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GIS Application in Landslide Hazard Analysis

Term Paper of CPR-514

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Outline

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- Landslide causes and impacts
- Landslide Risk Assessment Methodology and work flow
- Common triggering factors of slope movements
- Case Study of Hong Kong Landslide
- Conclusion

Introduction

Landslides can be in different forms including:

- **Rock falls.**
- **Rockslides and debris flows.**
- **Soil slips, rock avalanches, and mud-flows**

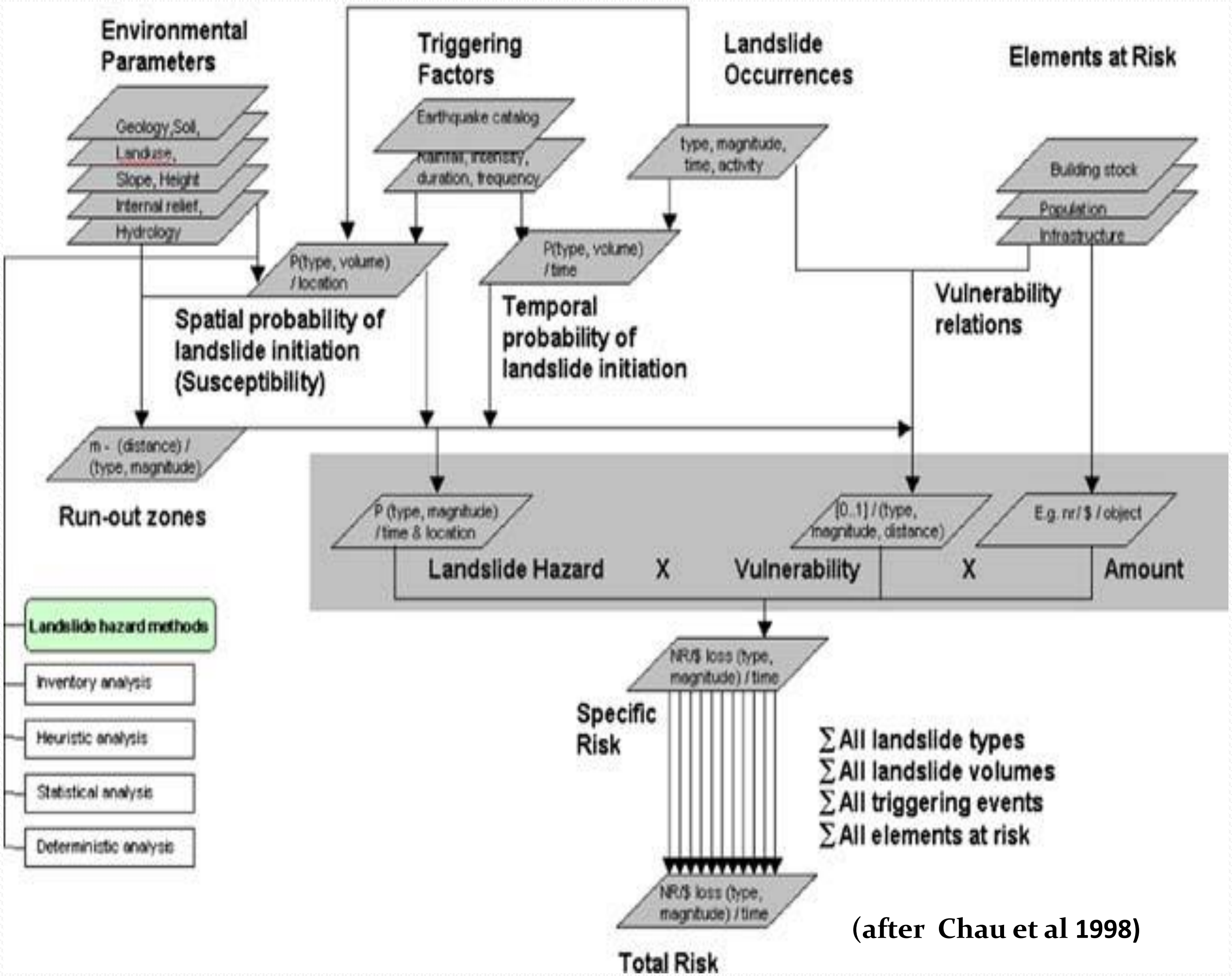
Landslide photo in mountain area of Hong Kong (after Chau et al 1998)

Objective

Landslide Hazard analysis aims to :

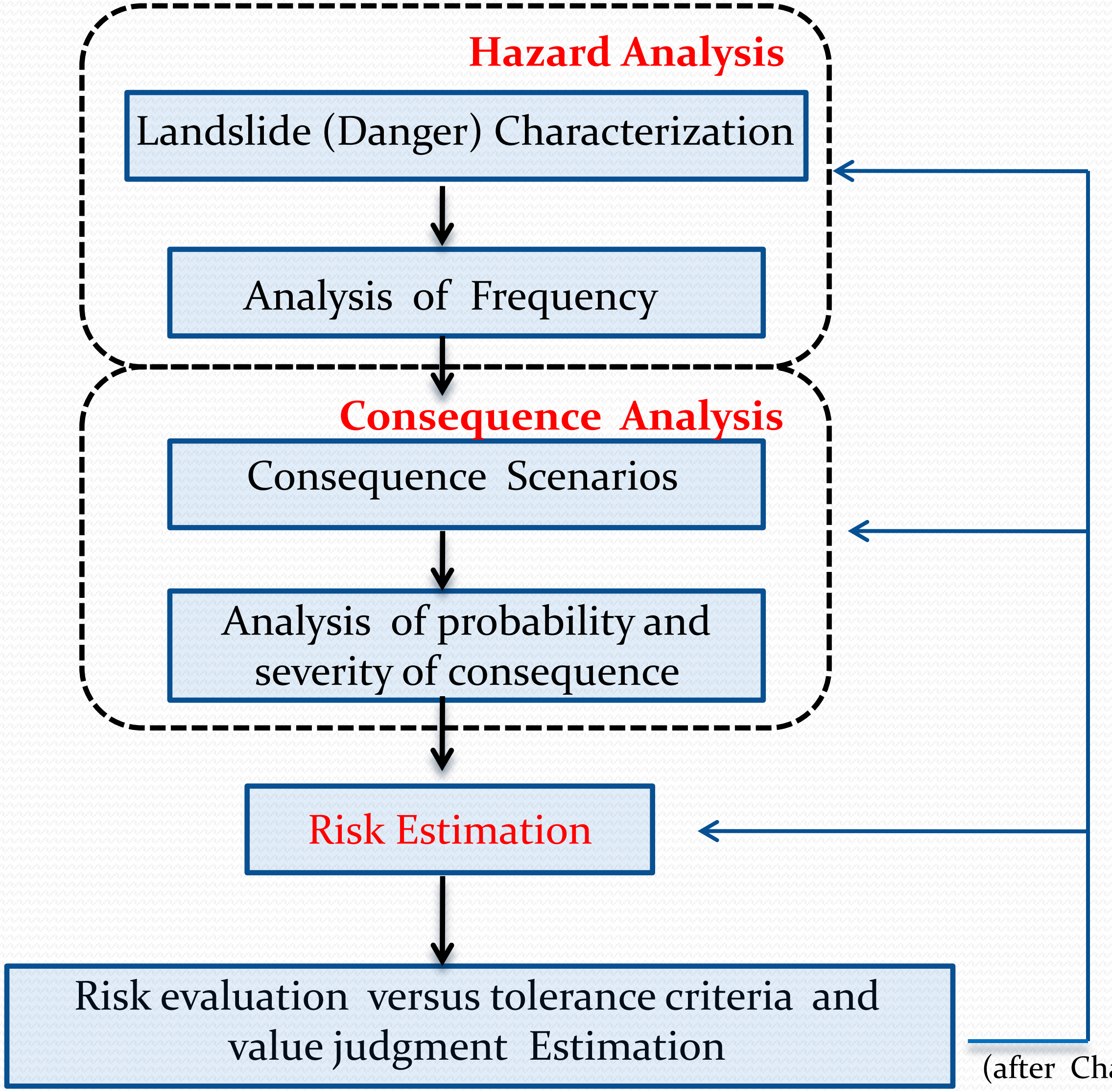
1. **Expected degree of loss due to a landslide.**
2. **Expected number of live lost, people injured.**
3. **Expected damage to property and disruption of economic activity**
4. **Help city planners and officials to make their decision.**

Landslide Risk Assessment Methodology



(after Chau et al 1998)

Landslide Risk Assessment work flow

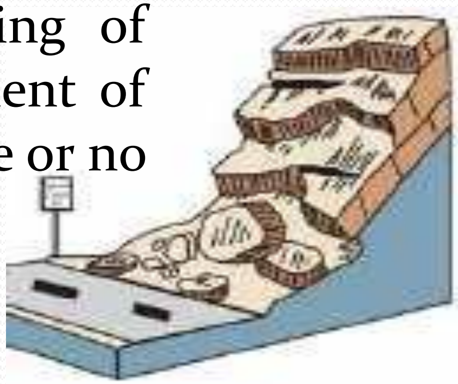


(after Chau et al 1998)

Landslide causes and impacts

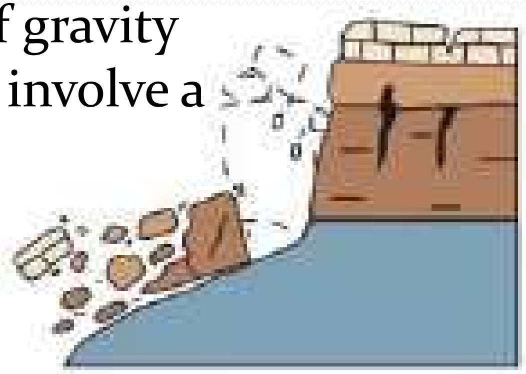
Fall

free fall movement by leaps and bounds and rolling of fragments of material. A fall starts with the detachment of material from a steep slope along a surface in which little or no shear displacement



Topple

slope movement that occurs due to forces that cause an over-turning moment about a pivot point below the centre of gravity of the slope. A topple is very similar to a fall, but do not involve a complete separation at the base of the failure



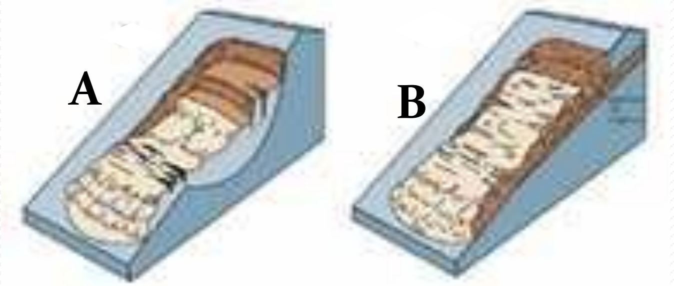
Landslide causes and impacts

Lateral Spreading

lateral extension of a more rigid mass over a deforming one of softer underlying material

Slide

Material is displaced more or less coherently along a recognizable or less well-defined shear surface or band rotational (the sliding surface is curved) or translational (the sliding surface is more or less straight)



Rotational Slide

Translational Slide

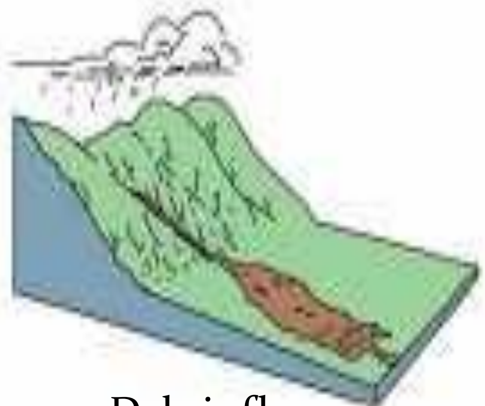
Landslide causes and impacts

Flows

Debris flow is a very rapid to extremely rapid flow of saturated non-plastic debris in a steep channel.

Characteristic of a debris flow is the presence channel or regular confined path

Debris avalanches are thin, partly or totally saturated and occur on hill slopes



Debris flow

Debris avalanche

Common triggering factors of slope movements

Increase in shear stress:

1. Erosion and excavation
2. Charging and loading at the crest
3. Rapid drawdown (man-made reservoir, flood high tide, breaching of natural dams)
4. Earthquake
5. Volcanic eruption
6. Modification of slope geometry
7. Fall of material (rock and debris)

Decrease in shearing resistance

1. Water infiltration
2. Weathering
3. Vegetation removal(by erosion, forest fire, drought or deforestation)

Case Study of Hong Kong Landslide

Divided into three distinct areas:

- ❑Hong Kong Island
- ❑Kowloon
- ❑ New Territories

Hong Kong Island is 77.5km^2

Arial photo of Honk Kong Island , web Source

Underlain mainly by volcanic rock and intrusive granite

hilly to mountainous with steep slopes exceeding 30 degree, covered by superficial deposits of Quaternary

Case Study of Hong Kong Landslide

Climate of Hong Kong

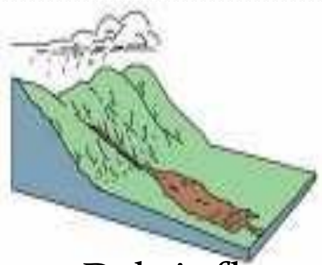
Climate is sub-tropical, with a winter temperature of 10 C to summer temperature of exceeding 31C.

Annual rainfall ranges from 1300 mm along the coast to more than 3000 mm on mountains.

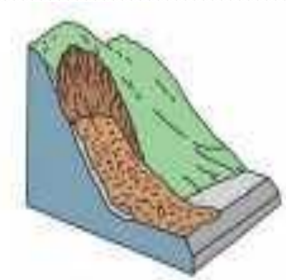
80% of the rain falls between May and September

Wettest month is August with an average monthly rainfall of about 400 mm

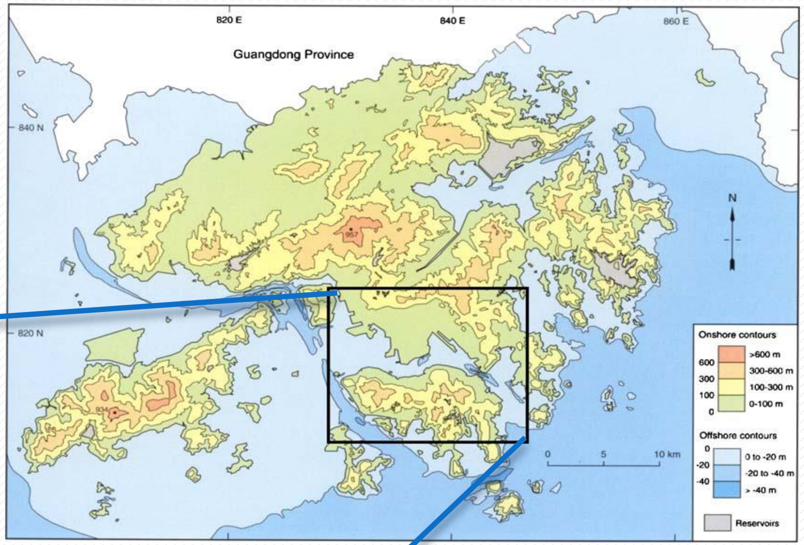
Case Study of Hong Kong Landslide



Debris flow



Debris avalanche

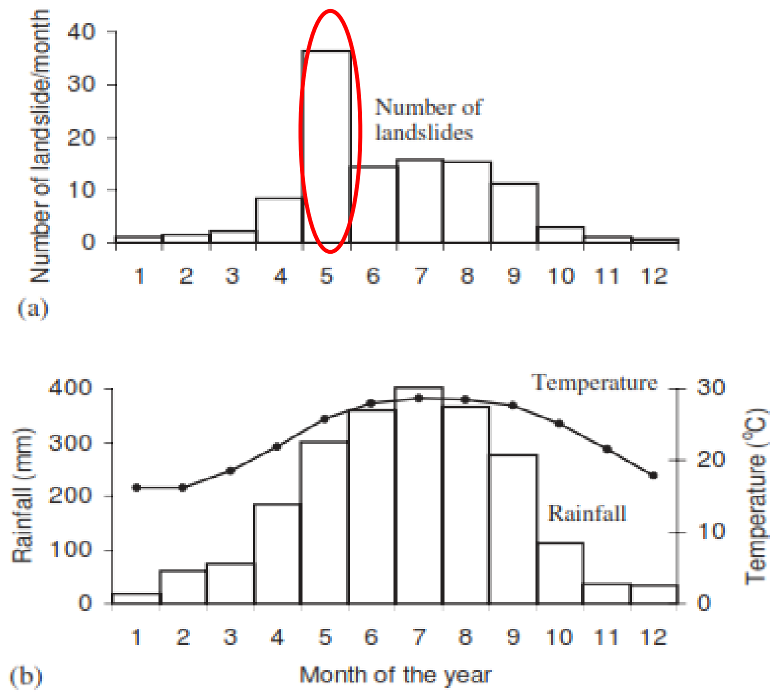


Contour map showing onshore and offshore . The mountain are in orange color with height 300-600m (after Chau et al 1998)

Case Study of Hong Kong Landslide

Plots of seasonal distribution for landslides average daily rainfall and temperature.

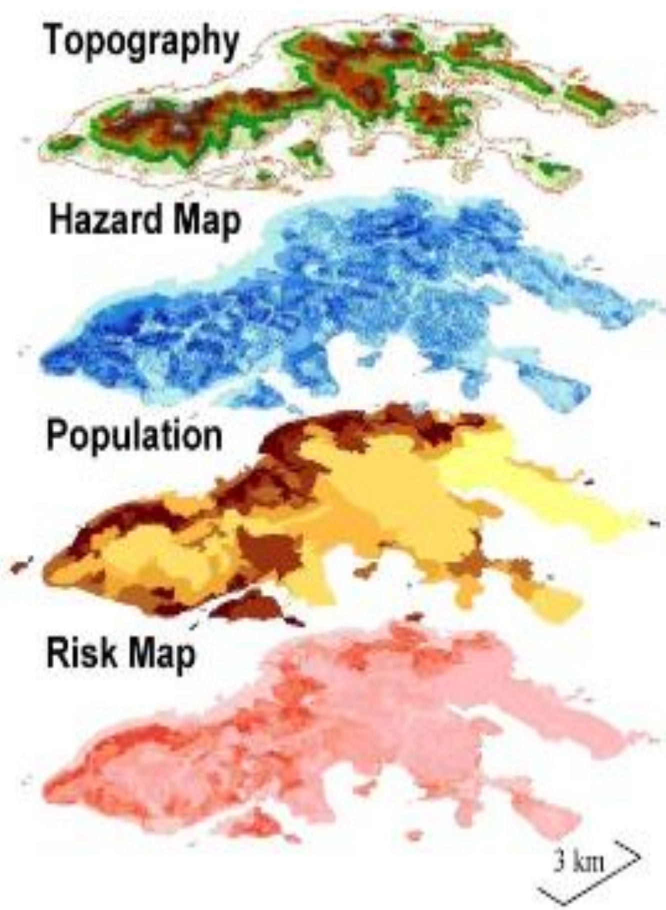
A total of **1448** data from **1984** to **1996**



Chau et al. (1998)

Case Study of Hong Kong Landslide

Analyzing landslide hazard analysis for Hong Kong based on landslide records through the use of GIS technology



Elevation

Slope

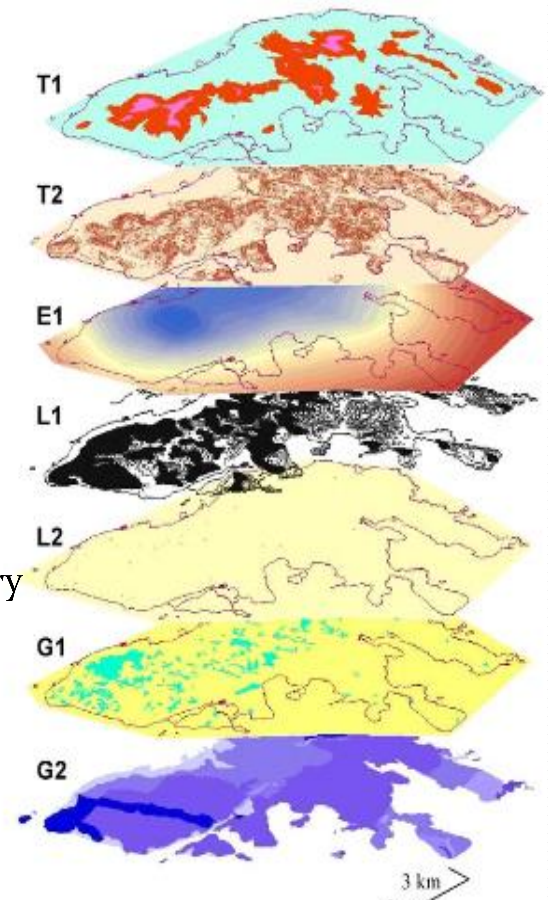
Rainfall

Potential runout

Landslide Inventory

Soil deposition

Geology



(after Chau et al 1998)

Conclusions and Recommendations

- Regional landslide hazard analysis and management is an important task for city planners and officials
- Considering the scale of these events, they are basically unpreventable
- The most reliable way to prevent landslide-induced casualties and economic losses is to avoid building towns or cities in the area of steep terrains
- considered impracticable or impossible in many countries due to the rapid growth of human population or due to the expensive cost in relocating of ancient or historical cities

References

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