

Multi-criteria decision making in flood risk management: research progress and the challenge of handling uncertainty and stakeholder participation

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Multi-Criteria Decision Making (MCDM) methods have received much attention from researchers and practitioners for solving flood risk management problems in the last decades due to its capacity to deal with multiple criteria, conflicting objectives as well as the knowledge arising from the participation of several actors. In order to consolidate recent research conducted in this area, this study presents a state-of-the-art literature review of MCDM applications to flood risk management, seeking to provide a better understanding of the current status of how participatory MCDM is being conducted and the way uncertainties are included in the decision-making process.

Totally, 128 peer-reviewed papers published from 1995 to June 2015 in 72 different journals were systematically analyzed. Results indicated that the number of flood MCDM publications has exponentially grown during this period, with over 82% of all papers published since 2009. A wide range of application areas was identified, with most papers focusing on ranking alternatives for flood mitigation (22.78% of the total) followed by risk (21.11%) and vulnerability assessment (15%). The Analytical Hierarchy Process (AHP) was the most popular MCDM method (42.72%) followed by Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) (13.33%) and Weighted Sum Method (WSM) (12.73%).

Although significant improvements have been made over the last decades, shortcomings remain in handling the uncertainty. Only eight papers (6.25%) have conducted uncertainty analysis, suggesting that a general procedure for performing it in MCDM does not yet exist. Researchers have applied the Monte Carlo simulation, Taylor's series error propagation method or assessed the uncertainty in qualitative ways, by describing its main sources or analyzing the stakeholders' degree of confidence. In addition, 35 articles (27.34%) have performed a sensitivity analysis of the criteria weights. Three distinct approaches were identified: one-way, global, and probabilistic sensitivity analysis.

About half of the studies have acknowledged the involvement of multiple stakeholders. However, participation was fragmented and focused on particular stages of the decision-making process such as the elicitation of criteria weights. This segmentation may be related to methodological and time constraints since participatory decision making is time-consuming and costly. Policy makers and experts were the most participated stakeholders, with few papers considering the involvement of local community members. Another issue is that only four studies seek to obtain consensus and that decisions were often made by majority vote or averaging approaches.

Therefore, greater rigor in addressing the uncertainties around stakeholders' judgments as well as in endorsing an active participation in all stages of the decision-making process should be undertaken in future applications. This could help to increase the quality of decisions and subsequent implementation of chosen measures.