LAND SLIDE ANALYSIS USING GIS

The term landslides have been used to designate Movement of surface and near surface earth material down slopes and towards streams valleys and coastlines. Landslides are natural phenomena such as mudflows, earthflows, snow or debris avalanches and subsidence or natural events would occur with or without human activity. However, human activity has increased some of these events.

Major types of landslides

- Slow flowage – Rock Creep, talus creep
- Rapid flowage – earth movement, mudflows, avalanche
- Sliding – slumps, rock slides, rock falls
- Subsidence – sinking of mass

Fall: A fall may be defined as a free fall or rock fragments of various sizes. They take place very rapidly and consist of materials of which cliffs and bluffs are made

Slide: Downward movements of initially intact masses of earth materials on well defined surfaces are called slide.

Flows: comprise a variety of slides that are distinguished by the chaotic movement of the material within the moving mass. This material especially sand, silt and clay, tends to appear during flow as if it were a viscous liquid.

Creep: It is a form of slope movement that takes place in a blanket of material that lies relatively close to the land surface.

Slump: A slump is a rotational slide in which the materials commonly retain coherence and move along a shear plane, which is concave upward.

Subsidence: Subsidence may be defined as the downward movement of the natural ground surface. Subsidence may be instantaneous and violent or gradual and may be caused by natural forces or by the activities of man.

Selection of parameters for landslide hazard zonation mapping

- Lithology
- Structure
- rock mass strength
- slope
- slope aspect,
- relief & drainage
- Landuse
- Incidence of landslides in the region.

Lithology

It is the study of nature of rocks. It also deals with the composition, texture, degree of weathering and other attributes

Structure

The occurrence of bedding planes, joints, fractures, faults, thrusts, shear zones reduce the strength of rocks

Rockmass strength

It pertains to the rock material properties (like lithology, structure, weathering etc.) and discontinuities, which has a direct bearing on the stability of slope

Slope and aspect

The steeper a slope the more liable, it is to be unstable. Aspect denotes the direction is the slope

Landuse

The study of land use, type of landcover and landuse practices leads to the assessment of stability of the slopes

Incidence of landslides in the region

Inventory map showing all "active" and "old" slides has to be prepared with the magnitude and intensity of corresponding terrain parameters

Methodology

- Data Quantification
- Calculation of Score Factor
- Integration
- Model testing
- Zonation
- Map Finalization

Data quantification

All the data sets have to be quantified and rasterised. This will provide quantified data at each point in the map for the application of multivariate techniques or any other spatial modeling techniques. All thematic information are qualitative, hence to make them quantitative with respect to landslide occurrence, a binary method is adopted. For example, in a lithological map wherever sandstone is occurring, let's give a value `1' showing the presence of sandstone and give `0' wherever other rocks are present. Like this, a single qualitative lithological map would be represented by numbers in binary maps. A lithological map with 5 litho types would result in 5 different binary maps, which are quantitative information for further analysis.

Most important factor is the selection of grid size, which is inversely proportional to accuracy and the processing time increases enormously with the decrease of size. Sometimes, if the grid size is too small, it results in memory problem while processing because it has to handle large data set. From experience and utility point of view, it is agreed by many that the ideal grid size is 200m x 200m in most of the cases. Also 100m x 100m can also be taken for small areas for more accuracy. Here, it has to be kept in mind about the resolution of the input data such as satellite products and slope/elevation maps.

Calculation of score factor

Now comes calculation of influence factor of each variable on landslide/slope failure. Here, manual ratings should not be taken, as they are highly subjective and vary from person to person. Hence, alternatively information value method or probability method or regression method can be applied to find out the influence factor of each variable (say sandstone on landslide) on landslide phenomena in a known area

Integration

Next stage is the integration stage. Here all the influence factors of different variables can be simply added together to find out the probable areas of landslide occurrence. To improve upon accuracy, any multivariate analysis such as discriminant function analysis or cannonical correlation can be applied to differentiate between two groups/multi-groups such as stable and unstable zone

Model testing

In the next stage, results of the analysis should be tested in a known area. For example, the study area should be divided into two parts. The model should be developed on the data of one half and it should be applied to the other half for testing the accuracy. Then, as per the model result, variables in the neighbouring area should be selected and model should be applied. Here, one significant achievement is that, all the variables having least influence on landslide would be automatically rejected on the basis of statistical result, hence reducing the cost and effort in subsequent stages.

Zonation and classification

Last stage is the zonation or classification stage. After integrating the scores of different variables as per the model, the whole range of variation should be classified into different groups, here natural groups can be selected statistically or user defined zones can be selected as per the requirement.

Map finalizaton

In the process we may expect errors such as a few of the grids with landslide are predicted as stable due to error of statistical prediction. All the grid units with landslide may be naturally zoned as unstable in the final zonation map.