



## **Using Formative Scenario Analysis approach for landslide risk analysis in a relatively scarce data environment: preliminary results**

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It is increasingly important to provide to stakeholders tools that will enable them to better understand what is the state of the environment in which they live and manage and to help them to make decisions that aim to minimize the consequences of hydro-meteorological hazards. Very often, however, quantitative studies, especially for large areas, are difficult to perform. This is due to the fact that unfortunately isn't often possible to have the numerous data required to perform the analysis. In addition it has been proven that in scenario analysis, often deterministic approaches are not able to detect some features of the system revealing unexpected behaviors, and resulting in underestimation or omission of some impact factors. Here are presented some preliminary results obtained applying Formative Scenario Analysis that can be considered a possible solution for landslide risk analysis in cases where the data needed even if existent are not available. This method is an expert based approach that integrates intuitions and qualitative evaluations of impact factors with the quantitative analysis of relations between these factors: a group of experts with different but pertinent expertise, determine (by a rating procedure) quantitative relations between these factors, then through mathematical operations the scenarios describing a certain state of the system are obtained. The approach is applied to Buzau County (Romania), an area belonging to the Curvature Romanian Carpathians and Subcarpathians, a region strongly affected by environmental hazards. The region has been previously involved in numerous episodes of severe hydro-meteorological events that caused considerable damages (1975, 2005, 2006).

In this application we are referring only to one type of landslides that can be described as shallow and medium-seated with a (mainly) translational movement that can go from slide to flow. The material involved can be either soil, debris or a mixture of both, in Romanian literature these typical movements has been described as alunecare curgatoare.

The Formative Scenario Analysis approach will be applied for each component of risk (H,V,and A) and then the acquired states will be combined in order to obtain for obtaining a series of alternatives scenarios for risk. The approach is structured in two main sections corresponding to a level of influence of conditioning factors and a response. In this latter are obtained the results of the formative scenario approach trained with the conditioning factors of the first level. These factors are divided in two subsets representing 2 levels of influences,  $k=1$  comprises the global factors while in  $k=2$  one finds local factors.

In order to include uncertainty estimation within the analysis the method of knowledge representation type-1 fuzzy sets is introduced and hence decisions made by experts on certain events are expressed in terms of triangular fuzzy numbers.