zones and positioning them arranged by the level of peril from landslides. Hence, detection of landslide risk areas is crucial for vigilant tactical developmental plans in the region (Kanungo et al., 2006). Landslide susceptibility investigation can be useful in such case as specific preventive measures can be carved out opportunity to limit future danger to human existence in the most ideal manner (P M & L, 2020). Landslide susceptibility zonation focuses in the Himalayas have customarily been completed based on manual translation of an assortment of thematic maps and their superimposition. Not with standing, this approach is tedious, relentless and uneconomical with information gathered throughout lengthy time spans. As of late, because of the accessibility of a wide scope of remote detecting information along with information from different sources in advanced structure and their examination utilizing GIS, it has now become conceivable to prepare different thematic layers comparing to the causative elements that are answerable for the event of landslide in a locale (Nagarajan et al., 1998).

Landslide Hazards Studies using remote sensing & GIS

(Sarkar & Kanungo, 2004) studies a system for landslide susceptibility mapping utilizing an incorporated remote detecting and GIS approach. A piece of the Darjeeling Himalaya was chosen for the model execution. IRS satellite information, geographical maps, field information, and other enlightening designs were utilized as contributions to the review. Significant landscape factors, adding to landslide events in the locale, were distinguished and it was produced to compare thematic information layers. These thematic layers address the land, geological, and hydrological states of the landscape. A mathematical rating plan for the variables was created for spatial information examination in a GIS. The subsequent landslide susceptibility map depicts the region into various zones of four relative weakness classes: high, moderate, low, and extremely low. The susceptibility map was approved by associating the landslide frequencies of various classes. This has shown a nearby concurrence with the current field unsteadiness condition. The viability of the map was additionally affirmed by the high statistically substantial value of a chi-square test.

(Pradhan et al., 2006) studies the assessment of stress design in the piece of the Himalayan area which shows the continuous neo-tectonic exercises. The review region falls into a tectonically dynamic zone of the Central-Himalaya, with a complex geotectonic set-up bound by various faults. Endeavours have been made to assess the method as a quick calculation for speedy and time restricted examination of linear element from which the directions of the lineaments are assessed by utilizing remote detecting information. Further, the assessment of stress and the lineament examination have been utilized in planning of landslide inclined regions. Landscape data, for example, land cover, topography, lineament, faults, geomorphology and seepage has been obtained from the satellite data, and the current thematic data has been refreshed to empower the measurement of avalanche causative boundaries. Spatial and temporal multi-layered data have been utilized for landslides hazard susceptibility investigation. The subjective peril examination has been done involving the guide overlying procedures in GIS climate along the focal piece of Himalayan locale. It has been seen that the high potential zones have been found to have extremely high lineament density, low to moderate drainage density of drainage and high incline region of the landscape.

(Rawat et al., 2016) studies a landslide stock was completed in the impacted regions in light of pre-and post-flood high resolution satellite information (LISS-IV and Cartosat-2). An aggregate of 290 landslides were recognized from pre-flood satellite LISS IV (2011) data and 1665 were distinguished in post-flood satellite data along significant streams. Utilizing remote detecting and geographic data framework strategies, thematic layers were created. Utilizing the weightage rating framework and landslide danger zonation guide of the area was produced. Each class inside a thematic layer was allotted an ordinal rating from 1 to 9. Summation of these trait values was then increased by the comparing weights to yield various zones of landslide peril. A landslide hazard zonation map having five distinct zones going from extremely low risk zone to exceptionally high peril zone was produced with the target to make a dependable information base for post-disaster arrangements and for strategic developmental exercises in the region.

(Zêzere, 2002) The point of the review is to affirm the significance of separate various sorts of slant developments for a superior landslide susceptibility assessment. The review was applied to the example area of Calhandriz (11.3 km2) in the region North of Lisbon. Sixty shallow translational slides, 23 more profound translational developments and 19 rotational developments were chosen for measurable examination. Landslide susceptibility evaluation was accomplished utilizing information driven approach: the Information Value Method (Yin and Yan, 1988). The technique was applied both to the absolute arrangement of considered landslides and to each sort of slope movement and the acquired achievement rates for the most noteworthy susceptibility classes are higher in the last option case.

(Dou et al., 2015) researches on the goal to study the most extreme number of related factors with landslide event for slope-movement delineation and evaluate landslide susceptibility on Osado Island, Niigata Prefecture, Central Japan, incorporating two methods, in particular certainty factor (CF) and artificial neural network (ANN), in a geographic data framework (GIS) climate. The landslide stock information of the National Research Organization for Earth Science and Disaster Prevention (NIED) and a 10-m digital elevation model (DEM) from the Geographical Survey of Institute, Japan, were investigated. The review distinguished fourteen potential landslide modelling factors. Considering the spatial auto correlation and element overt repetitiveness applied the CF method to deal with streamline these arrangements of factors. Theorizing assuming the thematic variable layers of the CF estimates is positive; it infers that these forging factors have a relationship with the landslide event. Hence, in view of this supposition and on account of their positive CF estimates, six causative factors including incline point (0.04), slant viewpoint (0.02),lithology (0.31), drainage density network (0.34),distance to fault (0.35) and distance to the geologic borders (0.37), and have been chosen as landslide causative factors for additional investigation. We divided the information into two gatherings: 70 % (520 landslide areas) for model preparation and the excess 30 % (220 landslide areas) for approval. Then, a typical ANN model, in particular the back-propagation neural network (BPNN), was utilized to deliver the avalanche helplessness maps. The receiver operating characteristics including the region under the bend (AUC) were utilized to evaluate the model exactness.

METHODS & MATERIALS

Qualitative Methods

Landslide hazard assessment through qualitative methods is utilized with master information and experience. It is least difficult strategy for landslide hazard zonation; it tends to be utilized straight forwardly in the field by geomorphologists or geologist. Landslide hazard zonation depends on this topographical and geomorphological properties are more well-known especially for provincial scale. These strategies can be generally arranged into two sorts: Field investigation and Use of parameter maps or index maps regardless of weights (Sarkar&Anbalagan, 2008).

Field Investigation/Analysis

In field an immediate technique known as geomorphological planning of landslide danger zonation is utilized that rely upon productivity of specialist to assess the actual and potential failure of incline in light of his prior experience. This technique really relies on how much analyst comprehends and realizes geomorphological cycles following up on the area. Results are exceptionally shifting individual to individual and unsteadiness factors are weighted and positioned by their normal or expected significance in causing incline disappointment.

Utilization of Parameter or Index /AHP

It is helpful for the reinforcement of our non-judicious comprehension of a complicated or amalgamated issue utilizing a various hierarchical arrangement (Yoon and Hwang, 1995) AHP strategy was utilized for distinguishing regions which are liable to landslides, here it appoints values to each causative module of landslides vulnerable regions that have been captured through aerial photos and assess the total vulnerability of landslide utilizing that score gave to each causative element. AHP technique utilizes the idiosyncratic judgment and their experience of expert into a layer design, and communicates the interaction quantitatively. Here, the landslide susceptibility implies the chance of another landslide in the area where landslides have been happened historically (Saaty & Vargas, 2013; Sarkar & Anbalagan, 2008).

Quantitative Methods

This strategy has been created to correct elevated degree of subjectivity regarding better adept decisions assessment. This assessment include the assurance of different blend of factors and these factors was primary explanation of prior flux after that these techniques are performed for stable incline and areas where comparative circumstance exist (Dai and Lee, 2001).

Statistical Methods

The statically techniques depend on connections that have been perceived between each element that have auxiliary to current and historical landslide conveyance. All potential causative landscape factors are weighted and coordinated involving GIS for landslide vulnerability analysis. The unwavering quality and limit of practical technique is relies upon magnitude and unwavering quality of gathered information. Statistical Methods includes Bivariate, multivariate statistic functions (Carrare et al., 1991).

Bivariate Methods

In bivariate statistical strategies, each element map is joined with the landslide dispersion map, and weight values in light of landslide densities are determined for every boundary class. A few statically techniques can be applied to work out weight values, for example, Bayesian combination rules, information value method, certainty factors, and weights of evidence modelling, fuzzy logic and Dempster–Shafer method. Bivariate measurable techniques are a great learning instrument that the expert can use to decide which elements or mix of variables assumes a part in the commencement of landslides. It doesn't consider the relationship of factors, and it needs to act as an aide while investigating the dataset before multivariate techniques are utilized (Pardeshi et al., 2013).

Multivariate methods

Multivariate methods assess the consolidated connection between a conditional variable (landslide event) and a sequence of autonomous factors (landslide controlling variables). In this sort of research, all applicable variables are tested either on a lattice premise or on the other hand in gradient morphometric units. For every one of the testing units, the presence or non appearance of landslides is defined. The subsequent lattice is then examined utilizing logistic regression, multiple regression, discriminant analysis, active learning or random forest. The outcomes can be communicated with regards to probability (Shano et al., 2020).

Physically based models

Physically based landslide vulnerability evaluation techniques depend on the demonstrating of slope failure courses. The techniques are just relevant over huge regions when the geographical and geomorphological circumstances are genuinely homogeneous and the landslide types are basic. Most Physically based models that are applied at a neighbourhood scale utilize the boundless slant model and are subsequently just relevant for the examination of shallow landslides (under a couple of meters top to bottom). Physically based models for shallow landslides represent various triggers, for example, the transient groundwater reaction of the slopes to precipitation and additionally the impact of tremor excitation.Physically based models are applicable to regions with inadequate landslide inventories. The factors utilized in such models are most frequently quantifiable and are viewed as state factors that have a distinctive value at a given period and space. Most physically based models are operational in nature, suggesting that they route forward (or in reverse) in time, continually working out the upsides of the state factors in light of the situations consolidated. Whenever carried out in a spatial structure (a GIS model), such models are likewise capable to work out the progressions in the qualities after some time for each unit of examination (pixel). The aftereffects of such models are more concrete and reliable than those of heuristic and measurable models (Corominas et al., 2013).

CONCLUSION

The evaluation of landslide hazard and arrangement of landslide risk zonation map is animperative task in the region of calamity. There are numerous strategies involved by a few researchers in various regions of the globe. In a large portion of the methods however input factors are generally something very similar, they vary in positioning the elements. In everyday the techniques are either founded on the subjective methodology which directs the weight task to the factors in view of the experience and master information or the statistical methodology which include connection between existing landslides and the variables.

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