Applying a structured multicriteria risk mapping method in Mount Cameroon

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This study aims at mapping the volcanic, induced landslides and earthquake risk in Mount Cameroon in an integrated way by applying a structured multicriteria method. The proposed methodology is an adaptation of Saaty's Analytic Hierarchy Process (AHP, Saaty 1977) to risk mapping. AHP is a decision approach designed to solve complex multiple criteria problems (Saaty, 1990). After having determined the geographic entities involved in the analysis (i.e. in our study area, the villages in the Fako division of Mount Cameroon), the AHP method requires the identification of each risk component to be taken into account and a data collection. One of the advantages of AHP is to include both qualitative and quantitative criteria in the evaluation.

In a typical hierarchy process, the top level reflects the overall objective (focus) of the decision problem, which is the risk in our case. The main criteria affecting the decision are represented in intermediate levels. The lowest level comprises the sub-criteria to assess the main criteria. Once a hierarchy is set up, the decision-maker can start a prioritization procedure to determine the relative importance of each criterion in each level of the hierarchy. All identified criteria are compared against each other in a pairwise comparison matrix which is a measure to express the relative preference among the criteria. For this, numerical values expressing a judgment of the relative importance (or preference) of one criterion against another have to be assigned to each criterion. Then the entity profiles are evaluated with respect to all sub-criteria, criteria and finally the risk to create a synthesis table finally.

Such a methodology has already been applied at the Merapi volcano by CVGHM/BPPTK. The same definition and components of risk have been kept for our study and so the same hierarchical scheme. The main criteria that are considered in risk assessment are the hazard itself, exposure aspect to the threat of disaster, vulnerability aspects and capacity to face disaster. Among these main criteria, we considered that each component of the risk has an equal importance.

The use of GIS tool helps spatial analysis to address multidimensional problems such as risk assessment. A matrix was created and organized according to a specific hierarchical model as defined in the previous step, and then potential datasets were selected for each sub-criterion. This matrix included 4 main criteria and 24 sub-criteria. Hazards and Exposure criteria are based on the '*Gestion des Risques Naturels et Protection Civile (GRINP)*' project, and the Vulnerability and Capacity criteria are associated with the report on Mount Cameroon "*Socio-economic vulnerability and resilience*" written by MINIMIDT/INGV for MIAVITA project.

In the GRINP project, a zoning map of risks associated with geological phenomena in the vicinity of Mount Cameroon was produced by crossing the hazards and elements at stake in a GIS system (Thierry and al., 2007). The elements at stake which were considered as most important were identified and mapped by the GRINP team. Therefore, in our matrix, multi-hazard levels correspond to sub-criteria to assess the Hazard main criterion. In the same way, the result of crossing each GIS layer of stakes with multi-hazard levels correspond to sub-criteria to assess the Exposure main criterion. In our study, we defined the Exposure criteria with data on the exposure of resident population, agricultural area, and number of drinking water supply stations that would be cut off if a disaster occurs.

In MIAVITA an anthropological-based perceived exposure study was carried out in Fako division of the Mount Cameroon Region by MINIMIDT and INGV. This study enabled to collect demographic and socio-economic data in several villages. Methods used in this work include a questionnaire-based survey, in-depth interviews, focus group discussions, field observations and check list to evaluate processes. Two sampling techniques were used on a geographical and population basis. For an overview of vulnerability and capacity to face disaster in this region, we took into account only the responses to questionnaires. Finally, the responses of about 1000 permanent residents were selected for analysis. As the geographical coordinates of sampled interviewees were taken using GPS and a question relative to their place of residence was asked in the questionnaire. Therefore we were able to link each person to a point in a village in our GIS project. The second step of this work was to identify indicators among the 430 questions collected in the questionnaire in order to complete the matrix for the Vulnerability and Capacity main criteria. Technically, for each village and sub-criteria, the answers of residents have been analyzed, divided into 3 classes, and then class values were estimated. This way we have identified in the Vulnerability main criterion all things that are susceptible to increase the vulnerability of an area to disaster like age of respondents, level of education, poverty level, community participation etc. And as well for the Capacity main criterion, with all things which are able to reduce the impact of disaster caused by Mount Cameroon volcano eruptions like land use planning, public awareness programs, emergency response drills, disaster management plan, insurance, public adaptation, etc.

This study shows an example where GIS analysis techniques combined with AHP can support the definition and calculation of spatial indicators allowing an integrated risk mapping at the scale of the entities (villages).

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