Hydro-economic modeling of conjunctive ground and surface water use to guide sustainable basin management

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1. Introduction-Motivation

- **Water is important as prerequisite for life and as an input to economic production activities**
- **Global water extractions have increased more than six-fold in the last century, which is more than twice the rate of human population growth**
- **Projected future climate change impacts together with population and wealth growth are expected to exacerbate the current situation of water scarcity, especially in arid and semiarid regions**
- **The conjunctive use of ground and surface water resources at basin level is an important strategy to address climate change-induced water scarcity**
- **Policies (institutions) for an adequate (coordinated) management of conjunctive use are needed. These policies should improve economic EFFICIENCY, achieve environmental SUSTAINABILITY, address EQUITY, and be ROBUST against a full range of future scenarios**

2. Study Area: The Jucar Basin

The Jucar Basin is chosen as our case study. This basin is located in the regions of Valencia and Castilla La Mancha in Southeastern Spain.

It is a good experimental region for an integrated basin scale analysis. One reason is that the Jucar is at present under severe stress, showing acute water scarcity, significant ecosystem degradation, and a politically charged relationship between ground and surface water users. Another reason is that the foreseeable climate change impacts are expected to exacerbate water scarcity problems in the basin.

It is one of the pilot basins for testing the implementation of the European Water Framework Directive

Jucar River mouth in Cullera

View of the Jucar River in Cuenca

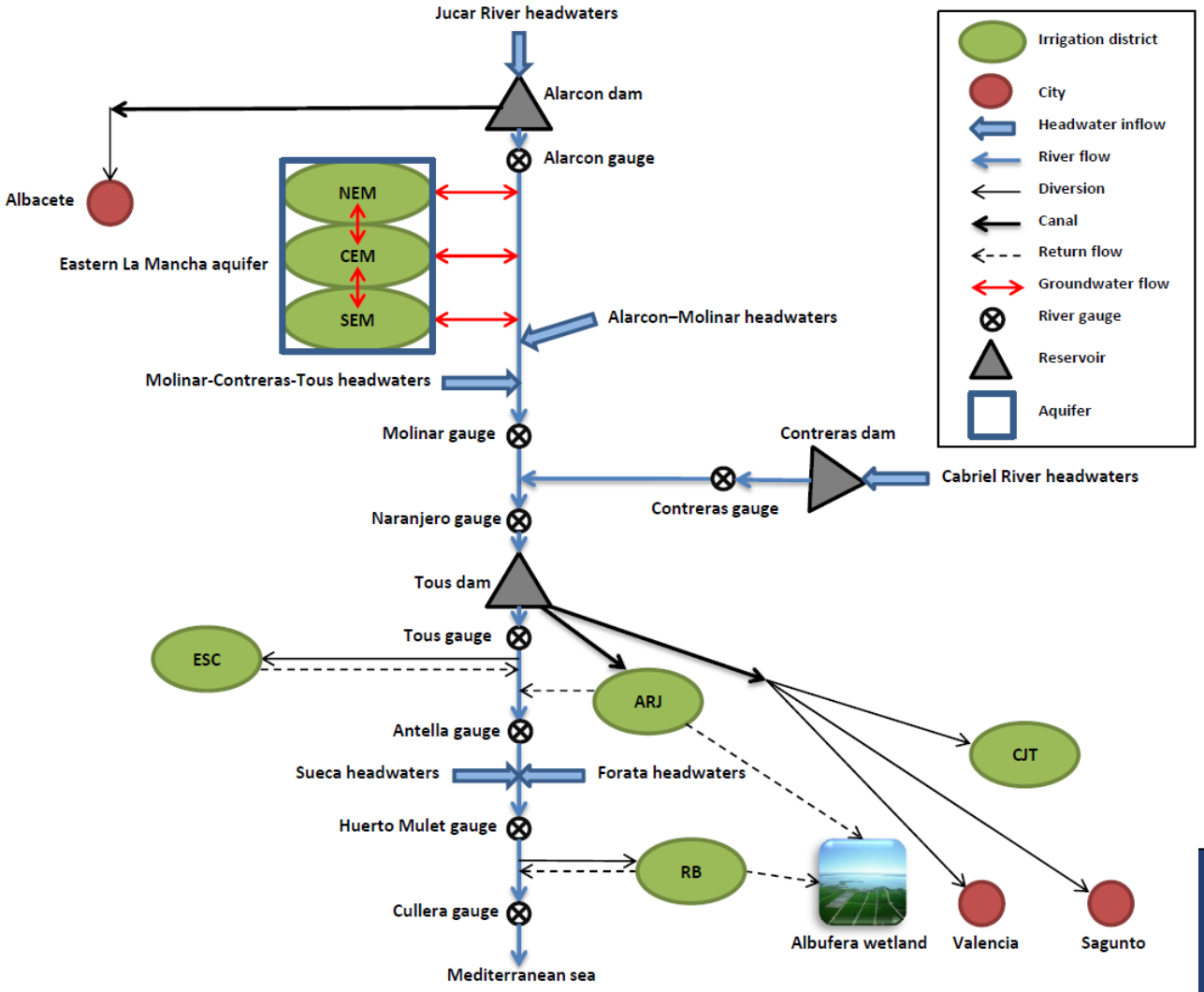
Alarcon reservoir

Fishing in the Jucar River

The Jucar basin includes the Albufera wetland, which is one of the most important aquatic ecosystems in Southern Europe. The Albufera is catalogued in the RAMSAR list, and declared a special protected area for birds. It receives water mainly from the irrigation return flows

3. Modeling framework

An integrated basin-scale hydro-economic modeling framework that includes several components including surface and groundwater hydrology, agronomy, land use, institutions, environment, and water-based economic activities



4. Climate change and policy scenarios

The model is used to analyze the following scenarios:

One climate change scenario that covers impacts on surface runoff, evapotranspiration and groundwater recharge

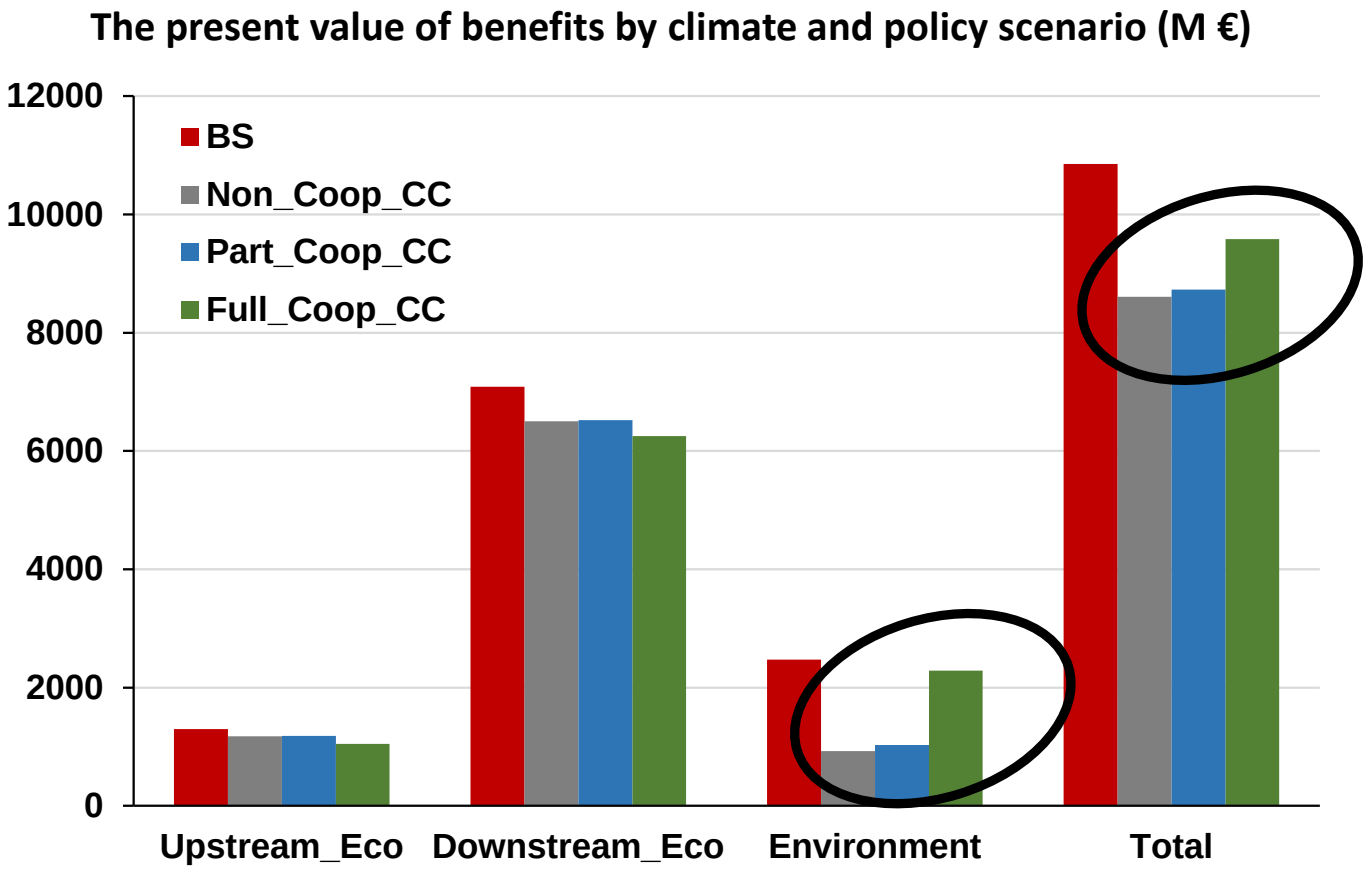
Three policy alternatives:

1) **Non-cooperation:** Each user (upstream and downstream) is maximizing his private benefits, disregarding the impacts on other users

2) **Partial cooperation:** Basin-level private benefits are maximized. This policy allows internalizing the upstream-downstream externality

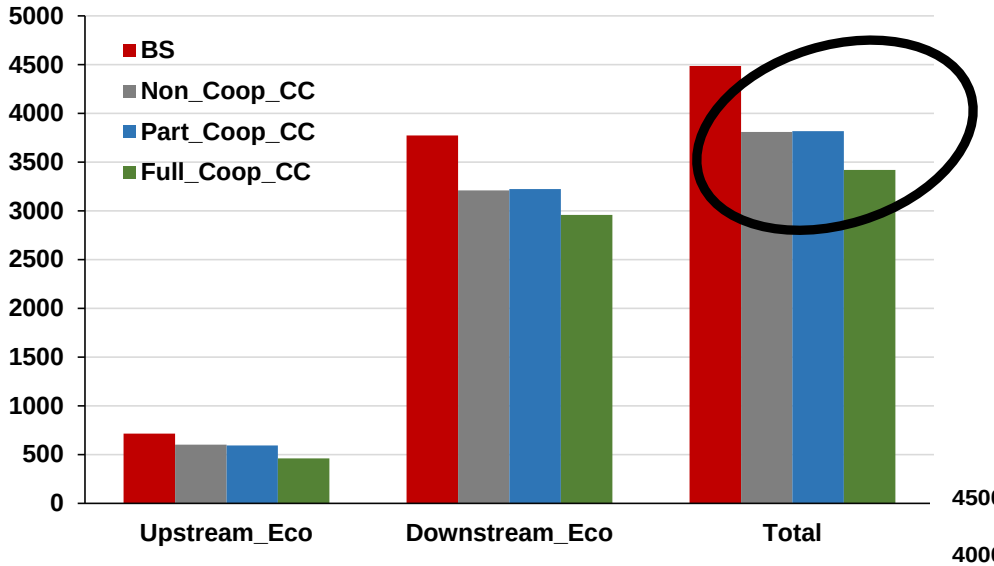
3) **Full cooperation:** Both private and environmental benefits (social benefits) at basin-level are maximized. This policy allows internalizing both the upstream-downstream and environmental externalities

5. Results

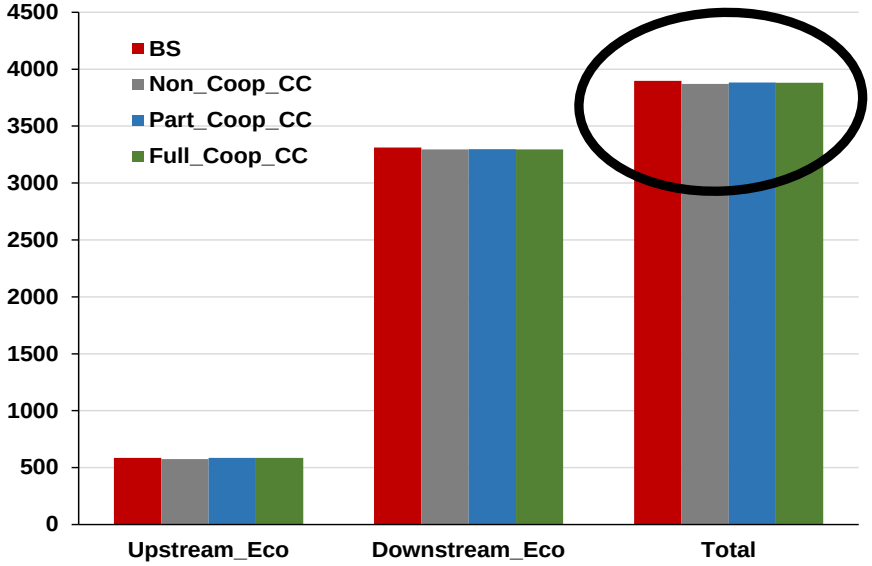

The present value of benefits by climate and policy scenario (M €)
12000
10000
8000
6000
4000
2000
0
BS
Non_Coop_CC
Part_Coop_CC
Full_Coop_CC
Upstream_Eco
Downstream_Eco
Environment
Total

The present value of benefits by use, climate and policy scenario (M €)

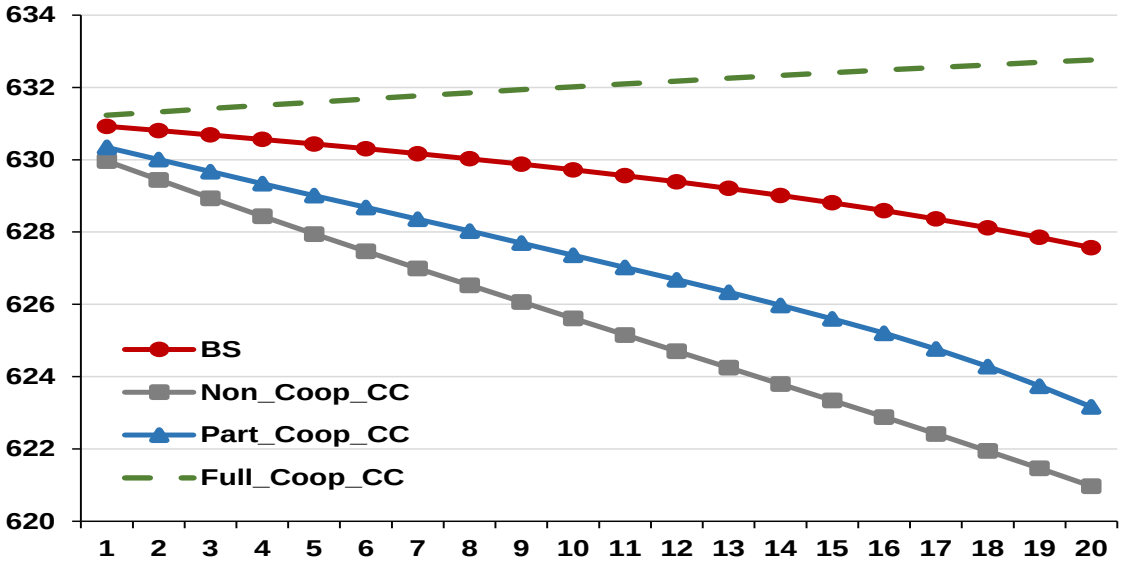
Agriculture



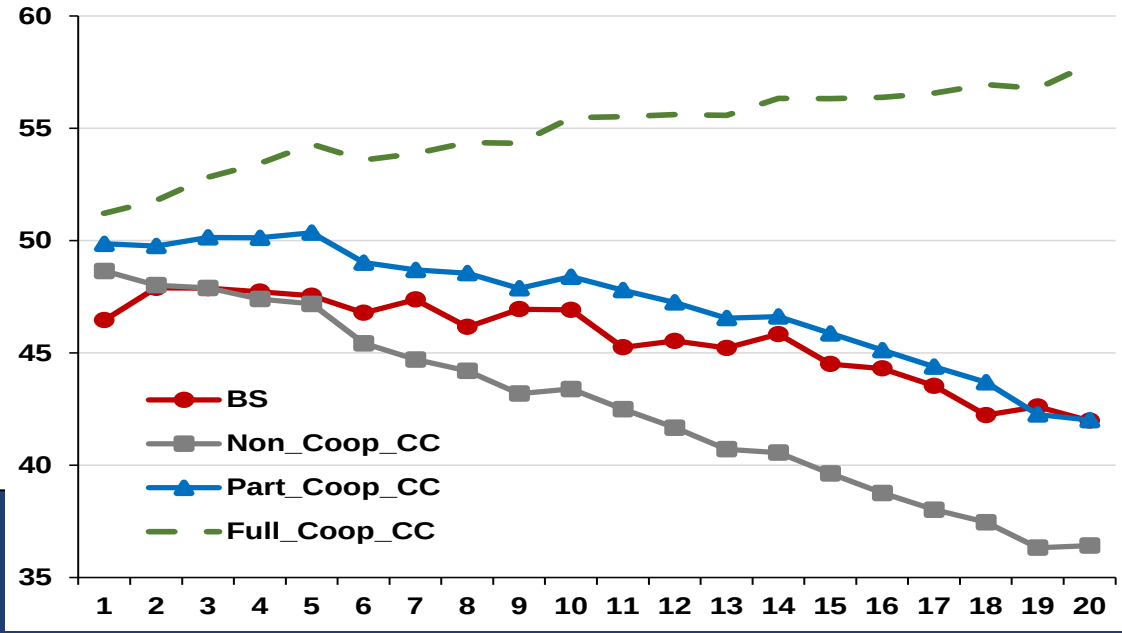
Municipal



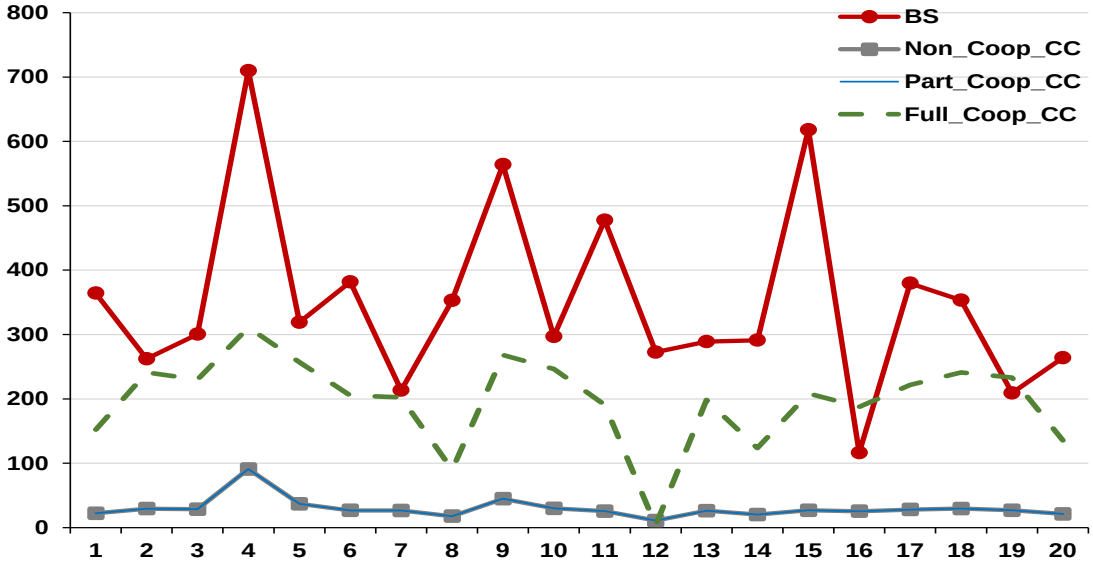
Aquifer head (m)



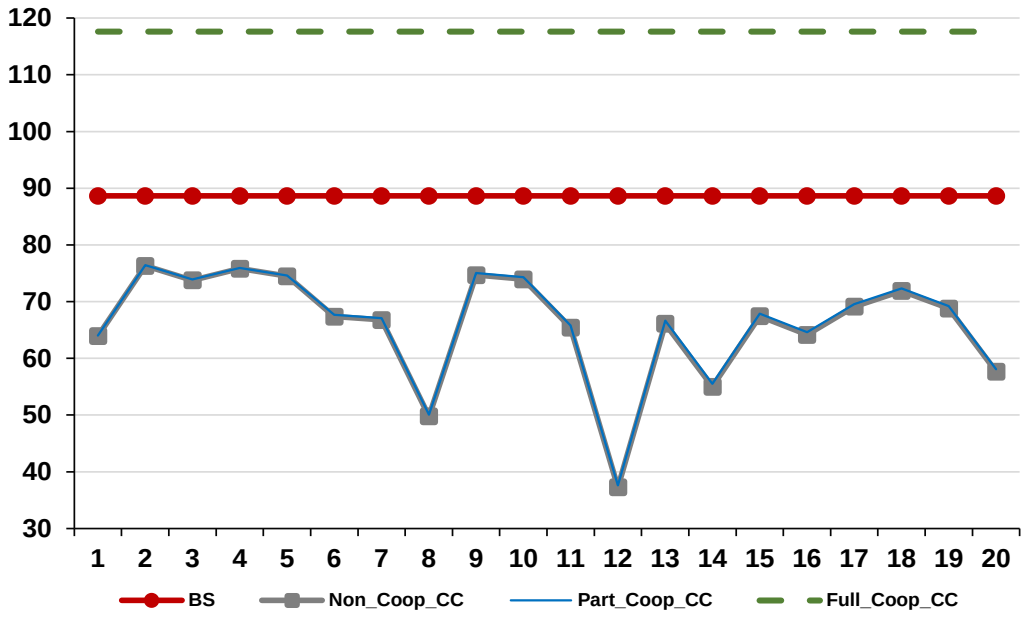
Discharge from aquifer to river (Mm^3)



Outflow to the Mediterranean Sea (Mm^3)



Inflow to wetland (Mm^3)



6. Conclusions and policy implications

- **Policymakers in basins face hard choices on water management and policies that involve complex environmental and economic tradeoffs**
- **Solving these challenges requires adequate policies and institutions that could advance sustainable management of water resources**
- **Results highlight the value of cooperation among water users in basins to address climate change impacts**
- **The achievement of acceptable and stable cooperative agreements at basin scale remains an important challenge**

Thank you for your attention