



## **Climate change adaptation & mitigation strategies for Water-Energy-Land Nexus management in Mediterranean region: Case study of Catalunya (Spain).**

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Water-Energy-Land (WEL) Nexus management is one of those complex decision problems where holistic approach to supply-demand management considering different criteria would be valuable. However, multi-criteria decision making with diverse indicators measured on different scales and uncertainty levels is difficult to solve. On the other hand, climate adaptation and mitigation need to be integrated, and resource sensitive regions like Mediterranean provide ample opportunities towards that end. While the water sector plays a key role in climate adaptation, mitigation focuses on the energy and agriculture sector. Recent studies on the so-called WEL nexus confirm the potential synergies to be derived from mainstreaming climate adaptation in the water sector, while simultaneously addressing opportunities for co-management with energy (and also land use).

Objective of this paper is to develop scenarios for the future imbalances in water & energy supply and demand for a water stressed Mediterranean area of Northern Spain (Catalonia) and to test the scenario based climate adaptation & mitigation strategy for WEL management policies. Resource sensitive area of Catalonia presents an interesting nexus problem to study highly stressed water demand scenario (representing all major demand sectors), very heterogeneous land use including intensive agriculture to diversified urban and industrial uses, and mixed energy supply including hydro, wind, gas turbine to nuclear energy. Different energy sectors have different water and land requirements. Inter-river basin water transfer is another factor which is considered for this area. The water-energy link is multifaceted. Energy production can affect water quality, while energy is used in water treatment and to reduce pollution. Similarly, hydropower — producing energy from water — and desalination — producing freshwater using energy — both play important role in economic growth by supplying large and secure amounts of 'green' energy or water where it is a scarce resource. Linkage of water & Energy to the land has been established through irrigated agriculture which has seen an increasing trend in the case study area. A detail scenario planning for regional water-energy demand and supply in conjunction with different climate change and economic growth scenarios are considered. For each future scenario of climate change, the goal is to obtain a ranking of a set of possible actions with regards to different types of indicators (costs, environmental etc.). The analytical method used is based on outranking models for decision aid with hierarchical structures of criteria and ranking alternatives using partial preorders based on pairwise preference relations. The proposed method has several advantages such as the management of heterogeneous scales of measurement without requiring any artificial transformation and the management of uncertainty by means of comparisons at a qualitative level in terms of the decision maker preferences. Result shows that such an integrated ("nexus") approach is likely to build resilience and reduces vulnerability to the combination of pressures acting upon the Mediterranean region's water systems, including climate-related shocks.