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Editorial

Challenges of Water Quality Management for Agricultural Development

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1. Introduction

Agriculture, including crop growing, livestock breeding, and fish farming, is essential for human survival. In agricultural practices, fertilizers, pesticides, antibiotics, clenbuterol, and chemical additives are often used in addition to water, and their improper use can adversely impact the quality of surrounding water bodies. To be more specific, using pesticides and fertilizers increases crop production, posing a potential threat to the aquatic environment. The livestock sector's growth increases the amount of organic loading from animal waste, causing the eutrophication and deterioration of aquatic ecosystems. Besides the residue of forage, fish excreta is also generated, which may impair the quality of receiving water bodies. Moreover, the use of antibiotics, fungicides, and anti-fouling agents are often adopted to increase production, which may contribute to downstream ecosystem contamination. Overall, improper agricultural activities can increase the concentration of nutrients, fecal coliforms, and sediment loads in water.

Sustainable planning for water resources is a challenging task, especially for countries experiencing strong economic growth and with high population densities. Groundwater is vital to supplement drinking and irrigation waters in semi-arid regions, and therefore, a poor water quality may lead to severe health issues. Assuring the water quality in agricultural areas, especially for rice cultivation, is also a challenge. Water quality is a critical factor impacting the health of human and all living organisms. Monitoring water quality is important for effective water management and achieving sustainable development. Surface water quality is particularly delicate and susceptible to climate change in arid or sub-arid regions, where anthropogenic activities such as industrial and agricultural practices determine the water quality. Water pollution from agriculture directly impacts human health, and we must implement smart agriculture practices for environmental sustainability, facilitate nutrient cycles of agroecosystems, enhance pollution control for agriculture, and conduct assessments and strategies for assuring agroecosystem sustainability. Conducting more research is essential to building a linkage between agriculture practices and sustainable agroecosystems to achieve the ultimate goal of environmental sustainability.

2. Overview of the Contributions of the Special Issue

The Special Issue "The Interrelationship between Agricultural Activities, Water Quality, and Human Health" covers recent advances in the understanding and improvement of irrigational water quality. The hydrogeological and geochemical processes accompanying the cycling of nitrogen transformation, heavy metals dissolution, and redox potential variation significantly affect the safety of using irrigational water and the stability of agricultural production. This Special Issue published seven research papers (three of them are feature papers). There are four papers related to groundwater quality for irrigation purposes, two papers related to water quality in irrigational canals, and one paper related to ecological control of reservoirs. In the study of "Geochemistry of Groundwater in the Semi-Arid Crystalline Terrain of Sri Lanka and Its Health Implications among Agricultural Communities" [1], the geochemistry of groundwater in the semi-arid crystalline terrain of Sri Lanka and its health implications among agricultural communities were investigated to provide valuable insights into the quality of groundwater and its impact on human health. The groundwater in the Yan Oya river basin in Sri Lanka is of poor quality and may contribute to the high prevalence of Chronic Kidney Disease of unknown etiology (CKDu). More than 50% of the groundwater samples exceeded the maximum permissible limits for various parameters, indicating the poor quality of groundwater throughout the region. Although there were no statistically significant differences between hot spots and cold spots, the mean concentrations of all hydrogeological parameters were higher in hot spots, suggesting their potential impact on CKDu prevalence. The conclusion also highlights the need for future research and effective measures to improve groundwater quality and mitigate its health implications among agricultural communities in Sri Lanka. The investigation of "Hydrogeochemistry of Shallow Groundwater and Suitability to Irrigation: The Case of the Karfiguéla Paddy Field in Burkina Faso" [2] provides valuable information on water quality and its impact on crop production in the studied area. The physicochemical parameters, major ions, and trace elements of water samples, as well as their implications for crop production and human health, were evaluated. Statistical analyses were employed, and various water quality indices, such as the sodium adsorption ratio (SAR), sodium percentage (%Na), potential salinity (PS), Kelly ratio (KR), residual sodium carbonate (RSC) and irrigation coefficient (Ka), were used to identify the hydrogeochemical characteristics of shallow groundwater. Anthropogenic activities and water–rock ion exchange impact the groundwater quality. The shallow groundwater suitability analysis revealed that its quality is good for irrigation, despite its vulnerability to pollution. These results were recommended to farmers and policymakers to improve irrigation practices. The reasonable utilization of groundwater resources as agricultural irrigation can increase crop productivity and reduce the costs of the irrigation canal system. In the paper "Assessment of Ammonium–N, and Nitrate–N Contamination of Shallow Groundwater in a Complex Agricultural Region, Central Western Taiwan" [3], nitrogen contamination in shallow groundwater in a complex agricultural region in Taiwan was evaluated. The study analyzed the current status of Ammonium-N and Nitrate-N concentrations under various cropping patterns to assess the effectiveness of reasonable fertilization. The article provides valuable information on the impact of agricultural practices on groundwater quality and highlights the potential risks associated with high levels of Ammonium-N and Nitrate-N. The factors that contribute to nitrogen contamination in shallow groundwater include agricultural practices, soil characteristics, and hydrogeological conditions. High levels of Ammonium-N and Nitrate-N contamination caused a significant potential risk. The paper "Evaluation of the Groundwater and Irrigation Quality in the Zhuoshui River Alluvial Fan between Wet and Dry Seasons" [4] addressed the difference in groundwater quality in shallow and deep aquifers during wet and dry seasons. Abundant groundwater resources are the main source of irrigation water in the investigated area due to insufficient surface water resources. However, climate-induced extreme hydrological events have led to variations in groundwater recharge and water quality. Although mean values of the groundwater quality parameters are not apparently different among aquifers, differences in groundwater quality parameters between wet and dry seasons are obvious. The groundwater temperature, dissolved oxygen content, and redox potential were changed due to rainfall water infiltration. The excessive application of fertilizers and farming systems in the area resulted in the deterioration in groundwater quality. Fine-grained soil in the area affects surface water infiltration and groundwater quality. The paper "Identifying Key Influences on Surface Water Quality in Freshwater Areas of the Vietnamese Mekong Delta from 2018 to 2020" [5] identifies factors that influence surface water quality in the Vietnamese Mekong Delta, including urbanization, industrialization, and the loss of freshwater resources. Additionally, limited groundwater resources, prolonged droughts, and flooding create pressure on the availability of freshwater sources in the region. This article also discusses how land use affects water quality, and correlation and principal component analyses were used to identify key influences on surface water quality. Several solutions were proposed to improve water quality, such as improving wastewater treatment, reducing pollution caused by agricultural activities, and promoting sustainable land use practices. This study highlights the importance of sustainable water resource planning in densely populated regions experiencing strong economic growth. The findings of this study can be applied to other freshwater areas facing similar challenges by providing insights into the factors that influence surface water quality and offering solutions for further improvements. In the paper "Hydrochemical Assessment of the Irrigation Water Quality of the El-Salam Canal, Egypt" [6], the authors evaluated the water quality of the El-Salam irrigational canal using various indices, including the permeability index (PI), residual sodium carbonate (RSC), magnesium hazard (MH), sodium adsorption ratio (SAR), percent sodium (Na%), Kelley index (KI), potential salinity (PS), total hardness (TH), and irrigation water quality index (IWQI). Croplands irrigated with this water do not face alkaline risks, but they may be at risk of salinity, particularly if the water is mixed with drainage water in the downstream area. To ensure the suitability of irrigation water for crops, particularly for the Hadous drain, it is recommended to treat the drainage water before mixing it with irrigation water from the El-Salam canal. The study "Interactions between Aquatic Plants and Cyanobacterial Blooms in Freshwater Reservoir Ecosystems" [7] provides insights into the mechanisms underlying these interactions and their potential impacts on the overall health and functioning of these ecosystems. Additionally, the research seeks to identify practical applications or implications for water management or conservation efforts. Whether macrophytes may inhibit or reduce the massive development of cyanobacteria was explored, and special attention was paid to plants with floating leaves and free-floating plants since data on their effects on cyanobacteria are controversial. The research also assessed the spatial distribution of cyanobacterial blooms and aquatic macrophyte patches using multispectral images captured with satellites, Sentinel-2a (S2A) and Sentinel-2b (S2B). The findings of this study indicated implications for water management and conservation efforts, particularly in the context of controlling or reducing cyanobacterial blooms in freshwater reservoirs.

The papers published in this Special Issue provide valuable insights into the impact of agricultural practices on surface water and groundwater quality and highlight potential risks associated with their improper use. Future research should aim to ensure the quality of water bodies and the health of living organisms. Sustainable Development Goal (SDG) 6 is dedicated to promoting clean water and sanitation by enhancing water quality through the optimizing treatment of wastewater and minimizing pollution in surface and groundwater. Agricultural chemicals can significantly degrade water quality, and high levels of pollution exceeding the water quality standards make freshwater resources unusable for irrigation and disturb the balance of aquatic ecosystems. Consequently, human health–agriculture–water environment interactions are highlighted, particularly in the linkages between SDG 2 (agriculture and food production), SDG 12 (sustainable consumption and production), SDG 15 (inland freshwater ecosystems), and SDG 6 (clean water and sanitation). The aim of sustainable agricultural practices and effective water management is to increase the resilience of the interrelationship between agricultural activities, water quality, and human health. Smart agricultural practices are essential for maintaining the sustainability of agroecosystems and ensuring that water bodies are not negatively impacted by improper agricultural activities. This includes facilitating nutrient cycles within agroecosystems, implementing pollution control measures, and conducting regular assessments to develop effective strategies for sustainability in agriculture.

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References

1. Udeshani, W.; Koralegedara, N.; Gunatilake, S.; Li, S.; Zhu, X.; Chandrajith, R. Geochemistry of Groundwater in the Semi-Arid Crystalline Terrain of Sri Lanka and Its Health Implications among Agricultural Communities. *Water* **2022**, *14*, 3241. [CrossRef]
2. Serge Gaëtan, S.; Marie Michelle, C.; Ouindinboudé Jacques, K.; Poulouma Louis, Y.; Idriss, S. Hydrogeochemistry of Shallow Groundwater and Suitability to Irrigation: The Case of the Karfiguéla Paddy Field in Burkina Faso. *Water* **2022**, *14*, 2574. [CrossRef]
3. Chen, S.; Lee, Y.; Liao, T. Assessment of Ammonium–N and Nitrate–N Contamination of Shallow Groundwater in a Complex Agricultural Region, Central Western Taiwan. *Water* **2022**, *14*, 2130. [CrossRef]
4. Chang, T.; Wang, K.; Wang, S.; Hsu, C.; Hsu, C. Evaluation of the Groundwater and Irrigation Quality in the Zhuoshui River Alluvial Fan between Wet and Dry Seasons. *Water* **2022**, *14*, 1494. [CrossRef]
5. Wehrheim, C.; Lübken, M.; Stolpe, H.; Wichern, M. Identifying Key Influences on Surface Water Quality in Freshwater Areas of the Vietnamese Mekong Delta from 2018 to 2020. *Water* **2023**, *15*, 1295. [CrossRef]
6. El-Amier, Y.; Kotb, W.; Bonanomi, G.; Fakhry, H.; Marraiki, N.; Abd-ElGawad, A. Hydrochemical Assessment of the Irrigation Water Quality of the El-Salam Canal, Egypt. *Water* **2021**, *13*, 2428. [CrossRef]
7. Bilous, O.; Nezbrytska, I.; Zhezherya, V.; Dubniak, S.; Batoh, S.; Kazantsev, T.; Polishchuk, O.; Zhezherya, T.; Leontieva, T.; Cantonati, M. Interactions between Aquatic Plants and Cyanobacterial Blooms in Freshwater Reservoir Ecosystems. *Water* **2023**, *15*, 672. [CrossRef]