



## **Financial tools to induce cooperation in power asymmetrical water systems**

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In multi-purpose water systems, power asymmetry is often responsible of inefficient and inequitable water allocations. Climate Change and anthropogenic pressure are expected to exacerbate such disparities at the expense of already disadvantaged groups. The intervention of a third party, charged with redefining water sharing policies to give greater consideration to equity and social justice, may be desirable. Nevertheless, to be accepted by private actors, this interposition should be coupled with some form of compensation. For a public agency, compensation measures may be burdensome, especially when the allowance is triggered by natural events whose timing and magnitude are subject to uncertainty. In this context, index based insurance contracts may represent a viable alternative option and reduce the cost of achieving socially desirable outcomes. In this study we explore soft measures to achieve global change mitigation by designing a hybrid coordination mechanism composed of i) a direct normative constraint and ii) an indirect financial compensatory tool. The performance of an index-based insurance (i.e. hedging) contract to be used as a compensation tool is evaluated relative to more traditional alternatives. First, the performance of the status quo system, or baseline (BL), is contrasted to an idealized scenario in which a central planner (CP) maximizes global efficiency. Then, the CP management is analyzed in order to identify an efficient water rights redistribution to be legally imposed on the advantaged stakeholders in the BL scenario. Finally, a hedging contract is designed to compensate those stakeholders more negatively affected by the legal constraint. The approach is demonstrated on a multi-purpose water system in Italy, where different decision makers individually manage the same resource. The system is characterized by a manifest power asymmetry: the upstream users, i.e. hydropower companies, are free to release their stored water in time irrespective of the timing of downstream users, i.e. farmers, demands. This situation can lead to financial losses by the farmers, an already disadvantaged group, and, as demonstrated by previous work, lead the global system to underperform. Results suggest that financial hedging tools may offer a reliable and relatively inexpensive alternative to other forms of compensation, and thereby favor more equitable management of multi-purpose water systems characterized by power asymmetry. This finding is especially relevant in times where granting of licenses to use/withdrawal water are often being reviewed with attention to environmental protection and social justice issues.