LANDSLIDE RISKS AND RELATED PREVENTION CONCEPTS IN THE NEVADO DEL TOLIMA REGION; COLOMBIA

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Rainfall related landslides are a major hazard in many regions of Colombia, mainly due to the rough topography and tropical rainfall conditions. A particularly affected area is the Combeima valley in the Tolima region on the eastern slopes of the volcanically active Cordillera Central. The Combeima river is the major drainage of the active ice-capped volcano Nevado del Tolima. Population centers along the river have repeatedly and severely been affected by landslides and debris flows from steep tributaries during intense rainfall events. Hundreds of people have been killed by such events in the past. Most recently, multiple slope failures and landslides destroyed major parts of population centers in June 2006. These recurring events are therefore a serious threat to life, welfare and local economy. So far, reconstruction works were usually undertaken after the events (Fig. 1) but adequate prevention strategy have not been implemented in the past.

The need for prevention has now increasingly been recognized, and efforts are now undertaken towards integrated risk management strategies. This includes a recently initiated project where the leading Colombian institutions involved in hazard, risk and prevention activities, and the University of Zurich, collaborated with the support of the Swiss Agency for Development and Cooperation. The objective of the project is the identification and quantification of landslide risks and the set-up of an early warning system for an improved protection of vulnerable people. To this aim, an integrated risk management strategy has been designed which includes the following main components: (i) assessment of landslide hazards; (ii) evaluation of vulnerability and economic damage potential to derive risk scenarios; (iii) implementation of an early warning system; and (iv) preparedness programs with the local population.

An important part of the hazard assessment is the analysis of the rainfall and runoff conditions in the steep catchments and tributaries of the Combeima river where landslides and debris flows are generated. Based on available data from hydrological and meteorological stations, frequency-intensity curves of rainfall and runoff processes are developed which are then used for developing hazard scenarios applying numerical two-dimensional flow models. For the vulnerability and risk analysis a major challenge is the estimation and quantification of the potential damage of settlements and important infrastructure such as transport/traffic and energy lines. Existing socio-economic data are integrated but have to be complemented by field surveys in collaboration with community leaders.

The early warning system is designed with a triple redundancy to reduce the uncertainties associated with each component of the system. The first component consists of precipitation gauges in the landslide zones from where real-time rainfall data is transmitted to an operational emergency center in the regional capital Ibagué. Rainfall-landslide initiation thresholds are defined based on frequency-intensity and antecedent rainfall analysis in

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combination with past landslide event records. The second component of the early warning system are geophones located close to the flow channel which record vibrations of increasing mass movements. Data is transmitted to the emergency center where operators compare the signals to defined thresholds. The third component is local people in the landslide areas that report field conditions back to the emergency center. Based on all available information, the emergency center releases a multiple-stage alarm to the local population centers via radio communication.

An essential part of the integrated risk management and risk reduction is the communication, exchange and the increase of preparedness of the local communities. Workshops for discussing risk scenarios and risk reduction strategies are performed together with specific capacity building programs.

This contribution presents the aforementioned integrated risk management project and related studies, and also underlines the specific challenges of such projects in terms of social, economic and political realities in a South American setting.

Fig. 1: Reconstruction works in Villa Restrepo, Tolima, Colombia, after the June 2006 landslide and debris flows that severely affected several population centers.

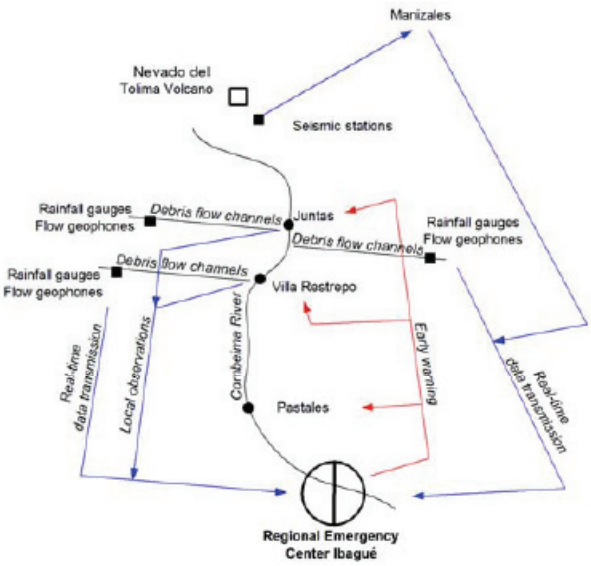

Fig. 2: Reconstruction works in Villa Restrepo, Tolima, Colombia, after the June 2006 landslide and debris flows that severely affected several population centers.

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