APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM (GIS) IN LANDSLIDE HAZARD MAPPING AT THE NATIONAL BUILDING RESEARCH ORGANIZATION (NBRO)

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INTRODUCTION:

Urban Planners, Architects, and Engineers often need to know the overall landslide potential at a site to plan their developments economically and effectively. Landslide potential at a site is basically dependent on the geological structure, soil overburden, hydrology, land slopes, land use types and landform at that location. Therefore, in a particular area, State-of-Nature (SON) maps of above factors can be integrated to produce a landslide hazard zonation map. These SON maps are individually synthesized to 'Derived Maps' based on their relative landslide potential. These Derived Maps are then digitized and integrated to produce an 'Inferred Hazard Map' for the area. The inferred hazard map is then digitally overlaid by the map of existing landslides for calibration, and finally, the integrated hazard zonation map is prepared. PC based Geographic Information system (GIS) model for preparation of hazard zonation maps have been developed at the Computer Division of the NBRO. Both AUTOCAD and PC ARC/INFO are utilized for data capturing. Integration of maps were done by using PC ARC/INFO.

STATE OF NATURE MAPS

A field team appointed by the NBRO has conducted a detailed survey in Nuwara Eliya, and Badulla Districts where frequently threatened by landslides. Information regarding the geological structure, landform, slope gradient, hydrology, soil overburden, and land use types in these areas were gathered by site investigations, air photo interpretations, statistical analyses. These information along with the topographical information obtained from the Agricultural Based Mapping Project (ABMP) maps published by the Surveyor General's Office in Sri Lanka was used to produce the State-of-Nature maps of each major factor. Each of these map sheet cover a 40 sq.km area, and is 500 mm by 800 mm (A1) in size, and at 1:10000 scale.

DERIVED MAPS

The SON map of Bedrock Geology represents the variations of subfactors or map units such as Lithology, amount and direction of dip, Deviation Angle, Discontinuities, and Lineaments. It also represents the areas where bedrock is not exposed. Based on the statistical data of past landslides, scientists at NBRO evaluate the relative hazard of each map unit in terms of their landslide potential. After this evaluation, the SON map of Bedrock Geology is redrawn to produce the derived map of Bedrock Geology which represent the variations of landslide potential based on the geological structure in the area.

In the same manner, the SON maps of Hydrology, Soil Overburden, Slope Category, Landfrom, and Land Use are individually analysed for the relative landslide potential of each of their map units and the derived maps of Hydrology, Soil Overburden, Slope Category, Landfrom, and Land Use are prepared respectively.

DATA CAPTURING, DIGITIZING OF DERIVED MAPS.

Digitizing SON maps, and derived maps is done using software AUTOCAD, and PC ARC/INFO which has a good positional accuracy. The raw data representing all geographic information in SON maps are also fed into the computers by using two A1 size digitizers and one A3 digitizer. The data input stage was very tedious and time consuming. AUTOLISP programming interface in AUTOCAD software is utilized for customizing the geographic symbols represented in SON maps.

HARDWARE AND SOFTWARE

AUTOCAD software version 2.5, version 9.0 and version 11 were used for digitizing maps. PC ARC/INFO version 3.4D was used in both digitizing and integration of factor maps. IBM compatible personal computer having 80386SX 33Mhz, 80486DX2 50Mhz, 80486DX2 66Mhz processors and VGA color monitor were the hardware utilized. Hewlett Packard 8-PEN PLOTTERs and LACER JET series 111 printer is used for obtaining hard copies.

DIGITIZING OF SLOPE CATEGORY MAPS:

Digiting slope category maps was given much consideration by our scientists, because of its complexity in nature. The digital slope maps can be generated in two ways. One is to digitize the manually prepared maps, and the other is computer based method. For the computer based method, a program was written in BASIC language to extract the AUTOCAD data in the form of a dxf file, and to calculate slope. The calculated slope information was then sent back to the AUTOCAD environment to generate slope maps. This approach was not totally successful, because the process was very time consuming and a sample output of a slope map did not indicate clear polygon units. ultimately, digitizing manually prepared slope maps were preferred to the computer generated slope maps.

CONSTRUCTIONS OF TOPOLOGY AND MAKING MAPS GIS USABLE:

Maps which were digitized using AUTOCAD were converted into Data Exchange Files (DXF) and imported to the PC ARC/INFO environment. In order to make the coverage GIS usable, following procedure should be followed.

(1) CLEANING the coverage for the elimination of overshoots and other intersections at the polygon joints.

(2) Correcting NODE ERRORS for the entire polygon coverage

(3) Correcting LABEL ERRORS for the entire polygon overages.

(4) Comparing with the manual map to ensure that all the polygon units are included in the digitized maps.

(5) Building the polygon coverage to generate the Topology and to form the Polygon Attribute Table, which can be used to input the spatial attribute to the occurrence of the land slides.

All digitized Derived Maps have to undergo the above steps prior to integration and spatial analysis.

OVERLAYING AND INTEGRATING MAPS

Integrating of digital maps will be carried out by the GIS software PC ARC/INFO. Using an SML program, for a specific area, Derived Maps of Landform, Land Use, Geology, Hydrology, and Slope are overlaid. Then the numerically rated landslide potential attributes of each map unit are added up using the same SML program to evaluate the overall hazard ratings in each location.

These cumulative hazard ratings are then categorized into four different Ranges depending on the degree of hazard applicable to each area and different colors are allocated to each hazard range as listed below. The ranges suggested in the following table were finalized through successive revisions based on matching of past landslides and inferred instabilities. This process result in an Inferred Map of Landslide Hazard for the given area. These Inferred Maps represent the variation of relative landslide hazard for the given area.

Description	Ranges	Color
1.Safe ares	R < =40	Green
2.Moderately Hazards	40 < R <= 55	Yellow
3.Hazards	55 < R <=70	Light Brown
4.Most Hazards	70 < R < 100	Dark brown

Finally, using the same SML program this Inferred Hazard map will be overlaid by the Map of past Landslides to form the
Integrated Hazard Zonation Map.
Carefully scrutinizing the Integrated Maps we can observed the past land slide have been scattered in the ares where we identified as hazards.Therefor we may have to keep on improving the Geo-spatial attributes in the respective converges in order to obtained the best fit for the Land slide ares.In this exercise in future we hopes prepare a computer program which would automatically update the new changes to the attributes in the final Inferred map.

STORAGE OF DIGITAL MAP DATA:

Storage and security against viral and fungus attack on all digital map data were highly concerned, since all digital maps should be accessible for any modification or for obtaining hard copies. At the initial stage of the project, the data were backed up in 60 MB tape cartridges. Since the data stored in such tapes showed few missing parts while retrieving, more secure and yet economical storage is being discussed. Until such time a better method is available, an additional copy of map data is saved in computer hard

disks having 1 GB capacity where the data can be frequently monitored.

CONCLUSION:

In a particular area, maps of Geology, Soil Overburden, Slope Range and Category, Hydrology, Land Use and Land Form can be integrated to produce a measure or a map which displays landslide hazard zones. Based on the statistical analyses and engineering judgement, the contribution of each map unit to a landslide potential is rated and fed into a computer using software, AUTOCAD and PC ARC/INFO. For a given area, above factor maps are then electronically overlaid and the overall hazard in terms of landslide potential is evaluated. The integrated hazard zonation maps prepared at the NBRO represent the variation of landslide hazard in Nuwara Eliya and Badulla Districts, and can be utilized by Urban Planners, Developers and Engineers for their future projects in the area.

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