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Editorial

How Does Agricultural Water Resources Management Adapt to Climate Change? A Summary Approach

Nektarios N. Kourgialas

Water Recourses-Irrigation & Environmental Geoinformatics Laboratory, Institute of Olive Tree, Subtropical Crops and Viticulture, Hellenic Agricultural Organization (ELGO Dimitra), 73134 Chania, Greece; kourgialas@elgo.gr; Tel.: +30-282-108-3442

Abstract: This editorial paper takes the form of a concise report and delves into a critical and intricate issue essential for the sustainability of agriculture. It centers on the intricate relationship between agri-cultural water resource management and agronomical practices, as well as their ability to adapt to the impacts of climate change while ensuring both the quantity and quality of crop yields. Specifically, this paper serves as a synopsis of how the far-reaching consequences of climate change for water resources impact agricultural production. It also highlights primary adaptation strategies for managing agricultural water resources, as drawn from the existing literature. Such strategies are designed to counteract the potentially adverse impacts of climate change on the rural sector. Fur-thermore, this brief report offers a valuable overview of the 17 selected papers featured in this Special Issue (SI) on Water, published by MDPI. These papers serve as exemplars of cutting-edge approaches to adaptability in water resource management and resilient crop production systems, as these fields attempt to thrive in an ever-changing environmental landscape.

Keywords: water resources reallocation; technology for smart water management; proper agronomic practices; climate-resilient crops

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1. Introduction

The relationships between water, agriculture, and climate change are characterized by complexity. Moreover, the effects of climate change on the availability of water for irrigation is one of the topmost concerns for agricultural sustainability [1,2]. There are numerous studies on the potential effects of climate change on agricultural water resources, presenting various approaches to monitoring and prediction in agronomic and irrigation management practices. Many of these studies investigate how adaptable the nexus of water and crop production systems is to climate change, based on various motivations, from a local to a global scale, including a wide range of water policies and modeling scenarios [3,4]. The results of these studies are, in many cases, contrasting and, on occasion, contradictory; however, one common element is that a key global impact of climate change is the reduction in crop yields due to a decline in the availability of irrigation water [5,6].

There are potentially five main ways in which climate change impacts water resources in agricultural production [1,7,8]: (1) Increased irrigation requirements—crop evapotranspiration is increasing, particularly in the spring and summer months, which, in turn, increases demand for irrigation water. This is a crucial issue, especially in areas already facing low water availability and/or areas where other important water consumers, such as tourism, compete for resources. (2) The deterioration of water quality in rivers, aquifers, and soil erosion. The alteration of carbon and nitrogen cycles contributes to an increase in water-related soil erosion and a reduction in the quality of available water resources. In addition, increased surface and groundwater contamination, due to increased water temperatures, lower runoff levels, and pollution from inappropriate agronomic practices place additional stress on irrigated agricultural zones. (3) A rising incidence of extreme events (floods and water scarcity). Flash floods or drought risk in agricultural areas are increasing as a consequence of the high spatiotemporal variation in the amount and duration of rainfall. (4) Changes in agricultural land use and in the quantity/quality of production. Pressures on the different elements of the hydrological cycle can reduce water availability in some regions and, at the same time, increase the frequency of infestations by pathogens or insects, reducing the quantity and quality of yields. Finally, (5) rising sea levels affect coastal cultivated areas. In these areas, a common problem also takes the form of high salt concentrations in irrigation water due to the salinization of freshwater, which, in turn, may reduce agricultural production.

2. Promising Features

The main goals of this brief report are draw on the existing literature to summarize and identify the various characteristics of the nexus between agricultural water supplies, climate change, and strategies of adaptation for globally sustainable agriculture. In this summary report, we propose a list of the most remarkable approaches to mitigating the adverse effects of climate change in agricultural water resources management [5,9–14]. The ten proposed categories of adaptation to climate change risk in agricultural water and soil management are: (1) leveraging innovation and technological advantages in terms of modeling/machine learning systems and IoT devices in the fields of water use efficiency, monitoring and early warning (for instance, smart irrigation approaches); (2) small-scale water reservoirs at the parcel scale; (3) water reutilization; (4) setting clear water use priorities by improving water charging/trade, optimizing water resource reallocation, the renegotiation of allocation agreements, and integrating water demands into conjunctive systems; (5) creating/restoring wetlands; (6) enhancing flood plain management and improving drainage systems; (7) improving agricultural insurance against extreme hydrological events; (8) introducing drought resistant and climate change resilient crops; (9) improving/introducing agronomic practices to retain soil moisture, prevent soil erosion, and improve nitrogen effectiveness and soil organic carbon input; and (10) improving or maintaining crop diversification and biodiversity.

The appropriateness of each of the above-suggested measures depends on local conditions; thus, the establishment of regional adaptation plans should be a high priority. For the selected adaptation measures, it is also important to define the appropriate level of implementation at the national, local/river basin, or farm level. The proposed adaptation measures should also be selected on the basis of the intersection of their high potential benefits and low or moderate implementation costs [7,12]. In general, the larger the scale of applied measures, the higher the benefits are for stakeholders. Therefore, water resources reallocation, the use of technology (such as smart irrigation) to improve water use efficiency, proper agronomic practices, and introducing climate-resilient crops by changing cropping patterns, seem to be the most beneficial measures to tackle issues of water scarcity [5,7,11,13]. In the context of water resource reallocation, in regions that face water shortages due to recurring droughts, water restrictions and water rationing (temporary suspension of water supplies or a reduction in pressure) are commonly applied soft measures. However, water rationing practices are often implemented without appropriate planning, scheduling, timeframes, or advanced warning to customers. Thus, the proper management of water rationing, based on the duration of supply (cycle time), rationing fraction (duration of non-supply), and water storage capacities, should be a high priority in terms of ensuring equity and optimal performance of the water supply network [15].

All these solutions may include changes in land use, infrastructure, and/or limitations to irrigation that may not be fully accepted by the entirety of society, which could lead to disagreements among various stakeholders. It is necessary, therefore, to harmonize the interests of the stakeholders affected by these processes and to foster the transformation from coping capacity to sustainable adaptive capacity [3]. Figure 1 depicts an overall schematic representation of this discussion.

In line with the above, this Special Issue presents research on new technologies and decision support systems to adapt the agriculture industry to climate-induced water supply issues. Tzerakis et al. (contribution 1) developed an IoT-based system that can enhance water-use efficiency in agriculture and tackle the problems caused by extreme climate events. This monitoring system could be a useful tool in irrigation management and pest control as it incorporates real-time soil moisture, soil electrical conductivity, soil temperature, and meteorological data. To ensure long-term water availability and accessibility, especially with the abandonment of climate-impacted plots of land, sustainable water management strategies and better hydrological models have been developed (contribution 2, 3) and are presented in this Special Issue. Tracking the impact of climate change on water and the agricultural sector, based on real-time production monitoring and forecasting systems, is also analyzed and discussed as one of the most promising prospects in effective agricultural water management (contributions 4, 5, 6, and 7). In line with the above and in order to improve water productivity on grain maize, Yang et al. (contribution 8) investigated the combined effects of plastic film mulching and water stress for different irrigation methods deployed in arid regions. Wheat is another important crop for global food production that is highly susceptible to drought stress; therefore, (contribution 9) examined drought priming and subsequent irrigation water regimes to improve yield and water productivity for this crop. The results indicate that drought priming during the early growth period of wheat plants may be a promising strategy to mitigate subsequent irrigation water regime levels and conserve freshwater.

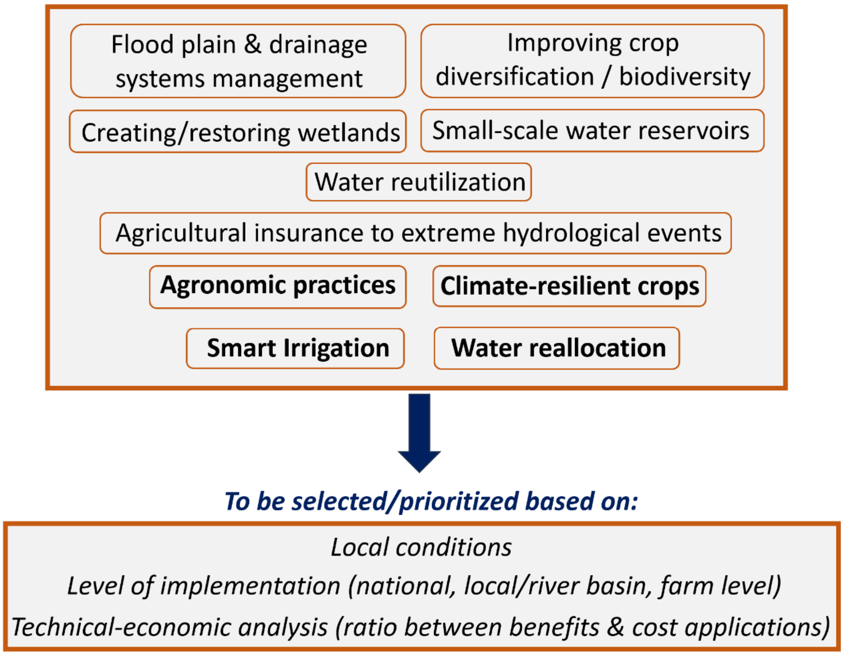

Figure 1. The 10 main categories of measures for mitigating climate change in agricultural water resource management and ways to prioritize them.

Ahmad et al. (contribution 10) evaluated the factors determining the most appropriate adaptive interventions in water-scarce areas, incorporating socioeconomic factors and the effects of climatic change on groundwater systems. An important aspect of this Special Issue is its goal of presenting advances in remote sensing, geophysics, and modeling tools to support precision agriculture in the context of dynamic interactions between plants, soil, water, and climate systems, also in combination with proper management (contribution 11, 12). In addition, a comprehensive review of the well-known HYDRUS 2D/3D modeling approach to managing the proper use of irrigation water for tree crops and predicting/monitoring water dynamics and pollutant transport is also presented in this Special Issue (contribution 13). Finally, this Special Issue notes the benefits of the adaptability and successful establishment of agrotechnical measures and methods based on collecting natural moisture and its long-term storage for improving rain-fed horticulture in regions with arid climates. This subject introduces innovative and effective agricultural water management strategies that address drought-related challenges and promote resilient rain-fed horticultural systems (contribution 14).

3. Conclusions

Based on the above-mentioned key objectives, the answer to the question of this Editorial, "how does agricultural water resource management adapt to climate change?", is that there are many directions and agrotechnological tools that can assist farmers, local authorities, and policymakers to address and realize climate-induced water impacts, based on the proper management of agricultural water resources. The key point is to select and prioritize adaptation measures appropriate to the cropping system based on local conditions, the applied scale, and a technical–economic analysis in order to achieve the highest ratio of benefits to costs. The contributions to this Special Issue have significantly contribute to the scientific understanding of the benefits associated with adapting agricultural water management to a changing environment. Our goal is that this report will serve to encourage our readers to embark on their own future research endeavors in this crucial field.

Conflicts of Interest: The author declares no conflict of interest.

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