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Editorial

Integration of Water Quantity/Quality Needs with Socio-Economical Issues: A Focus on Monitoring and Modelling

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1. Introduction

Freshwater is essential for a multitude of different uses, including drinking supply, irrigation, and energy production [1]. Healthy freshwater ecosystems are also necessary for the protection of biodiversity [2]. A global water crisis is currently affecting our planet [3], with impacts even in regions considered rich in water, such as the subalpine areas north and south of the Alps [4,5]. Climate change is also exerting direct and indirect impacts on both water availability and biogeochemical cycles [6,7].

The relationship between water quantity and quality is, thus, becoming increasingly stringent, particularly when high quality standards are required, such as for drinking and sanitary uses, with consistent economic consequences [8]. Therefore, our ability to monitor and model both the water availability and its quality assumes a fundamental strategic significance in the management of the water resource.

This Special Issue hosts twelve papers exploring advances in the monitoring and modelling of both water quality and quantity. Most of the contributions (10) are research papers that cover a wide range of topics including hydrology, environmental economy, and ecotoxicology. The remaining two contributions are review papers dealing with the development of circular economy approaches in the recycle of phosphorus and the monitoring of the water resource using remote sensing techniques.

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2. Water Resource Monitoring and Modelling, Insights from the Publications Included in the Special Issue

Wurl et al. [9] studied the impact of seawater intrusion due to overexploitation of groundwater in the Los Planes aquifer in the Baja California Peninsula (Mexico). The study showed a general increase in mineralization from 2014 to 2016, except for the north-western part of the bay affected by thermal water inflow, with high mineralization, through the El Sargento fault. This thermal water is further mixed with seawater, resulting in higher mineralization. The study highlighted the importance of considering hydrothermal activities when interpreting hydrochemical data to address management strategies.

Somorowska [10] analyzed changes in cold season temperature from 1951 to 2021 in the Liwiec River basin (Poland) and found that increasing temperature significantly impacted snowfall, rainfall, and baseflow metrics. The snowfall-to-precipitation ratio decreased by 16% and the baseflow index rose by 18%, resulting in a shift from snow-dominated to snow-affected river regime. The study provided evidence of a gradual temperature increase over the last 71 years. The results may be of interest for middle-latitude regions.

Graf and Vyshnevskyi [11] focused their attention on river-flow forecasts in Ukraine through direct multistep-ahead forecasting using an XGBoost (extreme gradient boosting) model, to estimate long-term changes and predict monthly flows of selected rivers. A single multi-output model was proposed to forecast short- and long-term scenarios. Three forecast stages were considered using measurements of monthly flows, precipitation, and air temperature in the period 1961–2020. Responses of different hydrological systems showed varying degrees of sensitivity to changes in precipitation and air temperature with different projections for future time horizons. The results may be of interest in other catchments, irrespective of their geographic location.

Graf et al. [12] developed two machine learning models to predict ice phenomena in the Warta River (Poland) using observational data from eight river gauges. The models, MLPNN (perceptron neural network) and XGBoost, provided promising results for the forecasting of ice phenomena. Most important predictors were the nature of phenomena on the day before an observation, as well as water and air temperatures, while river flow and water level were less important. These findings could be useful for predicting ice phenomena in other regions characterized by similar boundary conditions.

Somorowska [13] evaluated the trends in terrestrial evaporation (ET) across Poland using data from 1980 to 2020. The study aimed to assess annual and monthly ET trends and revealed significant changes of this variable over different seasons and regions. The results indicated that rising temperatures and small increases in precipitation led to an increase in ET during the summer months. The study found that in the period 2007–2020, annual ET increased by 7% compared to the reference period 1980–2006. These findings have important implications for water resources management in Poland and potentially in other in Eastern European countries.

Smol and Koneczna [14] discussed the importance of water and wastewater management in the transition towards a circular economy in the European Union and suggested a set of economic indicators to assess progress in this sector. These indicators are grouped under actions such as reduction, reclamation, reuse, recycling, recovery, and landfilling, and can be used by water supply and sewage companies to assess their progress towards a circular economy. The proposed set of indicators is flexible and can be adapted to maintain effectiveness throughout the transition period.

Sakai Cid et al. [15] addressed antiretrovirals (ARVs) in coastal waters. These pharmaceuticals are present in aquatic ecosystems worldwide and can have ecotoxicological effects on marine aquatic organisms. This study predicted environmental concentration (PEC) of 13 ARVs in the Santos Bay (Brazil) and found that all exceeded the European Medicines Agency's guideline limits. Three ARVs were then selected for acute and chronic toxicity tests with sea urchins (*Echinometra lucunter*) and showed potential hazards for aquatic life in this bay. The study highlighted the need for both specific ARVs monitoring and stringent policies to reduce the introduction of ARVs into the aquatic environment.

Szatten et al. [16] discussed the impact of human induced hydrologic alteration of river systems. The research focused on the Lower Brda river cascade dams (Poland) and used hydrological and water quality data from 1984 to 2017 and the Indicators of Hydrologic Alteration method to show how changes in regime operation affect sediment and nutrient balance. The study found that sustainable management of sediments and nutrients in the altered catchment can help in achieving a good river ecological status, suggesting important management insights.

Boryczko et al. [17] discussed the importance of a proactive strategy to prevent failures on water supply. The article presented the results of a simulation (using the EPANET 2.0 software developed by the United States Environmental Protection Agency) aiming at estimating the consequences of failures in a water supply system in Poland. Simulation results were used to create a water supply risk map. The study showed that the highest risk was related to the failure of the main pipe. Recommendations include attention on the system modernization and maintenance. The results of the study may be of interest for Eastern European countries.

Tchórzewska-Cieślak et al. [18] discussed the importance of investing in a water supply system (WSS) to provide high-quality water to residents. The paper presented a methodology to analyze consumers' willingness to accept additional costs for improving the operational safety of the WSS. The study was based on a regional WSS located in the

Poland's Podkarpacie province. The assessment suggested that consumers are willing to pay additional costs for better water supply services.

Smol et al. [19] highlighted the importance of phosphorus raw materials in the Visegrad Group countries (Poland, Slovakia, Czech Republic, and Hungary). These countries lack mineral deposits of phosphate rock. The authors analyzed the structure of import and export of phosphorus raw materials and revised primary and secondary phosphorus sources, suggesting their use in agricultural systems, and showcased examples of good phosphorus recovery practices in the Visegrad countries. Finally, the authors indicated that the proposed approach could ensure the safety of food production in the region and contribute to faster independence from phosphorus raw material imports.

Water quality monitoring is important to manage aquatic ecosystems and cope with inland water degradation. Remote sensing, particularly using multispectral and hyperspectral sensors, is recognized as an essential technique for water quality monitoring. Bresciani et al. [20] carried out a review focused on the use of data gathered from currently orbiting hyperspectral sensors (i.e., PRISMA and DESIS) to retrieve water quality parameters in various aquatic ecosystems, including deep clear lakes and river dammed reservoirs. The examples were from case studies in northern, central, and southern Italy.

3. Conclusions

The demand for fresh water of good quality is continuously increasing worldwide for reasons linked to both the development of human society and the onset of climate change. Our hope is that the articles published in this Special Issue could make a substantial and innovative contribution to the monitoring and modelling of this precious non-renewable resource.

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