APPLICATION OF GEOINFORMATICS FOR LANDSLIDE SUSCEPTIBILITY ANALYSIS IN KONKAN REGION, MAHARASHTRA

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ABSTRACT:

The aim of this project is to delineate the susceptible zones near Kankavli railway station situated in Konkan region of Maharashtra. The Konkan region has a big railway transport mode that connects many big cities of Maharashtra with Konkan region. Konkan railway project in itself is wondrous project in transportation sector. Due to heavy cutting of existing topography and unstable slopes the terrain is more prone to disasters such as landslides which often disrupt the smooth working of railway lines causing considerable damages to both life and property. Using geo informatics the region of railway track near Kankavli railway station was chosen to highlight the susceptible zones in that area so that preventive measures can be taken so as to prevent any further damages.

KEYWORDS: Remote sensing, Geographical Information System, Konkan, landslide hazard zonation, landslide susceptibility

INTRODUCTION:

Landslide is a general term for a wide variety of down slope movements of earth materials that result in the perceptible downward and outward movement of soil, rock, and vegetation is under the influence of gravity. The materials may move by falling, toppling, sliding, spreading, or flowing. Some landslides are rapid, occurring in seconds, whereas others may take hours, weeks, or even longer to develop. Landslides constituted 4.89% of the natural disasters that occurred worldwide during the years 1990 to 2005.

Similarly a recent event on 30 July 2014, a landslide occurred in the village of Malin in Ambegaon Taluka of the Pune district in Maharashtra, India. The landslide, which hit early in the morning while residents were asleep, was believed to have been caused by a burst of heavy rainfall, and killed at least 30 people. Due to such hazardous occurrences it is of utmost importance that a basis is formed so that future hazards can be minimized saving lives of people, infrastructure and environment. The western parts of Maharashtra which are prone to landslides need to be analyzed for mapping of landslide hazards and as such using Geo-informatics generating landslide hazard zonation map will point out susceptible areas which will help in further preventive work is studied in this paper.

STUDY AREA LOCATION:

Kankavali is located in the Sindhudurg Dist., Konkan region of Maharashtra State. The case study area lies at Bordave village Latitude 16° 15' 36" and Longitude 73° 43' 11.99". The railway track location marks the concerned area at 322/ 3-4. The lithology consists of basalt, lateritic soil and rocks.

Fig 2.1 Lithology at the study area

The average rainfall in this area is 3370 mm which is heavy rainfall and accelerates the process of weathering leading to erosion and sliding of loose materials. Landslide phenomenon is usually triggered in monsoon season.

OBJECTIVES:

The present study deals with the observations, analysis and interpretations of remote sensing data like LISS III imageries, Landsat 7 TM data and Aster DEM with various GIS layer output from the same DEM. The observations at the site made during the field visit were correlated with some RS and GIS data layers. The interpretative outcome has been brainstormed for finding the causative factors of the sliding movements. The vulnerable zones highlighted shall be available to suggest preventive recommendations to minimize further losses in such areas.

Remote sensing data used includes Band 4, Band 3 and Band 2 imageries of Landsat 7 TM data. High resolution color composite from a free web source has also been imported and georeferenced in GIS environment using ILWIS 3.3 free software. Also IRS 1D LISS III data has been used for interpretation. ASTER Digital Elevation model has been analyzed and the generated thematic layers have also been interpreted. The inherent objective is to correlate the RS & GIS database to locate most susceptible zones.

METHODOLOGY OF GENERATING LAYERS:

The methodology adopted for the landslide hazard zonation mapping in the study area includes the various geoinformatical tools comprising geographical information system (GIS) technology and the satellite remote sensing (RS) techniques. The guidance provided by NNRMS course (Indian Institute of Remote Sensing, Four Kalidas road Dehradun) of Information Value Method has been used. The generated RS/GIS layers have been interpreted by the conventional image interpretation keys along with the generated GIS data base for the decision making of landslide hazard management. The software ILWIS 3.3 (Integrated Land & Water Information System) was used for analysis.[7][12]

4.1 Preparation of the basic layers

The readily available Landsat 7 TM data was used with bands 4, 3 and 2 with 30 m spatial resolution. Similarly, IRS 1D LISS III data with 23.5 m resolution was also used. Aster DEM with 30 m ground resolution has also been used as a basic layer. High resolution color composite was also imported in ILWIS environment and georeferenced with respect to Landsat 7 and LISS III data. Also the mobile handset having the offline GPS facility has been specially procured for the groundtruthing of web based and generated RS & GIS layers. It has been found to be equally effective tool in comparison with the routine GPS handset available in the market.

The following remote sensing data specific to the study area was considered.

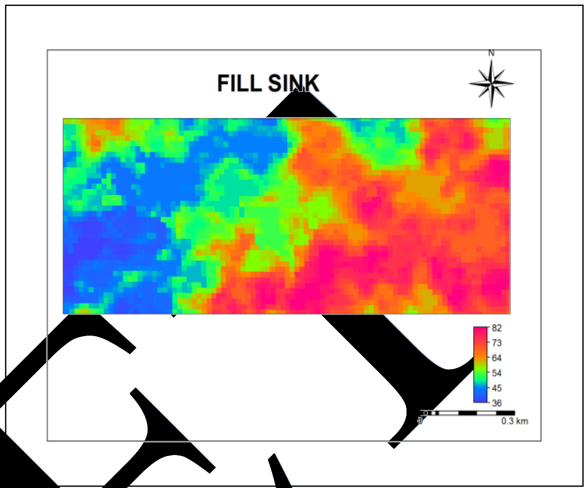

Fig 4.1.1 ASTER DEM

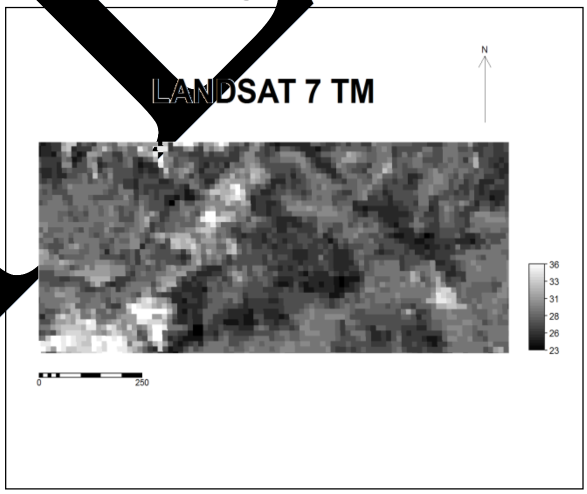

Fig. 4.1.2 LANDSAT 7 TM+

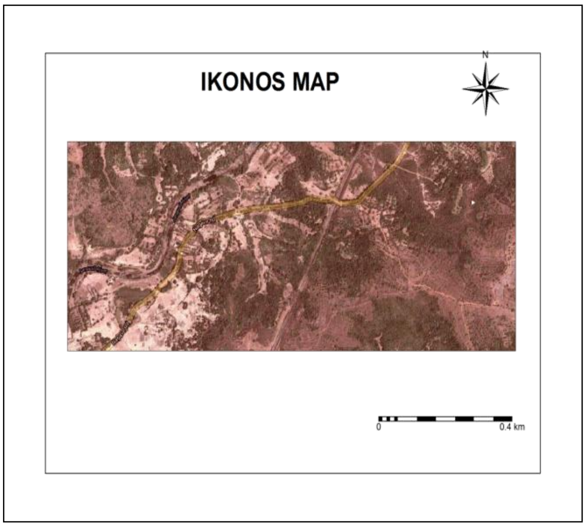

Fig. 4.1.3 Google Image

4.2 Preparation of Thematic layers

By on screen digitization on basic layers the following segment maps were prepared.

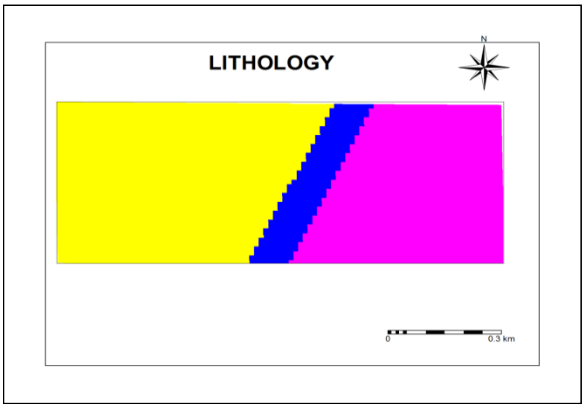

Fig. 4.2.1 Lithology Map

Digital Elevation Model (DEM) was analyzed for obtaining the following raster outputs.

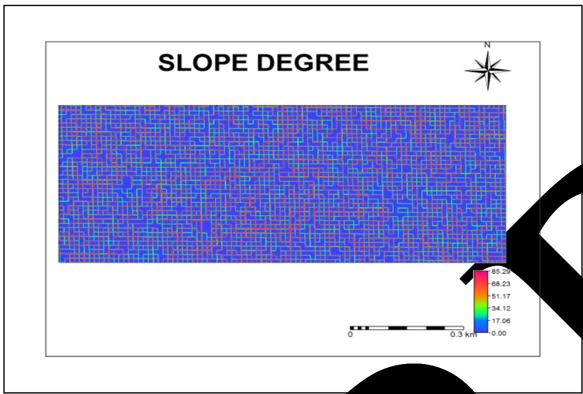

Fig. 4.2.2 Slope Degree Map

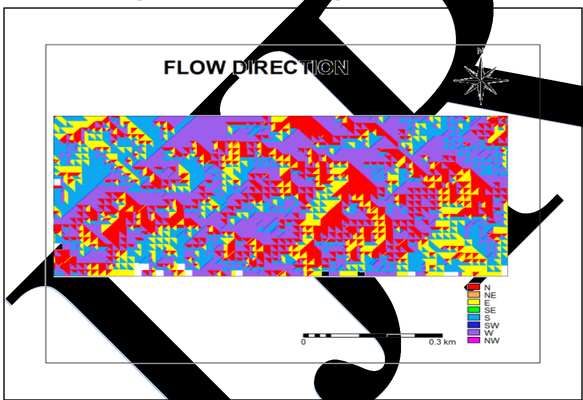

Fig. 4.2.3 Flow Direction Map

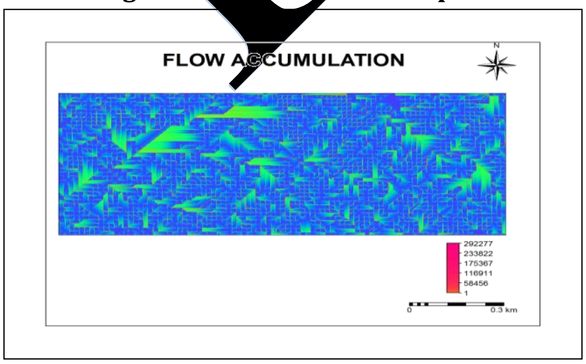

Fig. 4.2.4 Flow Accumulation Map

These rasters really speak volumes about the slide prone or unstable slopes in Bordave area. Slide prone slopes have been extracted from slope degree map. The slicing range was decided after measuring several slopes near prior events. Flow direction map is a basic layer to develop flow accumulation map. Each pixel in flow accumulation map indicates a number of pixels flowing towards that pixel from upstream locations. The slide prone flow accumulations were extracted from flow accumulation map. The value ranges of slide prone flow accumulations were decided after studying the flow accumulations near pre occurred slide events.

The map showing lithology (web source) was directly imported and georeferenced in ILWIS and used for analysis. This map depicts the outcrops of various lithological units as basalt rock, lateritic soil and lateritic rock zones.

Some of the vector and raster thematic layers generated have been illustrated in the pictorial collection.

INTERPRETATIONS AND ANALYSIS OF GIS LAYERS:

From the manual interpretation and the comparative observation of different thematic layer combinations the hazardous sites were located having unstable slopes where the landslide event maybe triggered in heavy rainfall. Information value method makes use of combination of weighted slope map, weighted flow map, weighted lithology map. It assigns each pixel values which are then used to form a weighted map of whole region combining these three factors. The sites of prior events and the sites where slide prone slopes, slide prone flow accumulations, structurally disturbed lithological conditions are found to be susceptible to slope failures. The susceptible locations having vicinity of railway tracks have been considered as landslide vulnerable sites. After such brain storming exercise on various rasters some locations on the railway track were identified as immediate trouble locations.

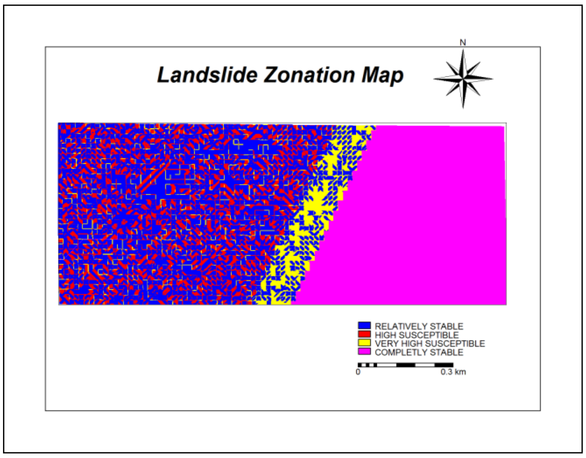

Fig. 5.1 Landslide Hazard Zonation Map

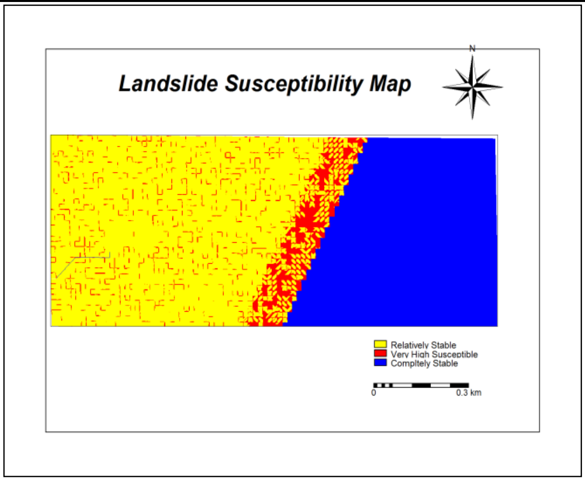

Fig. 5.2 Landslide Susceptibility Map

CONCLUSIVE REMARKS:

Remote sensing with its intelligent integration and next generation sensor tools has a great potential of getting information of an object without being in physical touch with it. The desired intention of this project is to find susceptible zones for helping mankind and saving future losses by avoiding a disaster called landslide. Geoinformatics is the integration of Remote Sensing along with Geographical Information System (GIS) which allows most reliable, accurate and updated database for land and water resource.

Due to everyday vibrations created on the tracks of Konkan railway there is a possibility of rock fall on the railway tracks making it a serious hazard for both life and infrastructure. The case study chosen for this project was the area near Kankavali railway station due to occurrence of a rock fall [illegible] landslide approximately 7 Km from Kankavali Railway Station near Bordave village. Susceptibility map divides the entire study area in only three zones as completely safe zone, susceptible zone and relatively safe zone. This facilitates to focus only on the most hazardous zone. It has been [illegible]led that the railway track points at (16⁰16'45.7 N, [illegible]349.09 E),(16°16[illegible]3 N, 73°4345.49 E),(16°1630.6 N, [illegible]41.1 E) ([illegible]24.2N, 73°4338.98 E) are immediate threat locations with slope varying from 59⁰ to 85⁰ being s[illegible]e.

FUTURE SCOPE:

1. The obtained information may prove a useful tool for National Disaster Management Authority (NDMA) and Konkan Railway authorities in planning mitigative strategy.
2. Vulnerability assessment can be carried out to determine the extent of losses in terms of property and infrastructure.
3. Railway induced vibrations should be taken into account but poses a large problem as to creating a raster map of the same. As such one can research to develop a methodology to inculcate these vibrations or even earthquake as a raster map to get a more vivid picture of the extent of combination of these vibrations on landslides.

There is also a need to develop the continuous monitoring which can monitor the probable disastrous movements of the hazardous area with the help of high resolution data and GIS technology

REFERENCES:

1) Alimohammadi [illegible], Ghafori G.R, Lashkaripour H, Sadeghi M. "[illegible]ide hazard zonation using the relative eff[illegible]t meth[illegible]"(2006),IEAGpp.1-8
2) Ahmad [illegible] Ansari M.[illegible]ngh T.N. "*Rock fall Risk Assessment along M[illegible]i-Pune Expressway, Maharashtra*", India (2012),International Journal of Science and Research,Vol.1,p[illegible]426
3) Arora M.K, Gupta R.P, Kanungo D.P and Sarkar.S "*Landslide Susceptibility Zonation (LSZ),Mapping - A Review*",(2009),Journal of South Asia Disaster [illegible]s,Vol.2,pp.81-1[illegible]
4) Ba[illegible]i S, Gomat[illegible]R, Ram Mohan. V "*Landslide Suscep[illegible] [illegible]nation in Kavithole and Kukalthur[illegible] water shed in Northern part of Nilgiris district*"(2013),International Journal of Basic and Life Sciences Vol.1,pp.27-33
5) BathrellosG.D,KalivasD.P,Skilodimou H.D ":*GIS-based landslide susceptibility mapping models applied to natural and urban planning in Trikala,Central Greece*",(2009),Studios Geol.,vol.1,pp.49-65
6) Chavan R. R, Desai S. S, Patil Amrut K, Tikke B. B. "*Review of landslide: a special attention to western ghat of Maharashtra*"(2014)International Journal of Research in Advent Technology, Vol.2,pp.128-135
7) Chandak P.G. ,Deshpande P.K. ,Gaikwad S.R., KumthekarM.B."*Generation of Thematic Layers from Spatial Database for Landslide Hazard Management in Part of Garhwal Himalaya* "(2013) International Journal of Scientific and Engineering Research Volume 4
8) Dr. S.C. Paranjape, Assistant Hydro geologist "*Ground Water Information Sindhudurg District, Maharashtra*", 1625/ DB/ 2009
9) District Disaster Management Plan Sindhudurg Updated 2014-15 by District Disaster Management Authority, Sindhudurg in Disaster Management Programme Govt.Of Maharashtra
10) Karanjot K.B, Vishwa B. S, Chandel,Y.C "*RS & GIS Based Landslide Hazard Zonation of Mountainous Terrains A Study from Middle Himalayan Kullu District, Himachal Pradesh,*

*India",(*2011),International journal of geomatics and geosciencesVol 2,pp.121-132

11) Nadage.B. S. Rajamanickam. G. Sriramkumar. C, Saranathan. E, *"Landslide Zonation Mapping – Konkan Railway, Ratnagiriregion, Maharashtra"*(2010) International Journal of Research in Advent Technology, Vol.2,pp.120-125
12) P. G. Chandak, S. S. Sayyed, Y. U. Kulkarmi, M. K. Devtale " *Landslide Hazard Zonation Mapping Using Information Value Method near Pakhi Village in Garhwal Himalaya*" (2016) International Journal of Engineering Technology, Management and Applied Sciences, Vol.4 Issue 6, pp. 228-236
13) Shekhar Gaikwad, P. G. Chandak, M. B. Kumthekar, P. K. Deshpande**,** " *Pictorial Informative Support to Landslide Hazard Management Maps of Uttarakhand, India"* (2013) IOSR Journal of Computer Engineering, volume 3, pp 51-59.

14)Sumana Chakraborty ,"*Spatio-temporal landslide hazard analysis along a road corridor based on historical information: a case study from uttarakhand India*"(2008), International Institute for geo-information science and earth observation Enscheda, the Netherlands & Indian institute of remote sensing (NRSA) Dehradun, India, pp [illegible]-16