A CONCEPT ANALYSIS AND REVIEW OF LITERATURE ON LANDSLIDE PREDICTION WITH DIGITAL IMAGE PROCESSING*

BY

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ABSTRACT

Global climate change causes landslide occurrence has been increased and subsequently, rise in the losses and damages associated with landslides. To save life of people in mountainous area from it is very important to warn them early. Landslides cause a serious harm to terrestrial life and activities in most high mountain ranges. Because of a difficult nature of such mountains ranges, it is very difficult to assess the susceptibility of slopes to landslides. Hence these situations give much importance to remote sensing specially in less developed areas. It is much important for the technique to be much accurate when it deals with life & environment. This review is to study Landslide Prediction in prone areas and to develop the new technique which will be more prominent warn administration or people so that they can take necessary actions to save life, environment & economic loss. It is very essential to build such a system which will earn the people and the authority in the hilly areas prior to the landslide which will save the people and animals in the prone region.

KEYWORDS

Landslide, Satellite, Hazard Assessment, Remote Sensing, Mountainous Region.

I.Introduction

Every year, landslides claim thousands of lives and cause considerable economic damage to buildings, roads, and other infrastructure around the world. As natural hazards, landslides are largely unpredictable. Improvement in the monitoring, detections, and investigations of landslide helps to raise the understandings of the process that causes this kind of disaster. Hence it can assist us to solve ecological problems, and to address it and for mitigating risk, and to deliver

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skilled prediction of the upcoming behavior of Earth system (natural disasters, state of oceans, atmosphere, land, vegetation, food, public health, etc). Landslides are severe environmental hazards in mountainous areas. Nowadays, the threat of landslides to public safety has become more pronounced resulting from the burgeoning development and the increase of deforestation in hilly areas, and the increase of regional precipitation caused by global climate change. Traditional landslide risk assessment requires immense physical power to assemble different data, such as identification of landslide location and land- cover classification. [1-2]

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across the world. As natural hazards, landslides are largely unpredictable. Improvements in the monitoring, detection, and investigation of landslides will help raise the understanding of the processes that cause these disasters and help researchers identify their early warning signs. This system will contribute to a society a very effective model which will work in the welfare of human beings by predicting landslide in prone areas.

II.Related Work on Landslide Prediction

This literature on landslide risk assessment indicates that a lot of developments have taken place in the last decade , and that quantitative risk assessment for individual locations is feasible .Though, the generations of quantitative risks conational map, expresses the expected financial losses as the product of probability (of happening of a landslides with a given extent), costs (of the elements at risk) and vulnerability (the degree of damage of the elements at risk due to the occurrence of a landslide with a given magnitude) seems still a step to far. In the intervening time, risk map is shaped for numerous municipalities, following practical and qualitative approaches.[3]

Current researches has established that in mountainous chains undergoes high rates of strengthen; landslide is an predictable and necessary environmental processes. This has important implications for humans, who are often adversely affected by landslides. As a result, the delineation of landslides is extremely important, but there is a general recognition that the process is Difficult, especially where the slopes are covered in dense vegetation or are cultivated. [4-6]

Further study is conducted on landslide with the forecasting model using ground based SAR data: it is the Portalet case study performed by the researcher G. Herrera in 2019.Researcher performed the Manual Landslide Prediction in Spain in by installing ground based station and SAR. Tree rings as an early warning against catastrophic landslides: assessing the potential of dendrochronology for determining slope stability by Małgorzata Wistuba in the year 2018; t his

study is Dendrochronological analysis conducted on landslides at Łaski, Siedloki and Janowiec to predict landslide.[7]

In the year 2020, Olga Sarychikhina, David Gómez worked on the Application of satellite SAR interferometry for the detection and monitoring of landslides along the Tijuana – Ensenada.It was Satellite, Ground based station and SAR based Landslide detection. Last studies of Landslide monitoring by using ground-based SAR interferometry: an example of application to the Tessina landslide in Italy by Dario Tarchi , Nicola Casagli in 2002, Landslide detection using GBSAR. Landslide susceptibility analysis (or spatial probability analysis) estimates the potential for a landslide by taking in to consideration the multiple factor such as landslide inducing (or conditioning factors) and analyzing the spatial distribution of these factors. [8-9]

Landslides forecasting consist in the prediction of incline failures in spatial and/or temporal conditions. In the initial case the plan is giving a spatial prospect of where instability might happen. This is classically carried out through susceptibilities, hazards, or risks map: the primary one implies classification, estimation of the areas or volumes, and assesses the spatial distributions of accessible and possible landslide in the study areas; danger map is associated to the

frequencies (i.e. annual prospect) of landslide; hazard maps also review the potential damages to the element at risks. Susceptibilities map is frequently the result of combine the weighted influences that numbers of parameters can have on the landslides disposition, e.g. slope gradients, lithology, land envelop, aspects, drainages characteristic, etc.. Risk map naturally defines the chance of occurrences from the data in terms of information concerning the frequencies of last event or from model that figure out the factors of security. The spatial predictions can also comprise where and how the separate materials will traverse and ultimately deposits. This is time and again considered with empirical or numerical model. The topic of spatial landslides predictions would necessitate a deeper dissertations which is not done till now.[Table-1][10-12]

Recent studies focus on the temporal prediction of landslides, that can be distinct as the determinations of the time of collapses of a landslides (or part of it) within an satisfactory margins of errors. Temporal predictions can be performing at worldwide/local scales or at slope-scales; the choices of the scales are typically associated to the choices of the monitor parameter. In fact, dissimilar approaches depending on which parameters are adopted to indicate possible imminent failures. Normally, regional scales prediction can only be completed using rainfall monitor and a geomorphologic, hydro-meteorology approaches, while slope-scales

predictions can take advantages of geotechnical approaches relating displacements or other kind of information at the time of failures. Though forecasting method employing rainfall information exists also for slope- scales application, researchers bring into notice that only 4.2% of the rainfall method they review is conceive for slope-scales,

while rest of them were for sink or regional scales.[Table-1][12-16]

and our abilities to execute relatively correct weather forecasts. [6][9]

On the other hand, if the slope-scales details are required, since these approaches adopts indirect indicator of instability (rainfall), they are more prone to wrong alarm. Such restriction may not forever convince the requirement of acceptable margin of errors. Other forecasting method can present slope- scales prediction of the time of failures and exploit emission greater frequency, water pr essure or special indicator as tell-tale sign that suggests the slopes are experiencing structure damage and may be lying on your front to failure. [10-13]

Though such parameters may be quantitatively measured all the way through experts‟ evaluations of failure risk, their enclosed space within codified early warning systems are not ordinary practices. [11,14]

Reference	Auth or	Year	Findings
[7]	DarioTarchi , Nicola Casag li	2002	To identify thelandslide GBSAR is used.
[8]	Gonz alo Pajares	2015	The use ofUAV to detect landslide is Studies in papers with 600 casestudies.
[16]	Jie Donga	2019	*Iterative Linear Model(ILM) *fuse troposphericdelays These twotechniques are used to predictlandslides.
[9]	G. Herrera	2019	SAR andground basedstation are usedto detect landslide.
[10]	Małg orzata Wistuba	2018	Dendrochronol ogical analysisconducted on landslides atŁaski, Siedlokiand Janowiec to predictlandslide
[11]	Sarychikhi na, Gómez	2020	SAR andground basedstation are usedto detect landslide.

[12]	Y. Zhang	2020	SAR andground based station are usedto detect landslide. (Interferometri c Synthetic ApertureRadar)
[13]	Lu Zhan g Mingsheng Liaob , Jianya Gong a	2016.	Proposed two complementaryapproaches to correct the stratified tropospheric delays for time series InSAR analysis when studying single Landslides.
[16]	Andrea Ciam palinia,∗, Federico Raspini a,SilviaBianchini a,William Frodella a, Feder ica Bardi	2015	In this work, ageo database oftheMessinaProvince ispresented anddescribed highlighting the capabilityof the GISenvironment to obtain useful products for themanagement ofthe landslide

Table 1: Literature Survey of Landslide Prediction

The most general uses of precipitations information is to derive rainfall threshold. These classically take the forms of rainfall- intensity threshold, threshold that are base on the whole event rainfall, event-duration threshold, event-intensity threshold, and threshold that are base on predecessor precipitations. All the method depends on the truth that rainfall is a chief trigger of slopes instabilities. Their extensive use is associated to the possibilities of making sequential prediction at the regional scales

A. Key Findings from the literature Review

- Most of the work is performed on landslide detection and very few are on the landslide prediction.
- No land slide prediction technique is available to cover huge prone areas.
- Some studies are based on the geotechnical approaches relating displacements or other kind of information at the time of failures.
- Certain studies are on the most general uses of precipitations information to derive rainfall threshold.
- Some landslide prediction is performed with the slope-scales details, since these
- approaches adopts indirect indicator of instability (rainfall), they are more prone to wrong alarm.

- Little work is performed on land slide prediction by using the nature of soil but it is very difficult to get the information of soil of huge prone areas.
- There is a need of some more prominent technology with which one can predict landslide at least two days before it happens. Eventually we can take corrective measures to save the life of people.

III.Landslide Inventory

There are multiple triggering factors which influence landslides which may cause the loss of lives as well as economic losses.

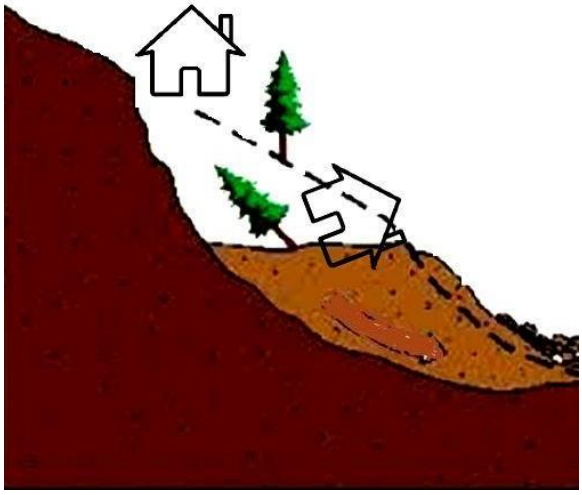

Fig1. Landslide Inventory.

There is a need of Inventory mappings of landslides to calculate the occurrences of landslides landslide. To measure the occurrences of landslides the inventory mapping takes in to account the multiple factors such as mass of the landslides, amount of landslide and the place of landslides. To implement essential mitigation measure to save life on earth and the economical losses the inventory maps are very essential.

Result and Discussions Findings

Landslide prediction is done only with the help of ground based SAR remote sensing stations. This technique is accurate but very time consuming, limited to small area and needs lots of hardware installation and manpower and not economic.

Image based land slide prediction is taken placed but these are the general drone images which does not provides accuracy to the result and this technique is limited to particular areas and not gives exact result.

So for the generation of accurate landslide prediction system there is a need to develop more prominent system.

IV.Conclusion:

As natural hazards, landslides are largely unpredictable. Improvements in the detection, monitoring, and examination of landslides will use to improve the understanding of the cause to disasters and help researchers recognize their early warning. To different areas are there in the field of landslide prediction to predict landslide accurately and cover large area for landslide prediction. To know the nature of soil in huge mountainous region is nearly impossible with current technology. So research in landslide prediction with conventional methods is restricted to limited area.

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