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Science and Technology for Combating Global Water Challenges

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Editorial

Science and Technology for Combating Global Water Challenges

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The survival and development of human society highly depends on the water availability. Driven by the growth of population and economy, global water demand has increased more than eightfold since the 1900s. Meanwhile, the commonly deteriorated freshwater quality cause a large proportion of available water resources unsuitable for human uses. This inter-coupled challenge of insufficient water quantity and inadequate water quality has rendered water scarcity a widespread problem in many parts of the world.

To cope with water scarcity, efforts have been made to protect water resources, restore water ecology, and improve water environment over the last few decades. New concepts and technologies have been developed and implemented to improve both the quantity and quality of water. For example, wastewater reuse has been promoted to fight water shortages. To ensure the success of these initiatives, wastewater reuse has been done in conjunction with careful management mitigating any potential ecological risks. Membrane technology integrated with nature-based riverbank filtration is used to produce safer and higher quality drinking water. In addition, the digital revolution in the water sector has exhibited great potential for imporving systematic management and precise control of the water processes and infrastructures.

Reviewing state-of-art technology, reporting on the latest progress, and exploring future-oriented perspectives will promote the development and application of new technologies. In this special issue, six articles are included that report novel insights into advanced water science and technologies based on the aforementioned aspects.

Van der Meer et al. presented a one-step reverse osmosis (OSRO) concept consisting of riverbank filtration and reverse osmosis for drinking water treatment. It was demonstrated that nature-based riverbank filtration is a robust and cost-effective pretreatment step for downstream reverse osmosis. To broaden the usage and enhance the sustainability of this technology, artificial aquifer purification to replace riverbank filtration and possible combination with wind power were proposed.

Savić reviewed and identified key advances in digital technology application in the water sector and applied forensic engineering principles to failures in automation and digital transformation. It was argued that by analyzing problems and shortcomings of digital technologies in the car and aircraft industries, similar risks and failures in the water sector could be prevented.

Bai et al. reviewed ecological and biochemical research based on next-generation sequencing and culture-based methods for *Phragmites* root microbes, including bacteria, archaea, and fungi. It was proposed that synthetic microbial communities and iron-manganese plaque could be applied to constructed wetlands to enhance water purification performance.

Elimelech et al. presented a study on the performance of nanopore power generators (NPGs) at coupon-size and module scale. Owing to the concentration polarization effects, results showed that the NPG coupons generated a far lower power density than the theoretical values. The authors highlighted these limitations and raised doubts about the viability of using NPG as a technology for blue energy harvesting.

Kubota et al. investigated and presented the microbial community structure of granules from anaerobic sludge treating phenolic wastewater using fluorescence *in situ* hybridization (FISH) and a clone library. Results showed that the phenol was first converted into benzoate by *Cryptanaerobacter* and then degraded to acetate by *Syntrophus*. In contrast to prior research, it is argued that Syntrophorhabdaceae is less likely to produce benzoate as an intermediate to feed neighboring organisms.

Zheng et al. studied chromite synthesis at room temperature and the critical influencing factors governing effluent quality and synthetic product stability. It was found that after the ferrite process, 99.9% of chromium was removed from wastewater, and the chromium concentration in the effluent reached the acceptable level. A promising industrial application of the ferrite process for treating chromium-containing wastewater and chromium recovery was demonstrated.

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We believe that the articles in this special issue will highlight efforts to combat global water challenges. At present, water scarcity meets increasingly severe climate change and vigorous development of digital transformation. We hope that the continuous effort and progress in water science and technologies will advance our ability on sustainable water quantity and quality management.