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Multi-Criteria Decision Making for a Spatial Decision Support System on the Analysis of Changing Risk

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Natural hazard risk management requires decision making in several stages. Decision making on alternatives for risk reduction planning starts with an intelligence phase for recognition of the decision problems and identifying the objectives. Development of the alternatives and assigning the variable by decision makers to each alternative are employed to the design phase. Final phase evaluates the optimal choice by comparing the alternatives, defining indicators, assigning a weight to each and ranking them. This process is referred to as Multi-Criteria Decision Making analysis (MCDM), Multi-Criteria Evaluation (MCE) or Multi-Criteria Analysis (MCA).
In the framework of the ongoing 7th Framework Program "CHANGES" (2011-2014, Grant Agreement No. 263953) of the European Commission, a Spatial Decision Support System is under development, that has the aim to analyse changes in hydro-meteorological risk and provide support to selecting the best risk reduction alternative. This paper describes the module for Multi-Criteria Decision Making analysis (MCDM) that incorporates monetary and non-monetary criteria in the analysis of the optimal alternative. The MCDM module consists of several components. The first step is to define criteria (or Indicators) which are subdivided into disadvantages (criteria that indicate the difficulty for implementing the risk reduction strategy, also referred to as Costs) and advantages (criteria that indicate the favorability, also referred to as benefits). In the next step the stakeholders can use the developed web-based tool for prioritizing criteria and decision matrix. Public participation plays a role in decision making and this is also planned through the use of a mobile web-version where the general local public can indicate their agreement on the proposed alternatives. The application is being tested through a case study related to risk reduction of a mountainous valley in the Alps affected by flooding. Four alternatives are evaluated in this case study namely: construction of defense structures, relocation, implementation of an early warning system and spatial planning regulations. Some of the criteria are determined partly in other modules of the CHANGES SDSS, such as the costs for implementation, the risk reduction in monetary values, and societal risk. Other criteria, which could be environmental, economic, cultural, perception in nature, are defined by different stakeholders such as local authorities, expert organizations, private sector, and local public. In the next step, the stakeholders weight the importance of the criteria by pairwise comparison and visualize the decision matrix, which is a matrix based on criteria versus alternatives values. Finally alternatives are ranked by Analytic Hierarchy Process (AHP) method. We expect that this approach will help the decision makers to ease their works and reduce their costs, because the process is more transparent, more accurate and involves a group decision. In that way there will be more confidence in the overall decision making process.

Keywords: MCDM, Analytic Hierarchy Process (AHP), SDSS, Natural Hazard Risk Management