

Editorial

Water Quality Assessments for Urban Water Environment

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Since ages, human societies have witnessed the intrinsic connection between their all-encompassing development and freshwater resources. However, with its increasing demand for the swelling population and growing economies, availability of these finite resources is further skewed down both in terms of quantity as well quantity. Rapid urbanization, land use land cover change, climate change, and frequent extreme weather conditions further exacerbate the challenges for sustainable water resource management. It is predicted that more than 60% of world population will live in the urban areas by the year 2050, which will lead to enormous increase in the need of water. In particular, hasty urbanization, poor governance, data scarcity, insufficient infrastructure are the key factors for urban water scarcity in the developing nations around the world. This leads to other cascading effects like changes in the hydrological cycle, food insecurity, health issues, high vulnerability to the frequent extreme weather conditions and stressed human well-being etc.

Most of the conventional research works are working in silos like quantitative analysis (e.g., water quality analysis, numerical simulation, use of spatial techniques like remote sensing and GIS for water resources analysis, evaluation of extreme weather conditions like flooding, droughts, and its impact on water resources etc.) or qualitative analysis (e.g., citizen science, perception-based studies, questionnaire-based analysis etc.). There is a big gap in relevant scientific information, needed to build robust water management policies. Since, existing management frameworks and plans are inadequate, which means that without a transformational change, most of these burgeoning cities within developing nations will face severe water scarcity. On the other hand, current COVID-19 pandemic has also affected various socio-environmental processes around the globe.

Therefore, there is an urgent need for transdisciplinary research works, which integrates both biophysical world with socio-economic dimensions to see how they impact hydrological cycle as well as human well-being. Outcomes of such research works will cater the policy-planners and decision-makers in terms of building climate resilient strategies for better water/wastewater and land use management policies, which ultimately will have substantial environmental and economic co-benefits for communities.

Finally, outcome of this sustainable water management plans will also contribute to national adaptation plans, which can briefly sketch the appropriate local actions for addressing local climate change impacts. In addition, most of the SDG goals are intrinsically linked and water-related goal i.e., SDG 6.0 is placed in the center of this, so sustainable management of water resources not only help nations to achieve different global goals in a timely manner but also help in socio-environmental development in a holistic manner.

Based on the aforementioned background information, this special issue entitled “Water Quality Assessments for Urban Water Environment,” strives to highlights the status quo of water environment, opportunities and challenges for their sustainable management in the urban space particularly in developing nations around the world. Moreover, it will highlight the extent by which different scientific innovations have contributed significantly to resolve these challenging issues. Finally, what is the way forward to enhance science-policy interface in a better way to achieve global goals e.g., SDGs at local level in a timely



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manner. This issue has eleven papers, covering a variety of water-related issues around the world.

Molekao et al. [1] studied the groundwater resources in the data-scarce region of Mokopane area of South Africa, considering groundwater as the main source of fresh water supply for this region. More specifically, authors have evaluated factors responsible for groundwater quality evolution with space and time using an integrated approach of hydrochemical analysis, spatial analysis, statistical analysis, and calculating the water quality index (WQI). Results suggest that rock-water interaction is the main cause of fluoride enrichment in the groundwater. Although most of the water samples are of good quality, this study stressed the need for regular monitoring and holistic management plans for the sustainable water resource management.

In the second paper, considering the problem of excessive phosphorus in the Yangtze river, Dong et al. [2] studied its distribution characteristics at a spatio-temporal scale more particularly in the middle and lower reaches of the Yangtze river using water quality analysis. Results suggest that particulate phosphate (PP) and soluble reactive phosphate (SRP) differ with depth and location because of the difference in transportation and sedimentation of the suspended sediment (SS), as well as differences in the location of urban sewage outlets. Lack of timely management of reactive phosphorus will pose a serious threat to the riparian ecosystem like eutrophication.

Considering the enormous effect of rapid global changes on the surface water qualities, Kumar et al. [3] used a methodology called the “Participatory Watershed Land-use Management” (PWLM) approach, which is a combination of participatory approaches and computer simulation modeling, with the goal to help make land-use and climate change adaptation policies more effective at a local scale. This study consists of four major steps: (a) scenario analysis, (b) impact assessment, (c) developing adaptation and mitigation measures and its integration in local government policies, and (d) improvement of land use plan. They have tested this PWLM approach in the Santa Rosa Sub-watershed of the Philippines, a rapidly urbanizing area outside Metro Manila. The scenario analysis step involved a participatory land-use mapping activity (to understand the likely land-use changes in the future), as well as downscaling the Global Climate Model (GCM) data for precipitation and temperature (to understand the local climate scenarios in the future). For impact assessment, the water evaluation and planning (WEAP) tool was used to simulate future river water quality under a business as usual (BAU) scenario and several alternative future scenarios considering different drivers and pressures to a target year. Results suggest that the current status of the river is already moderately to extremely polluted compared to desirable water quality. Moreover, this situation will further deteriorate by the year 2030 under all scenarios. In addition, they have also analyzed contributions from different drivers on water quality deterioration and it was found that population growth has the highest impact on future water quality deterioration, while climate change had the lowest (although not negligible). After the impact assessment, different mitigation measures were suggested in a stakeholder consultation workshop, and of them some were adopted to generate a final scenario including countermeasures. The main benefits of the PWLM approach are its high level of stakeholder involvement (through co-generation of the research) and use of free (for developing countries) software and models, both of which will contribute to an enhanced science-policy interface.

Minh et al. [4] studied the impact of agricultural intensification and urbanization on the water quality in An Giang from the Vietnamese Mekong Delta (VMD), one of the most productive agricultural deltas in the world. They have assessed seasonal variation of water quality parameters inside full- and semi-dike systems and outside of the dike system frequently used for rice production using multivariable statistical analysis and weighted arithmetic water quality index (WAWQI). The results show that the value of various water quality parameters exceeded the permissible limit given by WHO for both seasons. More precisely, high concentrations of NO_2^- and COD were found in rice-cropping systems and urban areas respectively. The WAWQI showed that 97.5 and 95.0% of water samples fall

into the bad and unsuitable drinking categories, respectively. The main reason behind this is the direct discharge of untreated wastewater from the rice intensification and urban sewerage lines into the ambient surface water bodies. The finding of this study is critically important for decision-makers to design different mitigation or adaptation measures for water resource management in lieu of rapid global changes in a timely manner in An Giang and the VMD.

In recent decades, rapid urbanization and land use land cover changes are putting natural resources especially water resources under enormous pressures throughout in Africa. With this background, Molekao et al. [5] conducted a spatiotemporal analysis of surface water quality and its relation with the land use and land cover (LULC) pattern in Mokopane, Limpopo province, South Africa. Integrated approach of hydrochemical analysis with spatial techniques was used to identify the factors affecting the water quality in particular heavy metals in Mokopane area dominated by mining activities. Based on the estimated values of heavy metal pollution index (HPI) and heavy metal evaluation index (HEI), water bodies are categorized as low to moderately polluted. On the other hand, all water samples fell under the poor category (>100) and beyond based on the calculated water quality index (WQI). Although water quality is showing deteriorating trend from year 2016 to 2019, this trend shows a sign of improvement in year 2020 because of lowering human activities during the lockdown period imposed by COVID-19. Land use has a significant proportional relationship with surface water quality, and it was evident that built-up land had a more significant negative impact on water quality than the other land use classes. Both natural processes (rock weathering) and anthropogenic activities (wastewater discharge, industrial activities etc.) were found to be playing a vital role in water quality evolution. At last, this study calls for continuous assessment and monitoring of the spatial and temporal variability of water quality in the area to control pollution and health safety in the future.

Although water quality index (WQI) is one of the most extensively used parameters for determining water quality worldwide, however the traditional approach for applying this technique is very time and labor consuming. With the above background, Agrawal et al. [6], applied and examined performance of artificial intelligence techniques namely particle swarm optimization (PSO), a naive Bayes classifier (NBC), and a support vector machine (SVM) for predicting the water quality index. Furthermore, the results obtained were validated from the observed groundwater water quality collected from Chhattisgarh, India. Study results show high prediction accuracy for the WQI indices and recommends that ensemble machine learning (ML) algorithms can be used to estimate and predict the water quality index with significant accuracy. Hence the proposed framework can be directly used for the prediction of the WQI using the measured field parameters while saving significant time and effort.

Despite inhabiting a large proportion of the world population and the rich biodiversity, coastal ecosystems are extremely vulnerable to changes in hydroclimatic factors, which significantly impacts the local socio-economic dimension. In addition, lack of scientific information presents a big hurdle for sustainable management of coastal ecosystem especially in the developing countries. Halder et al. [7] estimated future groundwater demand (domestic, agricultural, and livestock sector) in the fragile Sundarbans ecosystem considering different human population growth rates (high, low, and current) for the year 2050. Simulation results showed that with an increase of groundwater demand for domestic and agricultural sectors by 17% and 35% for Business as Usual (BAU) and high growth respectively. Sustainability of coastal aquifer-dependent rural livelihood is expected to face great danger in the near future. The impact of increasing groundwater demand was analyzed further to identify any socio-economic shifts in this region.

The novel coronavirus (COVID19) pandemic changed the different socio-economic and environmental factors to various degrees around the world. Considering these additional unprecedented shocks induced by the COVID19 pandemic, the next two papers by Avtar et al. [8] and Usman et al. [9] highlighted the importance of studying various

challenges and opportunities to manage water resources under these unknown situations. One of the most important effects of the COVID-19 pandemic is lockdown, which has brought countries around the world to a standstill. People stayed indoor, and industrial activities, transportation etc. operated at a minimum level and hence fewer pollutants also entered our ambient environment.

Hence, Avtar et al. [8] hypothesized that due to these pandemic-induced lockdowns, the hydrological residence time (HRT) has increased in the semi-enclosed or closed water bodies like lakes, which can in turn increase the primary productivity. To validate their hypothesis, they quantitatively estimated the chlorophyll-a (Chl-a) concentrations in different lake bodies in China and India using established Chl-a retrieval algorithm. Result shows that concentration of Chl-a increased for closed lake in Wuhan (China), whereas the concentration did not change for a semi-closed lake in India. This opened a door for both scientific communities as well as decision-makers to design proper countermeasures for sustainable water resource management in coming future.

Usman et al. [9] discussed the existence of SARS-CoV-2 in wastewater, which raises the opportunity of tracking wastewater for epidemiological monitoring of COVID19 related diseases. On the other hand, the existence of this virus in wastewater has raised health concerns regarding the fecal–oral transmission of COVID-19. This study highlights the potential inferences of aerosolized wastewater in transmitting this virus. As aerosolized SARS-CoV-2 could offer a more direct respiratory pathway for human exposure, the transmission of this virus remains a significant possibility in the prominent wastewater-associated bioaerosols formed during toilet flushing, wastewater treatment, and sprinkler irrigation. Hence, implementing wastewater disinfection, exercising precautions, and raising public awareness was advocated for prevention of infection spreading.

After having a broader discussion on different water quality issues in urban landscape, two papers (Poudel et al. [10] and Mishra et al. [11]) talked about urban water-security, its challenges and opportunities.

Considering a strong nexus between human health and water security, Poudel et al. [10] used systematic literature review to investigate how health has been incorporated as a dimension in the existing water-security frameworks in different scientific disclosures. The result shows that 11 distinct dimensions have been used to design the existing water-security framework. Public health aspects were mentioned in half of the reviewed papers, direct and indirect health impacts were considered only by 18% and 33% of the papers respectively. Among direct health impacts, diarrhea is the most prevalent one considered for developing a water-security framework. Among different indirect or mediating factors, poor accessibility and availability of water resources in terms of time and distance are the big determinants for causing mental illnesses, such as stress or anxiety, which are being considered when framing water-security framework, particularly in developing nations. Water scarcity in terms of its quantity is more of a common issue for both developed and developing countries. However, poor water quality and mismanagement of water supply-related infrastructure are the main concerns for developing nations, which proved to be the biggest hurdle for achieving water security. The result of this study sheds light on the existing gaps for different water-security frameworks and provides policy-relevant guidelines for its betterment. Moreover, it stresses that a health-specific water-security framework is imperative for dealing with issues arising from public health.

It is well understood that rapid global changes such as urbanization, population growth, socioeconomic change, evolving energy needs, and climate change put unprecedented pressure on water resources and its related systems. Moreover, achieving water security is vital for achieving all 17 sustainable development goals (SDGs) throughout the world. On the other hand, studies on water security with a holistic view with persistently changing dimensions is in its infancy. Hence, Mishra et al. [11] focuses on narrative review work for giving a comprehensive insight on the concept of water security, its evolution with recent environmental changes, its implications, and different possible sustainable solutions to achieve water security. It emphasizes that water security evolves from ensuring

reliable access to enough safe water for every person (at an affordable price where market mechanisms are involved) to leading a healthy and productive life, including that of future generations. The constraints on water availability and water quality threaten secured access to water resources for different uses. Despite recent progress in developing new strategies, practices, and technologies for water resource management, their dissemination and implementation has been limited. A comprehensive sustainable approach to address water-security challenges requires connecting social, economic, and environmental systems at multiple scales. This paper captures the persistently changing dimensions and new paradigms of water security providing a holistic view including a wide range of sustainable solutions to address the water challenges.

Way forward

In summary, this special issue gives a holistic picture of opportunities and challenges for managing the urban water environment in terms of quality or quantity in a sustainable manner. It provides valuable information about sustainable water resource management at the urban landscape, which is very much useful for policy-makers, decision-makers, local communities, and other relevant stakeholders. Considering the complex nature of the urban water security, emerging approaches like socio-hydrology, landscape ecology, regional-circular-ecological sphere etc., which presents a perfect combination of hard (infrastructure) and soft (numerical simulations, spatial technologies, participatory approaches, indigenous knowledge) measures, are the potential solutions to manage this precious water resource in coming future.

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