Mitigation of Landslide Impacts, Strategies and Challenges for the 21st Century

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1 Introduction

Before decisions can be made concerning the management of landslides and the mitigation of their impacts, it is necessary to make careful assessments of the potential for instability of specific sites or regions The limitations of traditional analytical approaches for slope stability assessment are now widely recognized .Experience has shown that assessing the potential of slope instability based on the conventional factor of safety can be misleading because of significant uncertainties concerning geological details, geotechnical parameters, pore water pressures and external triggering factors. .An understanding of spatial and temporal variability of different factors is very important. Often a deterministic and predictive approach is not successful. Observational approaches are very useful for both site-specific and regional assessments. Assessment of landslide susceptibility, hazard and risk require the application of probabilistic concepts and approaches.

It is important to survey modern approaches for developing economic and effective solutions for specific sites of instability or to develop strategies for long-term planning of urban development and transportation routes in mountainous regions.

In this paper, the following aspects will be discussed with particular reference to slope instability in the urban context.

2 Uncertainties in landslide risk management

These include geotechnical parameter uncertainty, geological uncertainty, hydrological uncertainty, uncertainty related to historical data and uncertainty related to natural or other external events.

3 Landslide inventory

It is important to develop a landslide inventory and to prepare of maps showing the distribution of existing landslides as this evidence is critical. A comprehensive landslide inventory should have several fields of information in order to capture the history of instability, the size of landslide and information on geological and geotechnical details. Landslide maps should identify different landslide categories such as slides, debris flows and rockfalls.

4 Landslide Susceptibility, Hazard and Risk

This section will deal with the use of GIS-based approaches for development of maps of landslide susceptibility and hazard. In general, there will be significant differences between the distribution and relative susceptibility and relative hazard of different landslide categories. There are several elements in modeling and simulation using a GIS-based approach. These include a digital elevation model (DEM) representing the topography of the study area in three dimensions, a comprehensive landslide inventory and data-sets relating to the main influencing factors such as geology, soils, vegetation, cadastre, land use, rainfall, assets, boreholes. The DEM is generally used to derive elements of topography such as slope inclination, slope aspect, slope curvature and drainage. Brief references will be made to the methodology for assessment of risk.

5 Regional Case Study

This section will deal with the Outcomes of susceptibility and hazard zoning for an urban area, the Illawarra region within the state of New South Wales, Australia. This section will also explain how the relative susceptibility and hazard of different zones may be quantified using the available historical data of landslide occurrence.

6 Observational Approach

A modern observational approach includes the setting up of monitoring stations which may include rainfall stations, inclinometers, piezometers and extensometers. Site-specific monitoring helps understand and manage individual

landslides and to develop early warning systems. Observation and monitoring also facilitate the understanding of widespread landsliding (multiple occurrences of instability) after a heavy rainfall or another external event. Reference will be made to examples of periodic, continuous monitoring or near-real-time continuous monitoring. In particular, near-real-time continuous monitoring data can be accessed via the web to facilitate risk management.

7 Landslide Triggering Rainfall Thresholds.

Detailed analysis of rainfall magnitude and frequency is necessary for understanding rainfall thresholds for occurrence of landsliding . This can be done on a site-specific basis as well as a regional basis. There are ,of course, advantages and disadvantages in each case .Examples will be provided of spatial and temporal distyributions of rainfall during a period of very heavy rainfall.

8 Reliability analysis

The methodology for carrying out a reliability analysis will be explained for both site-specific and regional applications.

9 Mitigation of Landslide impacts and/or potential disasters

In the concluding section, the role of the above strategies in disaster mitigation will be discussed. Many challenges still need to be overcome and it is important to consider carefully the research areas for the future.