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Integrating top-down and bottom-up approaches to design a cost-effective and equitable programme of measures for adaptation of a river basin to global change

Corentin Girard (1), Jean-Daniel Rinaudo (2), and Manuel Pulido-Velazquez (1)

(1) Research Institute of Water and Environmental Engineering (IIAMA), Universitat Politècnica de València, Valencia, Spain (C. Girard: cogimar@upv.es), (2) BRGM, French Geological Survey, Montpellier, France

Adaptation to the multiple facets of global change challenges the conventional means of sustainably planning and managing water resources at the river basin scale. Numerous demand or supply management options are available, from which adaptation measures need to be selected in a context of high uncertainty of future conditions. Given the interdependency of water users, agreements need to be found at the local level to implement the most effective adaptation measures. Therefore, this work develops an approach combining economics and water resources engineering to select a cost-effective programme of adaptation measures in the context of climate change uncertainty, and to define an equitable allocation of the cost of the adaptation plan between the stakeholders involved.

A framework is developed to integrate inputs from the two main approaches commonly used to plan for adaptation. The first, referred to as "top-down", consists of a modelling chain going from global greenhouse gases emission scenarios to local hydrological models used to assess the impact of climate change on water resources. Conversely, the second approach, called "bottom-up", starts from assessing vulnerability at the local level to then identify adaptation measures used to face an uncertain future. The methodological framework presented in this contribution relies on a combination of these two approaches to support the selection of adaptation measures at the local level.
Outcomes from these two approaches are integrated to select a cost-effective combination of adaptation measures through a least-cost optimization model developed at the river basin scale. The performances of a programme of measures are assessed under different climate projections to identify cost-effective and least-regret adaptation measures.

The issue of allocating the cost of the adaptation plan is considered through two complementary perspectives. The outcome of a negotiation process between the stakeholders is modelled through the implementation of cooperative game theory to define cost allocation scenarios. These results are compared with cost allocation rules based on social justice principles to provide contrasted insights into a negotiation process.

The interdisciplinary framework developed in this research combines economics and water resources engineering methods, establishing a promising means of bridging the gap between bottom-up and top-down approaches and supporting the creation of cost-effective and equitable adaptation plans at the local level. The approach has been applied to the Orb river basin in Southern France.

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