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Editorial: (10 years) Water-energy-food nexus: Impact of climate variability and change on the water-energy-food nexus

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Editorial on the Research Topic
(10 years) Water-energy-food nexus: Impact of climate variability and change on the water-energy-food nexus

Water, energy and food are essential for human wellbeing and sustainable development, and their availability and production are highly interconnected. Water is used along the entire food supply chain, from production to distribution, and it is used to produce and transport energy. At the same time, energy is required to produce, transport and distribute food as well as to extract, collect, transport, and treat water. Global projections of population growth and mobility, urbanization, economic development, and technological changes indicate that demand for food, freshwater, and energy will increase significantly over the next decades, challenging the sustainability of the water-energy-food (WEF) nexus. As water, food, and energy sectors are inextricably intertwined, policy related actions in one area will likely have an impact on the others. Additionally, increasing demand and poorly planned policy actions can have degrading effects on the health of ecosystems and provision of their services that humans ultimately depend upon.

The WEF nexus is tightly related with climate background state and variability, and climate change is then expected to further exacerbate the projected stress. Increasing temperature will lead to higher energy demand for air conditioning, especially in urban areas. At the same time, the growing renewable energy sector will be facing the threats of climate change. Changes in precipitation patterns will lead to water stress on the agricultural sector, eventually threatening food security. Climate models have been proved to provide a reliable picture of the observed evolution of global temperature during the 21st century. However, uncertainties still affect future predictions and projections at the regional and local scales, especially concerning the timing and amplitude of the change. In this context, this Research Topic provides a multidisciplinary platform for discussion on recent advances on the understanding of the impact of current and future climate variability and change on the WEF nexus, and to present perspectives for the implementation of concrete future sustainability actions.

The WEF nexus will be affected by climate change especially in developing countries where climate change is expected to have the strongest impact, and West Africa is a hot spot in this respect. Giannini et al. discuss how livelihood strategies shape vulnerability to climate of food security in Senegal. By integrating long-term observations of rainfall with nationwide household surveys of nutrition and socio-economic status, they show that food security is on average lower and more variable in the climatologically wetter south and east of the country than in the drier western center and north. In particular, they find that households in the western center and north are less dependent on livelihoods based on climate-sensitive activities, such as agriculture, because of their geographical proximity to the political and economic center. On the other hand, these activities are dominant in remote, landlocked and conflict-exposed areas in the south and east, where sensitivity to rainfall variability is still large. The authors suggest that, to strengthen the resilience of climate-sensitive activities, food security and climate-risk management projects and policies should invest in livelihood diversification to increase rural income and reduce vulnerability of food security to climate. Hydropower potential in the White Bandama watershed in Ivory Coast is assessed by Kouadio et al. through the coupling of a hydrological model with a geographic information system. A total of 22 hydropower sites is identified, geolocated, and classified with an estimated total production capacity of 538.56 MW. The study also shows that the hydropower potential in the basin is characterized by small-hydropower sites, accounting for 82% of all sites, while medium- and large-hydropower sites account for 18% of all sites, suggesting that energy security in the region should rely on decentralized electrification.

The Mediterranean is also a hot spot of climate change, projected to experience much hotter and dryer conditions in the future. In particular, the balance between water demand and abstractions vs. water availability, which is often under stress in the region under current climate conditions, is expected to be a critical issue in a changing climate. De Roo et al. explore aspects interlinked with water in the water-energy-food-ecosystems nexus, focusing on water scarcity and depletion of groundwater resources in the context of climate change. The authors detail the proposed measures for water efficiency, such as irrigation efficiency, urban water efficiency, water reuse and desalination, that might be effective to reduce the growing water scarcity problems in the region. Results of the analysis show that, whereas current envisaged water efficiency measures are effective in decreasing water abstractions and consumption, these measures might not be sufficient to keep up with the pace of diminishing water availability due to climate change, highlighting that more ambition is needed to keep water scarcity at bay in the Mediterranean.

Finally, the integrated and interactive nature of water, energy and food systems, and the implications for the WEF nexus of policies in each of these systems are discussed by Suckling et al. Specifically, the possibility of unintended negative outcomes of seemingly positive actions is explored. The article presents a categorization of such detrimental unintended consequences applied to examples in the WEF nexus, and highlights the potential for the unexpected to happen. The authors conclude with guidance on how measures addressed to secure sustainable water, energy and food systems should be implemented, avoiding and/or managing unintended consequences. In particular, the assessments and identification of potential unintended consequences of policies should be conducted by multidisciplinary teams, with as much consensus among decision-makers as possible, and policy plans should be iterative, with scheduled re-assessments and adjustments. Most importantly, more active learning by decision-makers about how to avoid repeating past unintended consequences is needed, through the documentation of assessment process and outcomes and the appraisal of the effectiveness of policy mechanism.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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