

## A comparative review of multi-risk modelling methodologies for climate change adaptation in mountain regions

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Climate change has already led to a wide range of impacts on the environment, the economy and society. Adaptation actions are needed to cope with the impacts that have already occurred (e.g. storms, glaciers melting, floods, droughts) and to prepare for future scenarios of climate change. Mountain environment is particularly vulnerable to the climate changes due to its exposure to recent climate warming (e.g. water regime changes, thawing of permafrost) and due to the high degree of specialization of both natural and human systems (e.g. alpine species, valley population density, tourism-based economy).

As a consequence, the mountain local governments are encouraged to undertake territorial governance policies to climate change, considering multi-risks and opportunities for the mountain economy and identifying the best portfolio of adaptation strategies.

This study aims to provide a literature review of available qualitative and quantitative tools, methodological guidelines and best practices to conduct multi-risk assessments in the mountain environment within the context of climate change. We analyzed multi-risk modelling and assessment methods applied in alpine regions (e.g. event trees, Bayesian Networks, Agent Based Models) in order to identify key concepts (exposure, resilience, vulnerability, risk, adaptive capacity), climatic drivers, cause-effect relationships and socio-ecological systems to be integrated in a comprehensive framework. The main outcomes of the review, including a comparison of existing techniques based on different criteria (e.g. scale of analysis, targeted questions, level of complexity) and a snapshot of the developed multi-risk framework for climate change adaptation will be here presented and discussed.