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Editorial

Feature Papers of Water Resources Management, Policy and Governance

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Water resource management aims to environmentally and economically satisfy the water demands of various water uses in a hydrological basin. The main sectors of water use are agriculture, urban, industry, hydroelectric power production, and preservation of the environment and the ecology of ecosystems. These uses of water require different water volumes and water quality standards and are usually very competitive. Most of the time, it is not possible to cover all water needs in a hydrological basin, due to the limited available water resources. Hence, it is imperative to set water use priorities in a way that serves societal and ecological needs. Managing the water resources and operating the water works may, sometimes, lead to confrontations, deliberations and negotiations. Proper policies and governance for integrated sustainable water resource management are essential. Water resource management, policy and governance are great global challenges due to competition for limited resources, regional disparities in water supply and affluence, growing global water demand, surface water and groundwater depletion and pollution, and climate-change-induced water stress.

This WATER Special Issue (S.I.) titled "Feature Papers of Water Resources Management, Policy and Governance" was set up to collect papers by invited reputable researchers and engineers to cover issues of water resource management, governance, and policy, such as: integrated water resource management, management of water resource systems and water availability, monitoring and protection of water resources, national and international water policy, institutional arrangements, and water law, water economics and commercialization of water, water conflict resolution, public participation, and decision making, water resource management, policy and governance in socially and environmentally sensitive areas and regions. The seven (7) papers of this S.I. cover a wide range of research topics related to water resources management, policy and governance. A short description and discussion of this whole set of experiences from the authors' contribution to this S.I. is provided.

Effective water resource management requires assessments of water availability within a framework of complex institutions and infrastructure used to manage extremely variable stream flow shared by numerous, often competing, water users and diverse types of use. Wurbs [1] uses and updates the Water Rights Analysis Package (WRAP) modelling system. WRAP is fundamental to water allocation and planning in the state of Texas in the United States. The WRAP modelling system combines: (1) detailed simulation of water right systems, interstate compacts, international treaties, federal/state/local agreements, and operations of storage and conveyance facilities, (2) simulation of river system hydrology, and (3) statistical frequency and reliability analyses. The continually evolving modelling system has been implemented in Texas by a water management community that includes the state legislature, planning and regulatory agencies, river authorities, water districts, cities, industries, engineering consulting firms, and university researchers. Environmental flow standards have been integrated into the modelling system and comprehensive statewide water management. The public domain WRAP software and documentation have

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Citation: Loukas, A.; Garrote, L. Feature Papers of Water Resources Management, Policy and Governance. *Water* **2022**, *14*, 2191. https://doi.org/10.3390/w14142191

Received: 5 July 2022
Accepted: 6 July 2022
Published: 11 July 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

been generalized for application in other basins of the world. Application of the modelling system in river basins in Texas, U.S.A. and in other basins of the U.S.A. indicates that the modelling system could be applicable worldwide, and it contributes to integration of water allocation, planning, system operations and research.

Securing water resources for the future is a key issue of global change. This issue is strongly connected with the global population growth, climate change, hydrological cycle, economy, energy production, land use change and pollution generation. Simonovic and Breach [2] present and apply the ANEMI3 model. The ANEMI3 model is an integrated global change assessment model that emphasizes the role of water resources. The paper is focused on the development of global water supplies necessary to keep pace with a growing population and the global economy. A series of experiments have been conducted using the ANEMI3 model, in order to assess: (i) the current role of water supply in the global Earth system; (ii) the level of water stress that can be expected in the future; and (iii) what are the potential effects of water quality on global surface water supply and the distribution of water supply types. The results of model simulations show that surface water resources were sufficient to meet the water demand and water quality has not shown to be a significant factor for the development of surface water supplies. However, these impacts are averaged to a global aggregated scale, and they are likely understated.

Environmental flows are necessary and essential for the preservation of river and riparian ecosystems below dams and hydropower projects. However, maintaining environmental flows has faced considerable resistance and caused conflicts among different stakeholders. Appropriate solutions should be examined. Ruan and associates [3] present a study and analysis of questionnaires and interviews to determine the key conflicts in the implementation of environmental flows in a small-scale hydropower project in China and to propose potential solutions. Three factors have been selected as the main reasons for conflicts, namely, economics, stakeholders' skepticism, and technology according to the international literature. The study uses online questionnaires and interviews with owners of small-scale hydropower projects, government administrators, and the public in Fujian Province, China. The results showed that the main hindrance for the implementation of environmental flows was the potential economic loss resulting from reductions in electricity production, stakeholder's' skepticism, technical difficulties, and a lack of the government supervision. Diversion-type projects pose the largest losses of electricity production after the release of environmental flows, and by adopting a 10% of mean annual flow as minimum target, most small-scale hydropower projects obtain low marginal profits without compensation. The authors proposed an appropriate payment for ecosystem services by introducing an economic compensation program for different types of small-scale hydropower projects scaled by potential losses in electricity generation. Under such a scheme, the government, hydropower project owners, and electricity consumers share the cost of economic losses from a reduction in electricity production. The paper also presents recommendations for policymakers, officials, and researchers for conflict mitigation when implementing environmental flows.

The understanding and realization of the complexity of water governance beyond an empirical concept is significant. Gumeta-Gómez and associates [4] propose a Water Governance Complexity Framework to address the complexity of water governance. Through a literature review, rapid surveys, and 79 semi-structured interviews, the authors propose how this framework may become operational using different representations. The framework has been applied to the urban water supply system of Oaxaca, Mexico. The authors found legal pluralism and diverse formal and informal stakeholders in a multilevel structure in rural communities of Oaxaca, where the state plays a partially absent role in the water supply. Four modes of governance at the local level were identified, resulting from seven trajectories of institutional change. These trajectories result from linear (alignment) and nonlinear (resistance and adaptation) interactions between local, state, and national institutions over different periods. The authors provide a pragmatic framework to understand complexity through the organization and historical configurations of water

governance that may be applied globally, providing a necessary starting point and solid foundation for the creation of new water policies and law reforms or transitions to the polycentric governance model to ensure the human right to water and sanitation.

The preservation of water ecosystems is imperative in the framework of water resource management. Investigations about changes in ecosystems and their relevant water environments under rapid changes in land use can provide valuable information to formulate sustainable protection and development strategies. Zhang and associates [5] present a study on the preservation of the ecosystem of the mulberry-dyke-fish ponds, which are a representative traditional eco-agriculture in the Greater Bay Area of Guangdong–Hong Kong–Macao (GBA). The study combines supervised classification and visual interpretation approaches using Landsat images obtained after 1986. A water intensity index and a synthesized index are used to identify spatial patterns of changes in the ponds in the GBA over the past 40 years. The results indicate that during the period 1986–2013, the total surface area of the ponds in the GBA increased significantly and reached its peak in 2013 with a total increase of 84.63%. After this period, the total surface area of the pond showed a downward trend with a total decrease of approximately 31.34%. The year 2013 was identified as the critical year of the changes. It seems that human activities have continuously influenced the spatial distribution and size of fishponds in the past 40 years. The fishponds had transformed from near-natural ponds with different sizes and a near-natural random distribution in the early stage into an artificial distribution and an artificial shape. Land use changes, industrial transfer, government guidance and financial motives have been identified as the major drivers for the changes. This shrinking trend in the ponds will continue in the future, if no effective measures are taken.

Natural hazards have caused significant damages to natural and manmade environments during the last few decades. Hydro-meteorological hazards are among the most destructive hazards and are considered responsible for the loss of human lives, infrastructure damages and economic losses [6]. Droughts affected 52.7 million people worldwide in year 2021 and 67.5 million people worldwide, on average per year, for the period 2001–2020 [7]. Drought is one of the most damaging natural hazards on the Iberian Peninsula, causing significant socioeconomic and environmental problems. Five (5) major river basins are transboundary river basins between Portugal and Spain. Cooperation between the two countries is needed to prevent the adverse impacts of droughts. However, in terms of drought planning and management the two countries are clearly in different stages. Portugal approved a national drought plan in 2017, while Spain has already had drought plans in place for all River Basin Districts since 2007 and approved an updated version of these plans in 2018. The Spanish drought plans currently in place foresee two sets of indicators: prolonged drought and water scarcity indicators. Maia and associates [8] present the definition of similar indicators for the Portuguese part of the Minho and Lima transboundary river basins, according to European guidelines and in common with Spain, with the aim of developing a joint international drought management plan for these basins. For the period from October 1980 to September 2017, the comparison of the indicators obtained for the Portuguese parts of the basins with those obtained for the corresponding Spanish parts shows a similarity in the occurrence of drought and water scarcity in both parts of the basins, although with a higher prevalence of water scarcity situations in the Spanish part of the Lima river basin. The work presented in the paper has been developed in close collaboration with the competent authorities of the river basin districts of both countries, with the aim to be a prototype for the definition of new and comparable indicators of drought and operational scarcity. Therefore, this work is a starting point for the creation of common tools for integrated management of drought in transboundary basins in the Iberian Peninsula.

Sustainable water resources management implies the study of all interrelated parameters (e.g., social, environmental, economic, engineering and political) in a comprehensive way. Although Greece is listed in the international rankings as a water-rich country, it has significant water problems due to its high temporal and spatial variation in the dis-

tribution of water resources and its unsustainable management practices, characterized by a fragmented and sector-oriented water management system. This problem has been significantly improved by the adoption of the EU Water Framework Directive (EU WFD) and the development of management plans at the river basin scale [9]. However, because of the effects of climate change, there is still a long way to go, and substantial changes are needed in order to reach sustainability. In this sense, adaptation is a vital response toward sustainability. Kolokytha [10] presents an analysis of water resources management and the application of EU WFD in the Mediterranean region and Greece. The paper focuses on the example of the Mygdonia basin located in Northern Greece. The agricultural basin of Mygdonia is a case study of a highly negative water balance system that highlights the shortcomings of both water management and adaptation in Greece. Analysis of the hydrology of the basin, as well as the climate projections until 2100, revealed the urgent need for concerted actions. A set of different adaptation strategies for development was applied and assessed for their effectiveness. According to the results of this research, integrated watershed management is a prerequisite for a successful adaptation policy. Radical reform is needed in the agricultural sector by decreasing agricultural land and changing the crop pattern. The study concludes that managing water demand is the solution rather than the development of water supply projects.

In conclusion, this Special Issue contains seven (7) invited papers with important results, covering several aspects of water resources management, policy and governance. Increasing demand for water, under the pressure of climate change impacts, is forcing water scientists and engineers to improve and develop new methods and approaches for integrating water resources management and protection, develop appropriate policies and define feasible governance structures. The results offer insights for further multi-methodological, multi-disciplinary and multi-purpose research. There are still challenges to be accepted and overcome to ensure a sustained and sufficient supply of good quality water for future generations.

Author Contributions: A.L. and L.G. have conceived the structure and wrote the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: In the Guest Editors thank all the authors of the published papers and the manuscripts reviewers.

Conflicts of Interest: The authors declare no conflict of interest.

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