



Elaboration of risk and vulnerability maps for landslide phenomena in the municipality of Zacapoaxtla, Puebla

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During the season of torrential rains of 1999 and now with the step of the hurricane Stan for the southeast of the Mexican territory, the North and North-eastern Ridge of Puebla suffered serious damages provoked by floods and landslides, that affected many social sectors including: housings, education, health, communication (highways and bridges), roads, electric power, agriculture and cattle raising etc. The economic damage of the disaster of 1999 in the mountainous region of Puebla were evaluated in more than 200 million dollars, and in this year 2005 the damage ascended to several millions of dollars. Of the acquired knowledge, we can state that the factors which impact in the stability of natural hillsides can be divided into: conditioning and triggering factors; the first ones depend on the intrinsic characteristics of the hillsides, and they include their topography and morphology, the geology and geomechanics characteristics of the superficial soils, the hydrogeology and the vegetation; on the other hand, the triggering factors, originate the slips and they influence directly the magnitude and the rate of the movements including the rains, the earthquakes, the volcanism, the freezing processes and thaw, the erosion, and the influence of the human activity (cuts, excavations, loose fillers, overload for constructions, deforestation, etc.). In these places there are many communities belonging to ethnic groups that inhabit areas classified as high and very high seclusion, whose characteristics among others include towns of less than 2500 inhabitants, illiterate population, economic very low revenues, social very reduced infrastructure and housing under conditions of accumulation; in these places the natural phenomena provoke true disasters. The objective of this project, in its first stage, will be to carry out the engineer - geologic studies, in the second stage to obtain a database for the integration of a catalogue of landslides and to integrate the

maps of risk for slips of hillsides in the Municipality of Zacapoaxtla. Finally in the third stage, they will be integrated the municipal and regional construction codes that will be useful as base for an appropriate planning and classification of the territory, that allow to impel this way the application of a culture of prevention and mitigation of disasters. For they will be carried out it the following works: 1) Engineer-geologic studies (topography, mechanical and elastic properties of soils, geology, seismology, geophysics, laboratory of soil mechanic, climatology, hydrogeology, influences of the human activity, evaluation of loads due to constructions and geotechnical slope stability analyses), 2) Database for the integration of a catalogue of slips (height and inclination of the hillsides, stratigraphy of the underground, cracking, classification and mechanical properties of the rocks, thickness of the stratum of the floor and saturation grade, type of vegetation, temperature, rain, seismic coefficient, volcanic activity, phreatic level, the drainage net and its basin, the influence of the human activity as cuts, excavations, fillers, overloads, the population's density, constructions, deforestation, etc.), 3) Threat maps, vulnerability and risk to landslides. The threat grade to slips of hillsides in the municipality of Zacapoaxtla will be determined creating appropriate databases that allow to end up establishing thematic maps elaborated in ArcView and/or Erdas Image, computational good programs to work in geographical information system (SIG). For the vulnerability maps it will be evaluated in an individual way each one of the exposed elements; you will proceed to the assignment of values of weights in function of their relative importance with regard to the damage that could cause the occurrence of the disaster (from 1 for the elements of smaller importance up to 10 for those of more importance). To end up obtaining the maps of risk, you will proceed to the creation of a two-dimensional chart in which combine the map of threats with the vulnerability map, establishing a relationship between both. This relationship will define a new classification starting from all the possible combinations of the involved classes. 4) Integration of the municipal construction codes. This stage will be able to be carried out once it is had the maps of risk and vulnerability. The construction regulations will also contain a detailed zoning of the land with ends of territorial classification, including soils where you can build, where you cannot, or where you can build stabilizing the soil previously with construction methods which include: geometric rectification, drainage elements, structural elements of reinforcement, contention walls and superficial protection.