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New integrated and multiscale decision-aiding framework in a context of imperfect information: application to the assessment of torrent checkdams' effectiveness.

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Mountain natural phenomena (e.g. torrential floods) put people and buildings at risk. Civil engineering protection works such as torrent check-dams are designed to mitigate those natural risks. Protection works act on both causes and effects of phenomena to reduce consequences and therefore risks. For instance, check-dams control sediment production and liquid/solid flow of torrential floods: several series of dams are located in the headwaters of a watershed, each having specific functions. All those works are damaged by time passing and flood impacts.
Effectiveness assessment is needed to define, compare or choose strategies for investment and maintenance which are essential issues in risk management process. Decision support tools are expected to analyze at different scales both their technical effectiveness (related to their structural state and functional effects on phenomena such as stopping, braking, guiding, etc.) and their economic efficiency through comparison between benefits and costs.
Several methods, often based on expert knowledge, have already been developed to care about decision under risk. But uncertainty has also to be considered, since decisions are indeed often taken in a context of lack of information and knowledge on natural phenomena, heterogeneity of available information and, finally, reliability of sources.
First methods derived from classical industrial contexts, such as dependability analysis, are used to formalize expert knowledge used for decision-making. After having defined the concept of effectiveness, dependability analysis are used to identify decision contexts and problems: criteria and indicators are identified in relation with structural or functional features.
Then, innovative and multi-scales multi-criteria decision-making methods (MCDMs) and frameworks are proposed to help assessing protection works effectiveness. They combine classical MCDM approaches, belief function, fuzzy sets and possibility theories. Those methods allow to make decisions based on heterogeneous, imprecise and uncertain evaluation of criteria provided by more or less reliable sources in an uncertain context: COWA-ER (Cautious Ordered Weighted Averaging with Evidential Reasoning), Fuzzy-Cautious OWA or ER-MCDA (Evidential Reasoning for Multi Criteria Decision Analysis) are thus applied to several scales of torrent check-dams' effectiveness assessment.
Those methods are then improved for a better knowledge representation and final decision. Enhanced methods are then associated together. Finally, individual problems and associated methods are integrated in a generic methodology to move from torrential protective single measure effectiveness assessment to complete protection systems at watershed scale.