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Editorial

Water-Secure River Basins: A Compromise of Policy, Governance and Management with the Environment

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Water-secure basins are a lifesaving goal of society that can be accomplished if political and water authorities, stakeholders, and the general public are networked and committed to effectively improve water security, river basin management, and water resource policies and governance. The United Nations defined water security as the "capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability" [1]. This definition comprises the elements of water security but does not direct the concept to a specific geographic space. If, as usual, the geographic space is a watershed, then water security overlaps the scope of river basin management as the later contributes to the former through a "coordination amongst operating and water management entities within a river basin, with a focus on allocating and delivering reliable water-dependent services in an equitable manner" [2]. The implementation of river basin management requires the preparation of a master plan reflecting sector plans and offering the most efficient use of water; the involvement of stakeholders for the sharing of basin-wide datasets and knowhow; the technical and scientific capacitation of involved human resources; and the implementation of monitoring and evaluation plans to identify the needs for adjusting management strategies; among others. However, even with these operational conditions ensured, river basin management can only succeed if political will and innovative water resource policies and governance approaches are capable to create a favorable legal atmosphere and respond to current water-born challenges. In the latter case, the response should help balancing the conflict between water demand and healthy ecosystems [3]; resolving water infrastructure finance constraints [4], bringing the payment for water resource services and ecosystem services into the equation; and implementing water-saving and green technologies through field rainwater harvesting [5], intelligent irrigation [6], wastewater treatment and reuse [7], desalinization [8], and education of population on efficient domestic and industrial water use [9]. The goal of understanding this complex imbrication and interplay between water security, river basin management, and water policies and governance, motivated the launch of a Special Issue on "Water Security and Governance in Catchments", which was edited with great enthusiasm.

During the working period, many submissions were received, which provided significant contributions for the main topics of this special issue. However, only 12 high-quality papers were accepted after several rounds of strict and rigorous review. These 12 contributions are summarized in the forthcoming paragraphs, being integrated into a coherent narrative. In brief, contributions 1–4 [10–13] discussed water security from the standpoints of quantity and quality, contributions 5–7 [14–16] addressed water hazard risks (floods and droughts), contributions 8–10 [17–19] looked into hazard mitigation measures and. Finally, contributions 11 [20] and 12 [21] focused on governance-related matters.

A key element of water security is availability, namely of surface water and groundwater. At the catchment scale, these parcels of total freshwater are frequently estimated by hydrologic models such as the SWAT. Contribution 1 [10] used this model to investigate the impact of current land uses, as well as of simulated land changes, on the runoff, groundwater storage and evapotranspiration, within the Uberaba River basin, Minas Gerais, Brazil. A scenario of extensive reforestation led to increasing groundwater storage but also to amplified water losses through evapotranspiration as well as decreasing contributions to the surface compartment through decreased runoff. Another vital element of water security is quality, namely the compliance of raw water with legal standards. In multiple-use watersheds where many activities can concur to water quality degradation, evaluation of security from the quality standpoint requires the continuous searching for effective evaluation methods. Contribution 2 [11] proposed a new method to estimate *Escherichia coli* load reduction in river basins, considering different flow regimes and seasons. The method is based on Load Duration Curves and the study area comprised the Piracicaba and Piranga basins (Minas Gerais, Brazil). The results made evident that the loading of raw sewage directly into the rivers was a leading cause of *Escherichia coli* contamination regardless of flow regime. Thus, the first mitigation measure of *Escherichia coli* pollution should be the installation of wastewater treatment plants in the basins. The presence of fecal coliforms as most serious alteration to the quality of Brazilian streams was corroborated in the study of an anthropized rural area located in the municipality of Igarassú, state of Pernambuco, presented as contribution 3 [12] in the special issue. Land use or occupation are not the sole human pressures capable to affect stream water quality in catchments. Damming is another frequent cause of water quality declines, especially if dam lakes receive contaminant-rich drainage from upstream agriculture or urban watersheds. Contribution 4 [13] studied the impact of damming on stream water quality of Lerez, Umia, Ulla and Mandeo rivers (Galicia, Spain), but found no evidence of degradation, probably due to the fact that the riparian habitat was in general classified as good quality or close to natural conditions around the studied reservoirs.

As entailed in the United Nations definition, a water-secure basin must ensure protection against water-related disasters, namely droughts and floods. Water scarcity is a worldwide problem aggravated by climate variations (especially in arid regions). Contribution 5 [14] showed how the expansion of the Dunhuang Oasis irrigation district and planting structure changes from 1987 to 2015 affected the oasis stability, as assessed by a ratio of precipitation over evapotranspiration. The stability dropped to a dangerously unstable level from 1985 to 2010, while the Dunhuang city and surrounding cropland were expanding. It recovered slightly from 2010 to 2015 with the implementation of water-saving measures, but a water-transfer project is viewed as the most practical measure to bring the oasis back to full stability in the future. Floods were also tackled in the Special Issue. Contribution 6 [15] created a water hazard risk map along the “Belt and Road” zone through combined flood and drought data from 1985. The Belt and Road Initiative is a global infrastructure development strategy adopted by the Chinese government in 2013, aiming to promote economic development and inter-regional connectivity within the nearly 70 countries involved. With regards to floods, the results showed that South-Eastern Asia, southern China and eastern Southern Asia are areas with the most abundant precipitations, while floods in these areas are also the most serious. Contribution 7 [16] addressed the long-term impacts of flood protection measures in Bangladesh. The authors tested whether the construction of an embankment in the Meghna–Dhonagoda region has affected the rural communities over time, benefiting those living inside more than those living outside the flood detention structure, but did not find a significant difference based on welfare, migration, or mortality indicators.

Prevention anticipates while mitigation responds to water-related hazards. Both initiatives are crucial to keep basins secure and were investigated in the special issue. Contribution 8 [17] presented the results of a restoration project that combined civil with soft soil engineering procedures and revegetation, aiming to mitigate the impacts of long-lasting dredging in the estuary of Lima river (in the northwest of Portugal), namely the collapse of banks and consequent destruction of riparian vegetation. The built structures, composed of an interconnected system of groynes, deflectors and rip-rap/gabion mattress, detained erosion but failed to trap sediments as much as expected. Contribution 9 [18] also addressed mitigation, but in the context of crop production systems. The authors reviewed resource-conservation technologies developed in the Eastern Gangetic Plain as a response to concerns about agricultural sustainability, with basic principles of rebuilding the soil, optimizing inputs for crop production, increasing food production, and optimizing profits. Conservation agriculture and water-saving measures were among the developed technologies, which had the benefit of reducing energy and nutrients usage and of reducing agrochemical leaching, being scale-invariant and intuitively clear. The anticipation of water scarcity was addressed in contribution 10, which was focused on wastewater reuse as an opportunity to meet the freshwater demand, and proposed a shift of paradigm from "safe treatment and discharge of wastewater" to "transforming used water to fit-for-purpose water".

Although related to the prevention of freshwater scarcity, contribution 10 [19] was more a reflection about governance of wastewater reuse. In their paper, the authors enumerated the steps that are necessary to take before practicing responsible water reuse, namely the assessment of water demand and availability, identification of reuse applications, evaluation of health and safety including water treatment, and the setup of a governance approach. The last two contributions included in the special issue also addressed water governance issues. Contribution 11 [20] compared various water governances with the purpose to identify the best approach to regulate integrated river basin management. The governances included in the comparison were the experimental, corporate, polycentric, metagovernance, and adaptive. The comparison was based on the governance dimensions of effectiveness, efficiency and trust, and engagement, as defined by the OECD (Organization for Economic Co-operation and Development). A combination of adaptative and metagovernance was elected the best approach to regulate integrated river basin management. The last contribution (no. 12) [21] was concerned with the link between implementation of new government strategies and water-related research. The authors investigated the impact of Jordan's 2008–2022 government strategy for water on the research conducted in the Azraq Basin. The results showed an increase in the number of water-related research papers, but the increase was not different from the increasing trend in research production in Jordan generally. Besides, the documents aligned with the water strategy goals were not larger than 80%.

In brief, the 12 papers covered most elements of water security at catchment scale, namely water quantity and quality or water-related hazards, besides establishing links with management actions such as prevention and mitigation of flood or drought risk, as well as with governance approaches such as the alignment of water-related research with governments' strategy for water. Taken altogether, the papers form an interesting view over the challenges of building water-secure river basins.

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References

1. UNU-INWEH Water Security & The Global Water Agenda. *The UN-Water Analytical Brief*; Springer: Berlin/Heidelberg, Germany, 2013; Volume 53, ISBN 9788578110796.
2. Wheater, H.S. Water in a changing world. In *Highlights In Environmental Research: Professorial Inaugural Lectures at Imperial College*; Imperial College Press: London, UK, 2000; pp. 17–65, ISBN 9789231041334.
3. Forslund, A.; Renöfält, B.M.; Barchiesi, S.; Cross, K.; Davidson, S.; Farrell, T.; Korsgaard, L.; Krchnak, K.; McClain, M.; Meijer, K.; et al. *Securing Water for Ecosystems and Human Well-Being: The Importance of Environmental Flows*; Swedish Water House: Stockholm, Sweden, 2009; Volume 24, ISBN 9789197587242.
4. OECD Financing Water: Investing in Sustainable Growth. *OECD Environ. Policy Pap.* **2018**, *11*, 16.
5. Barron, J. United Nations Environment Programme Rainwater Harvesting: A Lifeline for Human Well-Being. *Water* **2009**, *41*, 69.
6. United States Environmental Protection Agency. *WaterSense ®Specification for Weather-Based Irrigation Controllers*; EPA: Washington, DC, USA, 2021. Available online: https://www.epa.gov/watersense/weather-based-irrigation-controllers (accessed on 13 March 2022).
7. United States Environmental Protection Agency. *Guidelines for Water Reuse*; Report EPA/600/R-12/618; CDM Smith Inc.: Boston, MA, USA, 2012. Available online: https://www.epa.gov/waterreuse/guidelines-water-reuse (accessed on 13 March 2022).
8. Jones, E.; Qadir, M.; van Vliet, M.T.H.; Smakhtin, V.; Kang, S. The State of Desalination and Brine Production: A Global Outlook. *Sci. Total Environ.* **2019**, *657*, 1343–1356. [CrossRef] [PubMed]
9. Tober, O.C. *UN-Water Analytical Brief—Water-Use Efficiency*; FAO: Rome, Italy, 2021; ISBN 978-92-5-135025-6.
10. de Melo Martins, M.S.; Valera, C.A.; Zanata, M.; Santos, R.M.B.; Abdala, V.L.; Pacheco, F.A.L.; Fernandes, L.F.S.; Pissarra, T.C.T. Potential Impacts of Land Use Changes on Water Resources in a Tropical Headwater Catchment. *Water* **2021**, *13*, 3249. [CrossRef]
11. de Oliveira Serrano, L.; Borges, A.C.; Pruski, F.F.; Melo, M.C.d. A New Approach to Use Load Duration Curves to Evaluate Water Quality: A Study in the Doce River Basin, Brazil. *Water* **2020**, *12*, 811. [CrossRef]
12. Vieira, I.F.B.; Rolim Neto, F.C.; Carvalho, M.N.; Caldas, A.M.; Costa, R.C.A.; da Silva, K.S.; Parahyba, R.; da Boa Viagem Parahyba, R.; Pacheco, F.A.L.; Fernandes, L.F.S.; et al. Water Security Assessment of Groundwater Quality in an Anthropized Rural Area from the Atlantic Forest Biome in Brazil. *Water* **2020**, *12*, 623. [CrossRef]
13. Álvarez, X.; Valero, E.; De La Torre-Rodríguez, N.; Acuña-Alonso, C. Influence of Small Hydroelectric Power Stations on River Water Quality. *Water* **2020**, *12*, 312. [CrossRef]
14. Zhang, X.; Zhang, Y.; Qi, J.; Wang, Q. Evaluation of the Stability and Suitable Scale of an Oasis Irrigation District in Northwest China. *Water* **2020**, *12*, 2837. [CrossRef]
15. Huang, Y.; Li, Z.; Chen, M.; Song, X.; Kang, P. Spatial Variability of Water Resources State of Regions around the "Belt and Road". *Water* **2021**, *13*, 2102. [CrossRef]
16. Manandhar, A.; Fischer, A.; Bradley, D.J.; Salehin, M.; Islam, M.S.; Hope, R.; Clifton, D.A. Machine Learning to Evaluate Impacts of Flood Protection in Bangladesh, 1983–2014. *Water* **2020**, *12*, 483. [CrossRef]
17. Sanches Fernandes, L.F.; Sampaio Pinto, A.A.; Salgado Terêncio, D.P.; Leal Pacheco, F.A.; Vitor Cortes, R.M. Combination of Ecological Engineering Procedures Applied to Morphological Stabilization of Estuarine Banks after Dredging. *Water* **2020**, *12*, 391. [CrossRef]
18. Mojid, M.A.; Mainuddin, M. Water-Saving Agricultural Technologies: Regional Hydrology Outcomes and Knowledge Gaps in the Eastern Gangetic Plains—A Review. *Water* **2021**, *13*, 636. [CrossRef]
19. Dingemans, M.; Smeets, P.; Medema, G.; Frijns, J.; Raat, K.; van Wezel, A.; Bartholomeus, R. Responsible Water Reuse Needs an Interdisciplinary Approach to Balance Risks and Benefits. *Water* **2020**, *12*, 1264. [CrossRef]
20. Julio, N.; Figueroa, R.; Ponce Oliva, R.D. Water Resources and Governance Approaches: Insights for Achieving Water Security. *Water* **2021**, *13*, 3063. [CrossRef]
21. Alqadi, M.; Al Dwairi, A.; Dehnavi, S.; Margane, A.; Al Raggad, M.; Al Wreikat, M.; Chiogna, G. A Novel Method to Assess the Impact of a Government's Water Strategy on Research: A Case Study of Azraq Basin, Jordan. *Water* **2021**, *13*, 2138. [CrossRef]