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Recent Trends and Techniques in Landslide Hazard Assessment

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Abstract

Landslides are a serious concern in steep terrain where severe storms are common. The magnitude of landslide risk depends not only on storms and the physical characteristics of the land, but human activities, especially agricultural practices, are important. An essential stage in the management of landslide risk and hazard is landslide hazard assessment. Landslide Hazard Zone (LHZ) choice processes include intuitive, half size, Quantification, Probability and Multi-criteria approaches. Among the various techniques used traditionally, Multivariate approaches, albeit with limitations, to assess landslide risk at a regional scale Very feasible and cost effective. Over the past two decades, landslide research has expanded use of the sophisticated tools of remote sensing and geographic information systems (GIS) to study landslide hazards.

Keywords: Landslide Hazard, Land Hazard Zonation, Geographic Information Systems

Introduction

Landslides, one of the most common natural disasters, cost the economy heavily in direct and indirect costs of property loss every year. A landslide is described as the movement of rocks, debris, or soil down a slope caused by external factors such as heavy rains, earthquakes, and changes in water levels, storm surges, or rapidly eroding streams. A sudden rise in shear stress or a fall in the shear strength of the constituents of a slope [3]. Geologists, engineers, members of society, and local governments throughout the world have all developed a keen interest in assessing landslide risk and hazard in recent years [2]. Understanding, predicting and controlling the risk associated with landslides is still an empirical task given the current state of knowledge. Geology, structural geology, engineering geology, hydrology, hydrology, geophysics, geotechnology and civil engineering. Risk assessment can be analysed at multiple spatial and temporal scales according to the objective [6]. Advances in geospatial technology will help reduce losses as it emerges as a powerful technique for mapping the landslide hazard zone. Different researchers use different methods to assess landslide risk. But, there is no universally accepted method to effectively assess landslide risk [9]. The usage of such GIS-based technologies has demonstrated that the majority of tasks can be completed quickly and affordably. It is anticipated that improved GIS modules, faster computers, and more advanced data capture/visualization equipment will eventually be affordable and capable of doing broad and advanced spectrum spatial analysis.

Landslide Hazard

A major geological hazard that harms the natural and social environment is landslides. Although they are a part of nature, landslides may be dangerous, lead to fatalities, and harm both man-made and natural infrastructure. Numerous publications have varied definitions for the word "landslide risk." [1]. Landslides are considered hazards only when they impact society or the environment [14]. The chance of a pretty stable condition abruptly changing, or the likelihood that an event would cause harm in a certain location and over a specific amount of time, is how physicists describe a natural hazard [10]. Landslides are a minor but significant part of the range of risks that civilization is experiencing on a global scale. If given the option, individuals would choose to rely on their safety by residing in locations on Earth that are free from the risk of landslides [11]. In early twenty first century publication on landslide hazard in India were very rare. In recent years number of publications on landslide hazard in India are steadily increasing. The temporal frequency of triggering events and the danger of landslides are tightly related. When analysing the danger of landslides in a changing environment, the time component is crucial [12]. Landslides are frequently caused by earthquakes.

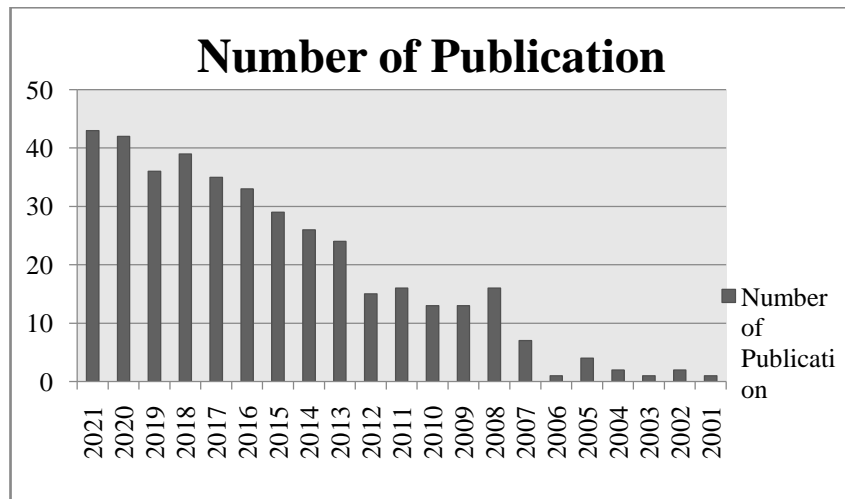


FIGURE 1. No of publication on Landslide hazard in India

Landslides and other types of ground collapses brought on by earthquakes can occasionally inflict more damage than damage directly caused by seismic activity and fault rupture [13]. A high number of landslides and related damage typically come from triggering events like moderate to severe earthquakes or extremely intense rainfall; maps showing a predicted strong seismic event or documented heavy rainfall event show a worst-case scenario. An area's deterioration can be attributed to a history of unstable obesity [34]. Since rainfall-induced landslides have recently resulted in considerable property damage and fatalities, it is crucial to evaluate the slopes' post-failure behaviour [29]. The initial impact of an earthquake increases as the earthquake's magnitude rises. Levelling happens quickly, but landslide losses rise more quickly. [60].

Land Hazard Zonation

Extrinsic factors, such as rainfall and human activity, and intrinsic factors, such as geological conditions and landslide structures, are two groups that affect the risk of landslides [17]. As a result of industrial and recreational expansion, infrastructure development, disruption of communication arteries and population growth across the country, many countries [19]. Related to vulnerability, risk and frequency assessments more on the list of difficulties a large amount of expert input is required to develop risk and subsequent risk zoning [4]. It is often desirable to estimate order to compare risk locations and calculate the resulting risk. Their sensitivity all affects the risk zone. These components should be evaluated for new developments. Risk maps for regions with current development should be updated often since hazards might alter when new development occurs [48]. Frequently occurring catastrophic natural events including earthquakes, large-scale movements, floods, and avalanches are linked to mountain building. These processes frequently conflict with one another, creating a variety of natural risks for infrastructure and mountain residents [21]. Maps showing landslide-prone locations are necessary for officials and decision-makers to take these areas into account when making development plans and/or putting suitable risk reduction measures in place. Many organizations and scientific societies have provided standards for creating landslide hazard maps to help with risk management choices. There are numerous techniques for determining landslide susceptibility, risk, and hazard [26]. An important to refer the unfavorable outcomes or loss of life and property as a result of the occurrence of landslides. Landslide risk assessments, necessary for planning a variety of development activities in the area [28]. Figure 2 shows the appearance of landslide hazard in India. In India most of the places have very low landslide hazard. In the Himalayan regions landslide hazard zones are high. Detection and monitoring of frequently inaccessible landslides and associated phenomena in the Himalayas owing to the mountainous terrain and inadequate infrastructure development, is the first step in achieving this. High resolution earth monitoring capabilities from orbiting satellites. Identification of landslide-prone regions by landslide hazard zoning, which refers to the partition of land into homogenous units and classifies them in accordance with the likelihood that landslides would occur, is a second step in this direction [27].

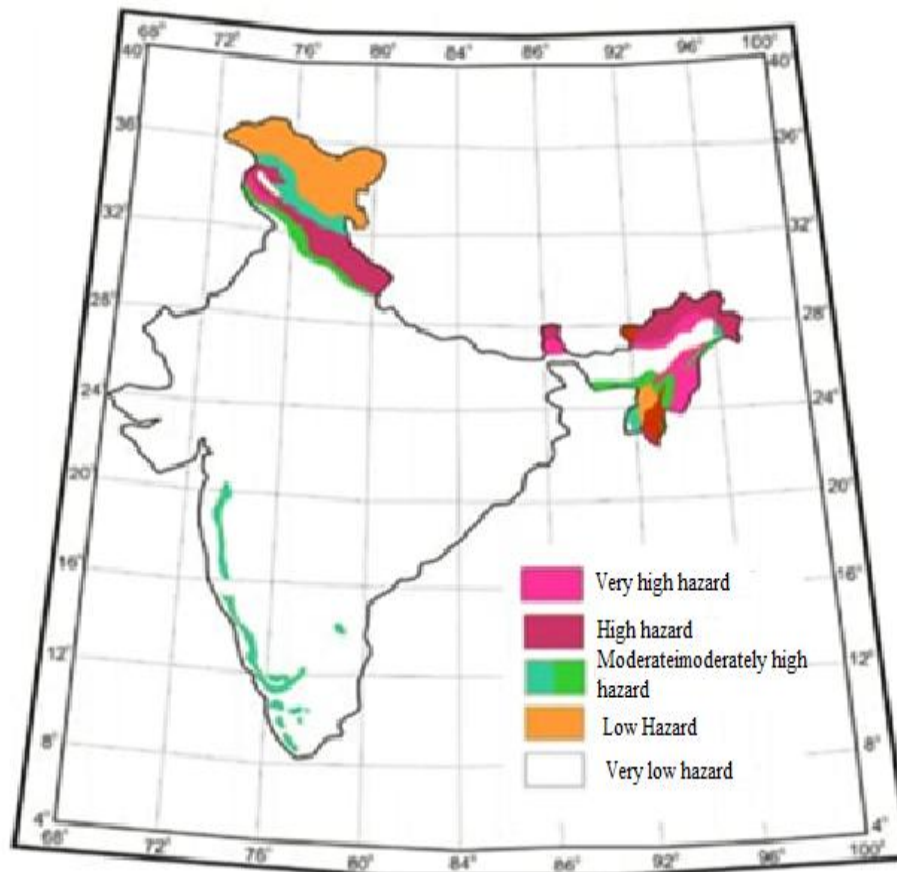


FIGURE 2. Map showing land slid hard zones in India

To get knowledge of the geographical and temporal frequency of landslides in order to produce an accurate map of landslide risk and hazard forecasting in a specific region. The fullest possible representation in time and place [30]. Landslide Hazard Zone Map, Based on the projected fit of factors that create instability Divides the ground surface into zones of different stability. Using a macro-zonal methodology, the Land Hazard Zone Mapping technology displays the likelihood of landslide dangers. Maps of land hazard zones are often created at scales between 1:25,000 and 1:50,000. Desk research and field investigations are the two basic parts of LHZ mapping [31]. A landslide risk reduction strategy is made easier by a map of the Landslide Hazard Zone (LHZ). Based on geo environmental elements conducive to landslides locally, it gives previous information about landslide prone zones. Based on the parallel that future landslides are anticipated in areas with the same geo environmental circumstances as previous and present landslide locations, the LHZ assumption was developed [42].

Land Hazard Assessment

A thorough understanding of landslide processes, probable failure modes, and features of landslide debris runout should serve as the foundation for any evaluation of landslide risk. Otherwise, it is impossible to provide a trustworthy assessment of landslide risk to guide risk management choices [23]. National, regional, and local authorities must participate in land slide risk reduction at different levels, frequently with the assistance of decision-makers from the scientific community [24]. To reduce potential harm, it is obvious that we need to better understand geological. In the past three decades, geoscientists have made a lot of efforts to create express implicit goal better managing slope instability [25]. Assessments of the risk of landslides in metropolises and urban regions have significant social effects. The chosen areas are populated thickly, and the predicted landslide damages are substantial. [32]. Figure 3 explains outline of a framework landslide risk assessment and management. The first step to a proper landslide hazard assessment must have thorough knowledge of past events, achieved through direct or indirect surveys [36]. Evidence of previous landslides, stress fractures, and other observable ground motion are thought to be the most helpful direct indications of landslide vulnerability. Indications of prior landslides and mass movement are therefore included in the most basic form of landslide risk assessment, suggesting that a region with previous landslides has a higher landslide risk and a higher possibility of new landslides [47]. Landslides are the consequence of a complex interplay between geological, geological, and hydrological factors that harm and disturb individuals, groups, companies, and the environment. Landslides are accelerated by human activity that modifies the environment, such as road construction and forest removal. These conditions are impacted by human activity in forests on various spatiotemporal scales. Such actions have an impact on age and plant density as well as composition, root strength, and biomass surcharge at the individual level. The climate, evaporation and transpiration and groundwater within the watershed may be impacted by these acts. Removal of aquaculture habitat, clogging of organic matter and debris during peak flows, these can degrade canals and riparian vegetation. Landslides have a regional and worldwide influence on water quality [38].

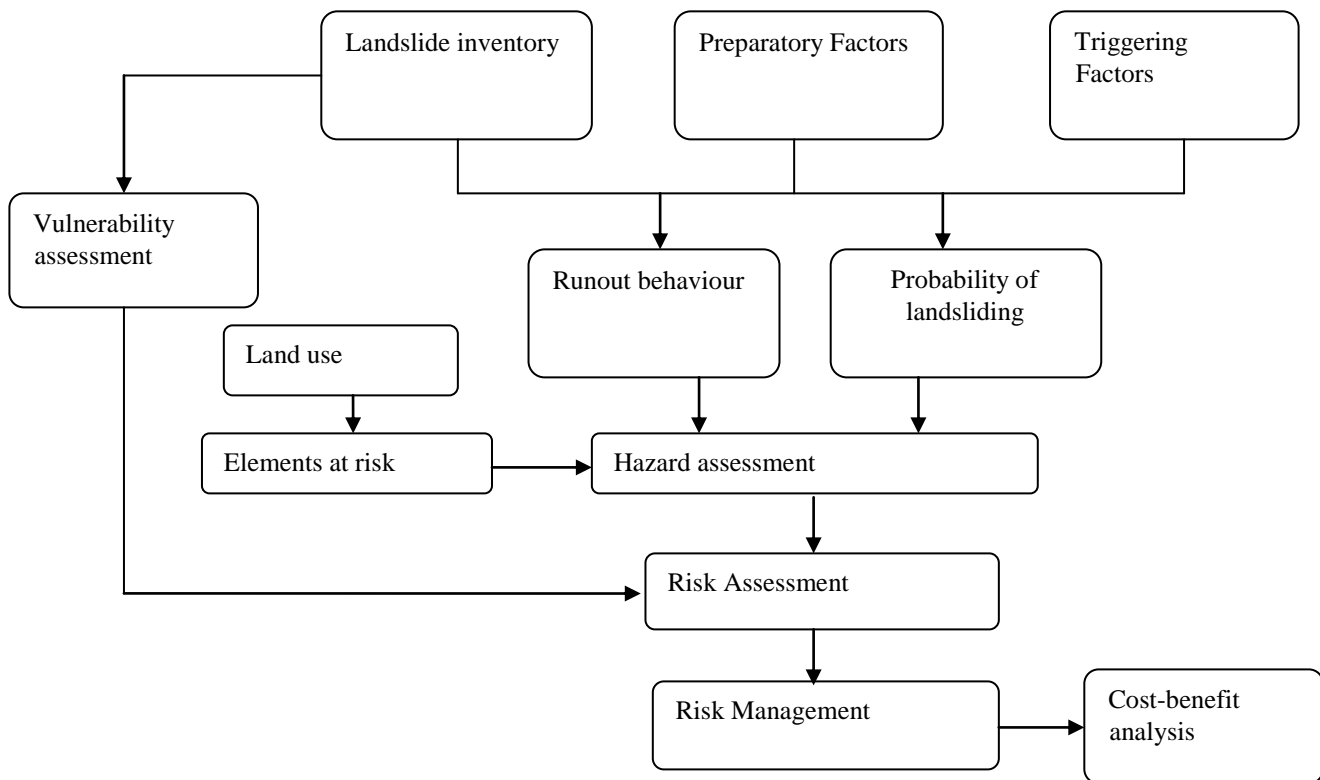


FIGURE 3. A framework Landslide Risk Assessment and Management

There is always a risk to the land when a landslide happens. It could be woodland, farmland, or deserted area. Transportation corridors, industrial and commercial complexes, schools, and parks are among the places that are susceptible to landslides [41]. Post-event/disaster evaluations are a crucial Component of risk and risk management. Human and physical systems about how they respond to stress they deepen our understanding. Which eventually yields more potent and effective risk-reduction strategies [43]?

Geographic Information System (GIS)

Using a Geographic Information System (GIS) various types of data can be created, maintained, analyzed and mapped. Location data (locations of objects), by combining different types of descriptive data with GIS links data to maps (what things are there). Many instability factors, mostly Morphological and geological character, can now be collected, stored and analysed in digital form at a reasonable cost. In example, novel morph metric parameters can be easily created over broad areas and employed as predictors of landslide occurrence by analyzing elevation data and its derivatives [5].

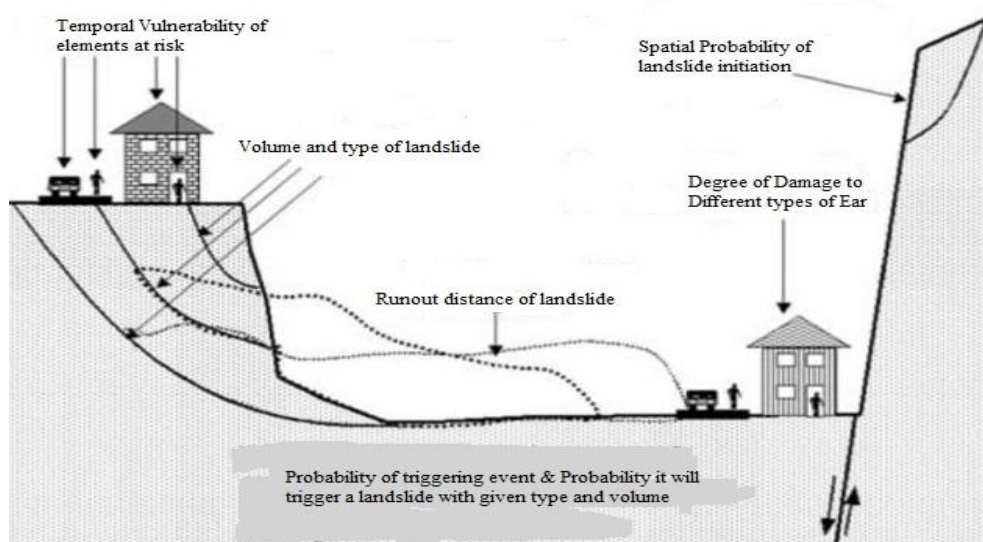


FIGURE 4. Illustration of some of the most problematic aspects of landslide risk assessment

Figure 4 illustrates a few of the issues with forecasting the volume of the estimated landslide, its movement range and its geographical and temporal likelihood of the risk.

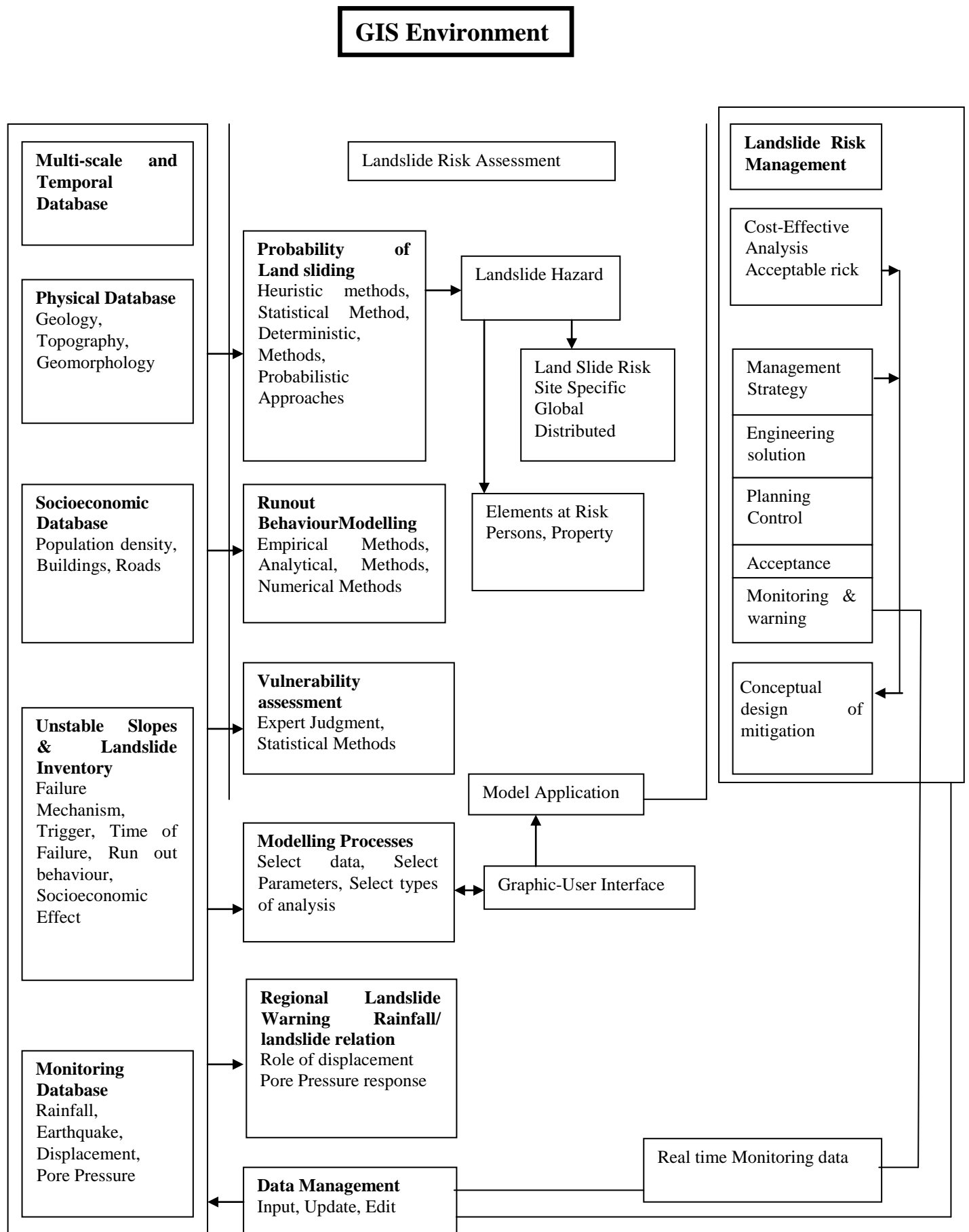


FIGURE 5. A GIS-based conceptual integrated system for landslide risk assessment and management

As shown in Fig. 5, these techniques can generally be integrated for the purpose of landslide risk assessment and management. For a probabilistic estimate of landslide hazard, accurate Location of landslides is essential. Such as Satellite photos and aerial photographs Use of remote sensing data can be beneficial in acquiring important and affordable knowledge concerning landslides [49]. The locations that are vulnerable to landslides are shown on a map of landslide hazard. The elements that cause and trigger the occurrence (such as terrain, geography, and weather), as well as information on the historical distribution of landslide failures. Assessment of the danger of landslides is crucial for managing and assessing natural catastrophes. For natural and urban planning in global government policy, it is a vital stage [35].

Conclusion

Identifying the landslide hazard zone is a crucial step in the landslide management procedure. Numerous preparation and triggering elements that differ greatly from place to region have an impact on landslides. As a result, estimating the weight of a particular characteristic is challenging. Despite the fact that landslide-related losses seem to be more severe in developed nations (such as the USA, Japan, Italy, France, etc.), given the mounting environmental strain, they might cause an economic downturn or even stagnation in emerging nations. The benefit of employing hazard maps is obvious: by using them rationally, appropriately, and on time, landslides' financial costs and other effects may be considerably reduced. Risk analysis and Recent Advances in Risk Assessment Structured to improve disaster management, have begun to provide accurate procedures. As a strategy to deal with the unpredictability that accompanies landslide hazards Risk analysis and assessment have gained prominence in recent years. The management and evaluation of landslide risk should make more use of contemporary technology like GIS and remote communications. Multivariate technologies are evolving into a better tool for creating predictive and descriptive risk models as GIS's capacity for effective data manipulation grows. Obviously, the calibre of the input elements and the chosen terrain-unit type affect both their dependability and utility. Although they have some limitations, multivariate approaches are the most practical and economical ways to assess landslide risk at the regional level. This is accurate provided data collecting, processing, and analysis are done extensively and carefully using GIS methodologies.

Reference

1. Dai, F. C., Chin Fei Lee, and Y. Yip Ngai. "Landslide risk assessment and management: an overview." *Engineering geology* 64, no. 1 (2002): 65-87.
2. Aleotti, Pietro, and Robin Chowdhury. "Landslide hazard assessment: summary review and new perspectives." *Bulletin of Engineering Geology and the environment* 58, no. 1 (1999): 21-44.
3. Van Asch, Theodore WJ, Jean-Philippe Malet, Ludovicus PH van Beek, and David Amtrano. "Techniques, issues and advances in numerical modelling of landslide hazard." *Bulletin de la Société géologique de France* 178, no. 2 (2007): 65-88.
4. Kaur, Harjeet, Srimanta Gupta, and Surya Parkash. "Comparative evaluation of various approaches for landslide hazard zoning: a critical review in Indian perspectives." *Spatial Information Research* 25, no. 3 (2017): 389-398.
5. Pardeshi, Sudhakar D., Sumant E. Autade, and Suchitra S. Pardeshi. "Landslide hazard assessment: recent trends and techniques." *SpringerPlus* 2, no. 1 (2013): 1-11.
6. Liu, Jian Guo, P. J. Mason, Nicola Clerici, S. Chen, A. Davis, F. Miao, H. Deng, and L. Liang. "Landslide hazard assessment in the Three Gorges area of the Yangtze river using ASTER imagery: Zigui-Badong." *Geomorphology* 61, no. 1-2 (2004): 171-187.
7. Guzzetti, Fausto, Alberto Carrara, Mauro Cardinali, and Paola Reichenbach. "Landslide hazard evaluation: a review of current techniques and their application in a multi-scale study, Central Italy." *Geomorphology* 31, no. 1-4 (1999): 181-216.
8. Crozier, Michael J., and Thomas Glade. "Landslide hazard and risk: issues, concepts and approach." *Landslide hazard and risk* (2005): 1-40.
9. Van Beek, L. P. H., and Th WJ Van Asch. "Regional assessment of the effects of land-use change on landslide hazard by means of physically based modelling." *Natural Hazards* 31, no. 1 (2004): 289-304.
10. Refice, Alberto, and Domenico Capolongo. "Probabilistic modeling of uncertainties in earthquake-induced landslide hazard assessment." *Computers & Geosciences* 28, no. 6 (2002): 735-749.
11. Kwag, Shinyoung, and DaegiHahm. "Development of an earthquake-induced landslide risk assessment approach for nuclear power plants." *Nuclear Engineering and Technology* 50, no. 8 (2018): 1372-1386.
12. Mori, Hiroto, Xiaoyu Chen, Yat Fai Leung, Daisuke Shimokawa, and Man Kong Lo. "Landslide hazard assessment by smoothed particle hydrodynamics with spatially variable soil properties and statistical rainfall distribution." *Canadian Geotechnical Journal* 57, no. 12 (2020): 1953-1969.
13. Budimir, M. E. A., P. M. Atkinson, and H. G. Lewis. "Seismically induced landslide hazard and exposure modelling in Southern California based on the 1994 Northridge, California earthquake event." *Landslides* 12, no. 5 (2015): 895-910.
14. Huabin, Wang, Liu Gangjun, Xu Weiya, and Wang Gonghui. "GIS-based landslide hazard assessment: an overview." *Progress in Physical geography* 29, no. 4 (2005): 548-567.

15. Lacasse, Suzanne, and Farrokh Nadim. "Landslide risk assessment and mitigation strategy." In *Landslides—disaster risk reduction*, pp. 31-61. Springer, Berlin, Heidelberg, 2009.
16. Van Westen, C. J., Th WJ Van Asch, and Robert Soeters. "Landslide hazard and risk zonation—why is it still so difficult?." *Bulletin of Engineering geology and the Environment* 65, no. 2 (2006): 167-184.
17. Flentje, Phillip N., Anthony Miner, Graham Whitt, and Robin Fell. "Guidelines for landslide susceptibility, hazard and risk zoning for land use planning." (2007): 13.
18. Corominas, Jordi, Cees van Westen, P. Frattini, L. Cascini, J-P. Malet, S. Fotopoulou, F. Catani et al. "Recommendations for the quantitative analysis of landslide risk." *Bulletin of engineering geology and the environment* 73, no. 2 (2014): 209-263.
19. Krishna Kumar, T. P., M. Ramachandran, and Sathiyaraj Chinnasamy. "Exploring Various Applications of Block Chain Technology." *Recent trends in Management and Commerce* 1, no. 1 (2020): 92-96.
20. Kanungo, D. P., M. K. Arora, R. P. Gupta, and S. Sarkar. "Landslide risk assessment using concepts of danger pixels and fuzzy set theory in Darjeeling Himalayas." *Landslides* 5, no. 4 (2008): 407-416.
21. Van Westen, Cees J., Enrique Castellanos, and Sekhar L. Kuriakose. "Spatial data for landslide susceptibility, hazard, and vulnerability assessment: An overview." *Engineering geology* 102, no. 3-4 (2008): 112-131.
22. Anbalagan, Rathinam. "Landslide hazard evaluation and zonation mapping in mountainous terrain." *Engineering geology* 32, no. 4 (1992): 269-277.
23. Anbalagan, Rathinam, Rohan Kumar, Kalamegam Lakshmanan, Sujata Parida, and Sasidharan Neethu. "Landslide hazard zonation mapping using frequency ratio and fuzzy logic approach, a case study of Lachung Valley, Sikkim." *Geoenvironmental Disasters* 2, no. 1 (2015): 1-17.
24. Ho, K. K. S., and F. W. Y. Ko. "Application of quantified risk analysis in landslide risk management practice: Hong Kong experience." *Georisk* 3, no. 3 (2009): 134-146.
25. Giordan, Daniele, Martina Cignetti, Aleksandra Wrzesniak, Paolo Allasia, and Davide Bertolo. "Operative Monographies: Development of a new tool for the effective management of landslide risks." *Geosciences* 8, no. 12 (2018): 485.
26. Remondo, Juan, Jaime Bonachea, and Antonio Cendrero. "Quantitative landslide risk assessment and mapping on the basis of recent occurrences." *Geomorphology* 94, no. 3-4 (2008): 496-507.
27. Sassa, Kyoji, Gonghui Wang, Hiroshi Fukuoka, Fawu Wang, Takahiro Ochiai, Masanori Sugiyama, and Tatsuo Sekiguchi. "Landslide risk evaluation and hazard zoning for rapid and long-travel landslides in urban development areas." *Landslides* 1, no. 3 (2004): 221-235.
28. Catani, F., N. Casagli, L. Ermini, G. Righini, and G. Menduni. "Landslide hazard and risk mapping at catchment scale in the Arno River basin." *Landslides* 2, no. 4 (2005): 329-342.
29. Nichol, Janet E., Ahmed Shaker, and Man-Sing Wong. "Application of high-resolution stereo satellite images to detailed landslide hazard assessment." *Geomorphology* 76, no. 1-2 (2006): 68-75.
30. Gorsevski, Pece V., Paul E. Gessler, Randy B. Foltz, and William J. Elliot. "Spatial prediction of landslide hazard using logistic regression and ROC analysis." *Transactions in GIS* 10, no. 3 (2006): 395-415.
31. Krishna Kumar TP, M. Ramachandran, Sathiyaraj Chinnasamy, —Investigation of Public Transportation System Using MOORA Method, *REST Journal on Emerging trends in Modelling and Manufacturing*, 6(4), (2020): 124-129.
32. Anbalagan, R., and Bhawani Singh. "Landslide hazard and risk assessment mapping of mountainous terrains—a case study from Kumaun Himalaya, India." *Engineering Geology* 43, no. 4 (1996): 237-246.
33. Crozier, Michael J. "Management frameworks for landslide hazard and risk: issues and options." *Landslide hazard and risk* (2005): 331-350.
34. Carrara, Alberto, Mauro Cardinali, Fausto Guzzetti, and Paola Reichenbach. "GIS technology in mapping landslide hazard." In *Geographical information systems in assessing natural hazards*, pp. 135-175. Springer, Dordrecht, 1995.
35. Carrara, Alberto, and Richard J. Pike. "GIS technology and models for assessing landslide hazard and risk." *Geomorphology* 94, no. 3-4 (2008): 257-260.
36. Perotto-Baldivezo, H. L., T. L. Thurow, C. T. Smith, R. F. Fisher, and X. B. Wu. "GIS-based spatial analysis and modeling for landslide hazard assessment in steep lands, southern Honduras." *Agriculture, ecosystems & environment* 103, no. 1 (2004): 165-176.
37. Gupta, R. P., and B. C. Joshi. "Landslide hazard zoning using the GIS approach—a case study from the Ramganga catchment, Himalayas." *Engineering geology* 28, no. 1-2 (1990): 119-131.
38. Lee, Saro, and Biswajeet Pradhan. "Landslide hazard mapping at Selangor, Malaysia using frequency ratio and logistic regression models." *Landslides* 4, no. 1 (2007): 33-41.