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Editorial

Drought and Groundwater Development

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Groundwater is an important freshwater source that satisfies the needs of a significant portion of the world's population, industries, and ecosystems. It is estimated that the total amount of groundwater in the world is approximately four trillion cubic meters [1]. Particularly, in the Middle East Asian and African regions, surface water sources are scarce and polluted, and people rely heavily on groundwater [2] Due to climate change and increased evapotranspiration, the depth of groundwater production is becoming deeper. Recently, unusual droughts have occurred not only in these regions but also in mid-latitude regions, leading to water scarcity. Therefore, various technologies are being developed and applied to secure water resources.

Groundwater exists in aquifers, the world's largest water reservoir, and plays an important role in maintaining ecosystems. Particularly, in an era of climate change, groundwater plays a crucial role in helping humans adapt proactively to climate variability. The importance of groundwater has increased even more in recent years as it plays a crucial role in regulating the quantity of soil and surface water to cope with extreme climate events, such as droughts and floods, and it is a key factor affecting food productivity. Thus, deciding how to utilize groundwater resources as a means of coping with climate change on a global scale has become a critical issue [3].

Drought is a costly natural disaster that has a widespread impact on agriculture, ecosystems, water resources, social economy, and politics. Although drought is a common phenomenon that occurs in a hydrological cycle, its frequency and magnitude have been increasing in recent years because of climate change [4] When drought occurs, it has serious impacts on various sectors and sometimes leads to the over-exploitation of groundwater, which is an alternative water source. Moreover, the demand for agricultural and domestic water continues to increase worldwide as economic growth and living standards are improved. In water-scarce countries with inadequate water supply systems, surface water is vulnerable to weather changes, such as drought; therefore, alternative water sources, such as groundwater, are considered as a systematic means of water supply.

Artificial recharge is a technique that increases the total water amount by artificially injecting surface water, rainfall, reused water, or other water sources into underground aquifers. This involves the installation of artificial structures, such as artificial recharge basins, wetlands, canals, underground dams, and infiltration facilities, or changing the ground conditions to inject water artificially [5]. This technology is becoming more widely used in areas affected by climate change, such as major drought-prone regions in Africa and India. The biggest advantage of artificial recharge is that surplus water can be infiltrated into the ground for later usage during dry periods. It allows a larger amount of water to be stored in the subsurface compared to natural conditions and takes advantage of the natural purification capacity of aquifers during storage [6] The methods of artificial recharge vary greatly and include injection wells, bank filtration, ditches, recharge basins, in-channel modification, and others.

In the United States, injection and infiltration technologies using wells have a long history, and aquifer storage and recovery (ASR) is one of the most widely used methods for storing and recovering groundwater. The main purpose of artificial recharge is to secure water for drinking water supply. It is stored underground to alleviate seasonal imbalances in water demand and is used when needed. In Europe, in particular Germany, the bank filtration technique, which is a form of artificial recharge, is widely used to secure water supply [7]. To design and investigate artificial recharge facilities for groundwater, various factors need to be analyzed, including terrain-related and meteorological characteristics, permeability and storage capacity of aquifers, clogging characteristics of soil, water supply for artificial recharge, and depth of groundwater level. In addition, the demand and supply of water and the specifications of the artificial recharge and extraction facilities used must be determined.

Groundwater helps alleviate droughts by providing underground flow to maintain stream flow during dry periods. The increased quantity of water resulting from artificial recharge not only contributes to increasing stream flow during drought periods, but it also slows down the rate of discharge in basins, thus contributing further to stream flow during such periods. Thus, artificial groundwater recharge can delay drought propagation and provide an efficient means of water supply during droughts. High technical challenges in the process of artificial recharge need to be addressed to increase the efficiency of artificial recharge facilities. The main cause of efficiency reduction is clogging, and various technologies have been developed over the past decades to evaluate and solve clogging, although current solutions are still inadequate. Land use and land cover (LU/LC) in a country are also important factors that influence groundwater recharge and surface runoff, and decision makers should consider LU/LC to increase natural groundwater recharge in the country's development [8].

This Special Issue focuses on various technologies to resolve water scarcity and contamination caused by abnormal droughts in Asia and Africa. It includes research on the utilization of groundwater level and precipitation data; drought prediction and diagnosis; and evaluation technologies for securing water resources [3,9,10]. In general, in an upstream watershed, water is quickly discharged, so drought damage appears there first. Then, the scope of the drought gradually widens, resulting in an increase in the scale of its damage. Generally, for widespread droughts, central governments show interest and quickly pursue various policies; however, for localized droughts that occur in upstream areas of a watershed, passive measures are mostly taken. In terms of water welfare, fundamental policies for drought relief and securing water resources should be pursued for these upstream areas that are marginalized [11]. Some of the technologies covered in this Special Issue are applicable to such water-welfare blind spots [12].

We conclude this Special Issue with the expectation that the research results presented here will contribute to solving water problems in various countries, particularly as solutions during periods of drought when surface water is limited.

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Short Biography of Author

Dr. Sang Yong Chung ompleted his Ph.D. program in the Department of Geological Sciences, University of Nevada, Reno, U.S.A., and his M.Sc. and B.Sc. degrees in the Department of Geological Sciences, Seoul National University, Republic of Korea. He is interested in hydrogeology, geostatistical and artificial intelligence applications to groundwater, and assessment of groundwater contamination vulnerability. He worked in the Department of Earth & Environmental Sciences, Pukyong National University, Republic of Korea, for 35 years, and he is now an Emeritus Professor. He served as the President of the Korean Society of Soil and Groundwater Environment (KOSSGE) 20 years ago and is currently an advisor of the KOSSGE. He has published over 110 articles, including SCI international and domestic publications, and has presented his research at more than 150 international and domestic academic conferences. His academic accomplishments are available for viewing at https://www.researchgate.net/profile/Sang Yong Chung.

Dr. Gyoo-Bum Kim completed his B.Sc., M.Sc., and Ph.D. in the Department of Earth and Environmental Sciences at Seoul National University in South Korea. From January 1991 to October 2015, he worked in various fields, including water resource policies, groundwater databases, groundwater investigations, and research at the Korea Water Resources Corporation. Since October 2015, he has been a professor of Disaster Safety Engineering at Daejeon University, where he is responsible for research and education in fields such as hydrogeology, geostatistics, artificial neural networks, artificial recharge, and environmental monitoring. He has served as the head of two large government-funded research projects, the "Riverside Groundwater Research Project" and the "Drought Response Groundwater Research Project (GW-SMART Project)", for 10 years and has published over 110 SCI international and domestic research papers to date.

Dr. Venkatramanan Senapathi completed his Ph.D. in the field of Environmental Geochemistry at Annamalai University, India, in 2013. He was a postdoctoral fellow (Brain Korea, BK21) at the School of Earth Environmental Hazard System, Pukyong National University, Busan, Republic of Korea, from 2013 to 2017. He also worked as a visiting research faculty member in the Department for Management of Science and Technology Development, Faculty of Applied Sciences, Ton Duc Thang University, Ho Chi Minh City, Vietnam, from 2016 to 2020. He is currently working in the Department of Disaster Management, Alagappa University, Karaikudi, Tamil Nadu, India. He has published more than 100 papers, which are indexed in Thomson Reuters and Scopus (https://www.researchgate.net/profile/Venkatramanan-Senapathi). He was also an alternate faculty member in the Department of Earth & Environmental Sciences at Pukyong National University during the 2015–2016 academic year. He has more than 10 years of experience in research and teaching. Recently, he edited two books on "GIS and Geo-statistical Techniques for Groundwater Science" and "Groundwater Contamination in Coastal Aquifers" published by Elsevier in 2019 and 2022. He is also currently editing books on "meso- and microplastic risk assessment in marine environment: New threats" with Elsevier. His research mainly focuses on the environmental geochemistry of water and sediments with respect to new contaminants and their sustainable management.