Geophysical Research Abstracts
Vol. 15, EGU2013-7120, 2013
EGU General Assembly 2013

Water demand and supply co-adaptation to mitigate climate change impacts in agricultural water management

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Agriculture is the main land use in the world and represents also the sector characterised by the highest water demand. To meet projected growth in human population and per-capita food demand, agricultural production will have to significantly increase in the next decades. Moreover, water availability is nowadays a limiting factor for agricultural production, and is expected to decrease over the next century due to climate change impacts. To effectively face a changing climate, agricultural systems have therefore to adapt their strategies (e.g., changing crops, shifting sowing and harvesting dates, adopting high efficiency irrigation techniques). Yet, farmer adaptation is only one part of the equation because changes in water supply management strategies, as a response to climate change, might impact on farmers' decisions as well. Despite the strong connections between water demand and supply, being the former dependent on agricultural practices, which are affected by the water available that depends on the water supply strategies designed according to a forecasted demand, an analysis of their reciprocal feedbacks is still missing. Most of the recent studies has indeed considered the two problems separately, either analysing the impact of climate change on farmers' decisions for a given water supply scenario or optimising water supply for different water demand scenarios. In this work, we explicitly connect the two systems (demand and supply) by activating an information loop between farmers and water managers, to integrate the two problems and study the co-evolution and co-adaptation of water demand and water supply systems under climate change. The proposed approach is tested on a real-world case study, namely the Lake Como serving the Muzza-Bassa Lodigiana irrigation district (Italy). In particular, given an expectation of water availability, the farmers are able to solve a yearly planning problem to decide the most profitable crop to plant. Knowing the farmers decisions, the operation of the upstream reservoir (Como Lake) is optimised with respect to the real irrigation demand of the crops. Then, the farmers can re-adapt their decisions according with the new optimal operating strategy, thus activating a loop between the two systems that exchange expected supply and irrigation demand. Results show that the proposed interaction between farmers and water managers is able to enhance the efficiency of water management practices, foster crop production and mitigate climate change impacts.