EMEKveTOPLUM

Derleme Makale / Review Article
Geliş Tarihi-Received Date: 28.01.2024
Kabul Tarihi-Accepted Date: 25.04.2024
DOI: 10.31199/hakisderg.1427121

FROM ACCESS TO CONSERVATION: ADDRESSING THE GLOBAL WATER ISSUE

Mehmet KARATAŞ[1]
ORCID: 0000-0001-8803-0017

Abstract
Water is a fundamental necessity for the continuation of life. It is imperative for humanity that water resources are distributed fairly and managed equitably. This ensures the sustainable use of water resources and guarantees everyone access to clean and healthy water. Water resources are dwindling and becoming increasingly polluted, leading to serious issues such as water scarcity and pollution. Water scarcity refers to situations where water is inadequate or its quality has deteriorated, causing significant impacts on societies, agriculture, and ecosystems. Agriculture is particularly affected by water scarcity as it heavily relies on water. Ecosystems suffer from water scarcity as well, since water is a fundamental source of life for various organisms. Water pollution poses threats to human health and the environment. Pollutants from various sources such as industrial waste, agricultural pesticides, and domestic waste contaminate water resources, leading to reduced availability of drinking water and harming aquatic life and ecosystems, ultimately affecting biodiversity. There are several strategies for conserving water resources and ensuring clean water. Methods such as industrial waste control, improvement of agricultural practices, and domestic waste management can help prevent water pollution. Furthermore, the development of water treatment facilities and technologies plays a crucial role in making water cleaner. The impacts of climate change on water resources must also be considered. Factors such as rising temperatures, changes in rainfall patterns, and the risk of drought significantly affect water resources.

Keywords: *Water scarcity, Water resources, Water pollution, Conservation, Climate change*

Atıf İçin: Karataş, M. (2024). From Access To Conservation: Addressing The Global Water Issue. *HAK-İŞ Uluslararası Emek ve Toplum Dergisi*, Cilt: 13, Sayı: 35, ss. 140-166.

1 Necmettin Erbakan University, Faculty of Science, Department of Biotechnology, Konya, mkaratas@erbakan.edu.tr

Erişimden Korumaya: Küresel Su Sorununu Ele Alma

Öz

Su, yaşamın devamı için temel bir gerekliliktir. İnsanlığın, su kaynaklarının adil bir şekilde dağıtılması ve adil bir şekilde yönetilmesi hayati önem taşımaktadır. Bu, su kaynaklarının sürdürülebilir kullanımını sağlar ve herkesin temiz ve sağlıklı suya erişimini garanti eder. Su kaynakları azalıyor ve giderek kirleniyor, bu da su kıtlığı ve kirliliği gibi ciddi sorunlara yol açıyor. Su kıtlığı, suyun yetersiz olduğu veya kalitesinin bozulduğu durumları ifade eder, bu da toplumlar, tarım ve ekosistemler üzerinde önemli etkilere neden olur. Tarım, suya ağır bir şekilde bağımlı olduğundan su kıtlığından özellikle etkilenir. Su, çeşitli organizmalar için yaşamın temel bir kaynağı olduğu için ekosistemler de su kıtlığından zarar görür. Su kirliliği, insan sağlığı ve çevre için tehditler oluşturur. Endüstriyel atıklar, tarımsal ilaçlar ve evsel atıklar gibi çeşitli kaynaklardan gelen kirleticiler, su kaynaklarının kirlenmesine neden olarak içme suyunun azalmasına ve sucul yaşamın ve ekosistemlerin zarar görmesine, sonuç olarak da biyoçeşitliliği etkiler. Su kaynaklarının korunması ve temiz suyun sağlanması için çeşitli stratejiler bulunmaktadır. Endüstriyel atık kontrolü, tarım uygulamalarının iyileştirilmesi ve evsel atık yönetimi gibi yöntemler, su kirliliğini önlemeye yardımcı olabilir. Ayrıca, suyu daha temiz hale getirmede su arıtma tesislerinin ve teknolojilerinin geliştirilmesi de hayati bir rol oynar. Su kaynakları üzerindeki iklim değişikliğinin etkileri de dikkate alınmalıdır. Artan sıcaklıklar, yağış desenlerindeki değişiklikler ve kuraklık riski gibi faktörler, su kaynaklarını önemli ölçüde etkiler.

Anahtar Kelimeler: *Su kıtlığı, Su kaynakları, Su kirliliği, Koruma, İklim değişikliği*

Introduction

The worldwide water crisis has escalated fast in recent years due to uneven distribution, wasting, and growing demand for freshwater supplies. Multiple issues, such as water pollution, poor water management practices, and the influence of climate change, contribute to the worsening of this issue.

Furthermore, the global population is consistently expanding, resulting in a heightened need for water in the realms of agriculture, industry, and households. Moreover, climate change intensifies meteorological phenomena such as droughts, floods, and unpredictable rainfall, hence diminishing the availability of water supplies. As these complex factors converge, the water crisis is deepening day by day. In this situation, it becomes increasingly imperative to manage freshwater resources sustainably worldwide.

1. Understanding Water Scarcity

Water scarcity is a critical worldwide problem caused by an unequal distribution of water resources, which leads to an inability to fulfill diverse needs such as production, living, and ecological requirements (Zhao et al., 2020). Water shortage and drought are two separate phenomena. Drought is a temporary occurrence caused by changes in climate, whereas water scarcity is an ongoing problem caused by human actions. (Loon et al., 2016; Murshed et al., 2019).

Insufficient availability of water is caused by the prolonged and unsustainable utilization of water resources, which is driven by variables such as climate change, population increase, and inadequate water management techniques (Loon & Lanen, 2013).

Water scarcity poses a dual hazard by endangering water availability and exerting adverse effects on health, migratory patterns, and socio-economic situations in regions experiencing water shortages (Dahri et al., 2021).

The issue of water scarcity is a pressing global concern that arises from a multitude of sources. An important factor contributing to this issue is the disparity between the increasing worldwide demand for water and the declining availability of freshwater (Li et al., 2020).

Furthermore, water scarcity can be impacted by both natural and anthropogenic forces. Drought circumstances can produce temporary water scarcity, but persistent water shortage can be caused by underlying factors such as unsustainable demand growth, inadequate infrastructure for water storage or delivery, and limitations in water management (Martín-Carrasco et al., 2012). Human activities, such as alterations in land use and water use practices, can also influence the dynamics of water shortage, leading to the movement of water scarcity downstream (Veldkamp et al., 2017).

Various metrics, such as the Falkenmark Indicator and the water stress index, are employed to evaluate water scarcity by examining the ratio of water demand to the overall availability of water resources (Rijsberman, 2006; Liu et al., 2019). Falkenmark has determined the minimum drinking water consumption per capita in a moderately developed country located in arid and semi-arid climate regions as 100 liters per day, while the water needs for agriculture and industry are considered to range from 500 to 2000 liters per day. Taking into account the pressure on water resources during drought periods, the threshold value has been set at 1700 m^3 per capita per year (equivalent to 4600 liters per day).

Inefficient irrigation techniques also contribute to the exacerbation of water scarcity, as a significant amount of the available water is utilized for irrigation purposes (Yavuz, 2021).

Additionally, the decline of the photosynthetic system in plants caused by lack of water, combined with disruptions in metabolic processes and compromised root structure, might result in a reduction in agricultural yield, hence exacerbating worries about water scarcity (Mathur & Roy, 2021). Moreover, the accelerated exhaustion of water tables on a worldwide scale as a result of an unexpectedly high water demand exacerbates the issues of water scarcity (Moncaleano et al., 2021).

To cope with water scarcity, it is essential to adopt a comprehensive approach that includes implementing effective water allocation techniques, practicing conjunctive water use, and improving water management practices. These measures are crucial for reducing the costs associated with water scarcity and ensuring the long-term sustainability of water resources (Mattiuzi et al., 2019).

1.1. The Impacts of Water Scarcity on Community, Agriculture, and Ecosystems

Water scarcity has profound effects on society, agriculture, and ecosystems. Water scarcity in communities can result in socioeconomic difficulties, impacting both livelihoods and health (Dahri et al., 2021). Water scarcity significantly impacts the agricultural sector, leading to decreased crop yield and increased food insecurity (Nephawe et al., 2021). Furthermore, the scarcity of water has a detrimental impact on ecosystems, intensifying the consequences of other pressures and resulting in heightened pollution and disturbances in the ecological balance (Navarro-Ortega et al., 2015). Water scarcity can have far-reaching consequences on the environment, including the drying up of rivers, loss of biodiversity, and disturbances in aquatic ecosystems (Hoekstra et al., 2012). Moreover, the problem of water scarcity in agriculture can be exacerbated by salinity problems, hence amplifying the difficulties encountered by farmers (Thorslund et al., 2022). Water shortages can lead to migration, which can have a significant impact on the socio-economic structure of communities (Dahri et al., 2021). The scarcity of water also impacts the accessibility of drinkable water, which is essential for maintaining communities and facilitating population expansion (Buh et al., 2021). In addition, water scarcity has wide-ranging effects that extend beyond acute shortages. It impacts the overall quality of freshwater supplies as a result of contamination from numerous sources, such as agriculture and industry (Foster et al., 2018).

To effectively tackle water shortage, it is imperative to implement comprehensive strategies that take into account the interdependence of water resources, human activities, and natural systems, and to ensure the sustainability of water management.

According to UNICEF (2017) data, today, four billion people, constituting two-thirds of the world's population, experience severe water scarcity for at least one month each year. It is projected that by the year 2050, when the world population is expected to reach 9.5 billion, 40% of the population will suffer from water scarcity, and it is anticipated that Turkey will soon become a country experiencing water scarcity.

There are many factors contributing to water scarcity. Climate change affects the water cycle, leading to changes in precipitation patterns and increasing the frequency of droughts. Population growth increases water demand, putting pressure on available water resources. Pollution reduces the availability of usable water by contaminating water sources with industrial waste, agricultural chemicals, and domestic sewage. High levels of water consumption in agriculture, industry, and households further exacerbate water scarcity. Inadequate water management and infrastructure in some regions hinder the effective collection, storage, and distribution of water. Soil erosion affects water sources by causing rivers and lakes to become muddy and turbid, reducing water quality and availability. Unequal distribution of water resources globally exacerbates water scarcity, with some regions having abundant water while others face water shortages. Addressing this complex issue requires adopting strategies such as water management, pollution control, and sustainable usage

2. Comprehending Water Pollution

Water pollution is a significant environmental concern that results from the introduction of harmful substances into water bodies, rendering the water unsuitable for its intended use. Various sources contribute to water pollution, including industrial discharges, agricultural runoff, sewage systems, and improper waste disposal (Lama et al., 2022).

The main causes of water pollution include industrialization, urbanization, domestic waste, sewage systems, and agrochemicals, which can have adverse effects on aquatic life and human well-being (Jindal et al., 2020; Hanif et al., 2020). Moreover, the discharge of domestic waste, radioactive waste, population growth, and the excessive use of pesticides and fertilizers are identified as major sources of water pollution (Haseena et al., 2017). Human activities related to land use have a notable impact on water quality (Pei et al., 2022). Additionally, emerging pollutants like microplastics have raised concerns due to their persistence and potential impacts on marine ecosystems (Fältström, 2020).

Nonpoint source pollution, particularly from agricultural areas, is a major cause of surface water contamination (Schulz, 2004). This type of pollution is challenging to address due to its complex nature (Zhou et al., 2019). Both nonpoint sources of runoff pollution and point sources of wastewater discharge contribute to water quality degradation (Chen et al., 2016). Analyzing point source pollution, especially from domestic sources, is crucial in understanding water pollution (Wang et al., 2015).

Different types of water pollution include wastewater discharge, river pollution, thermal pollution, microplastic pollution, non-point source pollution, and oil pollution. These pollutants can degrade water quality, harm aquatic organisms, and disrupt ecosystems. Efforts to combat water pollution involve implementing wastewater treatment processes, pollution prevention measures, and regulatory frameworks to mitigate pollution impacts (Ross et al., 2020). Stakeholder engagement and awareness of the causes and effects of water pollution are essential for effective water quality management (Nare et al., 2006).

Water contamination is a multifaceted problem that necessitates comprehensive approaches to safeguard water sources and the environment. Effective collaboration among stakeholders is crucial for mitigating the detrimental impacts of pollution on ecosystems and human health. This can be achieved by comprehensively knowing the origins, factors, and categories of pollutants.

2.1. The Effects of Water Pollution on Humans and the Environment

Water pollution is a significant environmental issue with far-reaching effects on ecosystems and human health. Various studies have highlighted the diverse sources and impacts of water pollution. For instance, industrial and agricultural activities, as well as transport, contribute to water pollution by introducing contaminants of emerging concern (Morin-Crini et al., 2022).

Water pollution has become a significant concern due to industrialization, agricultural activities, and urbanization, leading to the degradation of water resources like rivers and oceans (Kamble & Kamble, 2022). The presence of pollutants in water bodies, such as heavy metals, can lead to health risks like bladder cancer, hereditary disabilities, bone distortions, miscarriages, and infertility (Ullah et al., 2022).

Various pollutants entering water bodies from human activities can have detrimental effects on human health, with implications ranging from respiratory diseases to cardiovascular issues (Jindal et al., 2020). Contaminated water can cause stomach pain and cancer. Additionally, the risk of outbreaks of water-borne diseases like cholera and hepatitis due to polluted water is a significant concern (Ogbomida & Emeribe, 2013).

Pollutants from electronic waste can affect the environment by being released into the air, water, and soil (He et al., 2022). Additionally, heavy metal pollution in water and sediments can have serious effects on aquatic ecosystems and make water unsuitable for consumption (Beale et al., 2017).

The effects of water pollution are not limited to aquatic environments; they can also impact human health. Furthermore, water pollution can lead to various health issues for individuals, such as eye inflammation, skin problems, respiratory discomfort, gastrointestinal disturbances, and fever (Gong et al., 2023).

Mitigating water pollution requires a multi-faceted approach. Studies have shown that rainfall-induced runoff from exposed streambed sediments can be a crucial source of surface water pollution (Frey et al., 2015). Additionally, the spatial distribution of pollutant discharge in water environments can be influenced by agricultural, urban, and mixed sources, necessitating targeted pollution control measures (Ren & Li, 2021). Implementing pollution control deadlines and other regulatory measures has been effective in improving water quality in rapidly urbanizing areas (Qin et al., 2014).

Water pollution has significant adverse effects on both human health and the environment. Contamination of water sources with pollutants such as heavy metals, pesticides, and pathogens poses serious risks to human populations. Studies have shown that water pollution can lead to various health issues, with diarrhea being a common disease transmitted through contaminated water sources (Liu et al., 2022). Additionally, the presence of pollutants in water bodies can result in the deterioration of food safety, increasing the risk of carcinogenic diseases and impacting human health (Lü et al., 2015).

Furthermore, unsafe drinking water due to contamination can have severe consequences on human health, leading to waterborne diseases and other health complications (Daud et al., 2017). The impact of water pollution extends beyond human health to encompass environmental degradation. Pollutants entering water bodies can harm aquatic life and disrupt ecosystems, affecting biodiversity and ecosystem services (Li et al., 2020).

Water pollution not only aggravates the deterioration of the ecological environment and endangers human health but also has a significantly negative impact on economic growth and social development (Li et al., 2022). Moreover, the presence of heavy metals in water bodies poses risks not only to human health but also to wildlife and the environment, emphasizing the need for comprehensive pollution monitoring and assessment strategies (Kumar et al., 2022).

To prevent water pollution and safeguard clean water sources, a multifaceted approach integrating various technologies and strategies is essential. One effective method is the implementation of advanced water treatments utilizing engineering and biotechnological tools. These tools, such as porous electrospun fibers embedding TiO_2 for adsorption and photocatalytic degradation of water pollutants, have shown promise in enhancing treatment efficiency and reducing energy requirements (Lee et al., 2018).

Preventing water pollution and maintaining clean water sources require a combination of advanced technologies, intelligent algorithms, and stringent policies. By implementing innovative water treatment methods, optimizing pollution prevention projects, and leveraging artificial intelligence for efficient planning, it is possible to mitigate water pollution effectively and ensure the sustainability of water resources.

2.2. Strategies for Achieving Clean Water

To achieve clean water, various strategies and approaches have been proposed in the literature. Local authorities play a crucial role in understanding and addressing the social and economic challenges within communities to provide clean water (Zindi & Shava, 2022). Human resource strategies are essential for effective clean water management, especially in addressing challenges faced by water management entities (Sakawati et al., 2019). Water pollution control strategies are vital tools to ensure the availability of safe and clean water (Rangata, 2014). Strategies involving community participation are crucial for achieving regional rural water security, particularly in areas like tropical peatlands (Herawati et al., 2021).

Developing comprehensive watershed-based approaches is imperative for protecting water quality and ensuring sustainable clean water supplies, especially with increasing population growth (Randhir & Genge, 2005). Solar-powered water-solute separation systems show promise in clean water production and treatment due to their high energy conversion efficiency (Xu et al., 2021). Efficient cleaning strategies are essential for membrane technologies used in treating various wastewater (Masse et al., 2014; Masse et al., 2015). Strategies for desalination technologies, such as controlled salt precipitation, are crucial for a sustainable clean water supply (Shi et al., 2018).

Hydrogen generation from water splitting, coupled with clean energy sources, holds the potential for achieving clean and sustainable societies (Guo, 2023). Efficient cleaning procedures are vital for maintaining the performance of reverse osmosis membranes processing wastewater, emphasizing the need for effective cleaning strategies (Rumbau et al., 2016). Factors like temperature, shear stress, and cleaning solution concentration play a role in enhancing cleaning effectiveness (Fan et al., 2023). Innovative approaches like in situ electrochemical generation of reactive chlorine species have shown superior performance in membrane self-cleaning compared to conventional methods (Wang et al., 2020).

2.3. How to Prevent Water Pollution

To prevent water pollution, a comprehensive approach is essential. Addressing pollution sources is paramount, which includes implementing safe agricultural practices, treating industrial waste before discharge, and controlling pollution at its origin (Sahoo & Goswami, 2024; Abdallah et al., 2022). For example, utilizing phytoremediation methods to treat industrial liquid waste before its release into the environment can significantly reduce water pollution (Widyastuti & Suprayitno, 2020). Additionally, the enforcement of international agreements by governments plays a crucial role in reducing water pollution (Abdallah et al., 2022).

In terms of technological solutions, incorporating advanced methods such as porous electrospun fibers embedding TiO_2 for adsorption and photocatalytic degradation of water pollutants can enhance the efficiency of water treatment processes (Lee et al., 2018).

Water contamination has wide-ranging and significant impacts, affecting several aspects such as human health, ecosystems, agriculture, and the economy. Drinking water that is contaminated can result in a range of health problems, as well as negatively impacting aquatic organisms, altering the balance of ecosystems, and contributing to the extinction of species. Water contamination leads to substantial economic damage in industries such as tourism, fishing, and manufacturing. Hence, it is crucial to take measures to minimize water contamination and safeguard water resources.

A modern approach to preventing the effects of water pollution involves the development of remediation methods using microorganisms and plants. By targeting the origins of pollution, employing cutting-edge treatment techniques, and harnessing the power of artificial intelligence, substantial advancements can be made in the preservation of water resources.

If immediate measures are not taken, the environmental, economic, and social harm will intensify, causing a decline in the availability of clean water, which is crucial for maintaining a healthy and sustainable lifestyle, ultimately leading to water crises. Entrepreneurial strategies need to be devised and executed on both local and global scales to tackle the consequences of water contamination.

3. Examining Climate Change

Climate change is the persistent modification of temperature and usual weather patterns in a certain location over a prolonged period. Climate change is a progressive phenomenon that can result in a range of outcomes, including heightened precipitation, intensified erosion, periods of drought, excessive water, floods, landslides, and implications for human well-being (Lestari, 2023). The enduring impacts and repercussions of climate change are now deemed irreversible as a result of both direct and indirect anthropogenic actions, alongside natural fluctuations (Bulut & Özden, 2023). Climate change poses a substantial risk to the survival and ongoing progress of civilization (Han et al., 2022). Individuals' thoughts and attitudes regarding climate change are pivotal in determining their inclination to engage in efforts aimed at alleviating its impacts. Research conducted by Blennow et al. (2012) has demonstrated a significant correlation between personal characteristics, such as the intensity of belief in the local consequences of climate change, and individuals' responses to climate change. Research has also shown that having information about climate change can have a positive impact on public discussions about the topic (Guy et al., 2014). Moreover, a thorough understanding of the factors that contribute to climate change and its consequences is crucial for encouraging proactive measures and mitigating the associated hazards (Dorji et al., 2021).

3.1. The Effects of Climate Change on Water Resources

Climate change has profound effects on water resources worldwide. Climate change can cause changes in the patterns of precipitation and temperature, which can in turn affect the distribution of water resources. This can lead to variations in the availability of water (Abbaspour et al., 2009). In addition, climate change has the potential to lengthen periods of low rainfall in arid regions, which can have a significant impact on the availability of water resources, particularly in places that do not have access to dependable underground water supplies (Green et al., 2011). Climate change significantly affects the global water supply. Studies have shown that climate change alters precipitation patterns, which in turn impacts the availability of water resources (Alcamo et al., 2007). The relationship between climate change and water supply is complex and varies across different geographic regions (Khôi et al., 2021). Fluctuations in the relationship between tree growth and water availability, which can impact the productivity of forests and the storage of carbon, can be attributed to many variables such as elevated levels of CO_2 and alterations in patterns of precipitation (Maxwell et al., 2019). Moreover, it is expected that climate change will alter hydrological processes and the overall availability of water worldwide (Touseef et al., 2021).

Climate change can have a considerable impact on the hydroclimatology of river basins, affecting the availability of water and techniques for managing it (Setegn et al., 2011). In addition, the impacts of climate change on water resources are not restricted to natural ecosystems but also affect communities that depend on these resources (Novruzova, 2022). Addressing climate change is essential to minimize the negative effects it has on water resources (Kundzewicz et al., 2008). Climate change has an impact on both surface water and groundwater resources, which might have consequences for water security (Green et al., 2011). Climate change can affect groundwater levels, recharge rates, and contributions to baseflow, which in turn can alter the overall availability of water (Dennis & Dennis, 2012). Furthermore, climate change has the potential to worsen the risks and expenses related to the management of water resources, impacting both the amount and quality of available water (Hamidi et al., 2021).

To summarize, climate change has complex and wide-ranging effects on water resources, including hydrology, water availability, and management. Implementing mitigation techniques is crucial for minimizing the negative impacts of climate change on water resources and ensuring sustainable water management in the context of changing climatic circumstances.

4. Ensuring Fair and Equal Access to Water

Ensuring fair and equal access to water is essential for promoting sustainable development and safeguarding public health. The process entails tackling discrepancies in the availability and allocation of water to provide equitable and impartial access to this important resource for all individuals. Multiple studies highlight the importance of governance, policy interventions, and community engagement in attaining fair and equal access to water resources (Schattman et al., 2020; Woodhouse & Müller, 2017).

Amidst the COVID-19 pandemic, the importance of water has heightened significantly as it plays a crucial role in maintaining hygiene and sanitation practices that are vital for limiting the transmission of the virus (Zhang et al., 2022; Warner et al., 2020). The absence of universal service obligations and disconnection protections in some areas underscores the need for more robust governance mechanisms to preserve water access during emergencies (Warner et al., 2020).

The fair distribution of water resources is intricately connected to larger concerns of equal access to healthcare and fairness in society. Research emphasizes the need to tackle structural obstacles that impede underprivileged people, such as disabled individuals, from obtaining clean water and sanitation services (Kumwenda, 2019; White et al., 2016). To promote inclusivity and fairness in the distribution of resources, it is essential to consider the special requirements of disadvantaged people when making efforts to ensure equal access to water.

Equitable access to water is crucial for sustainable agricultural practices and adapting to climate change in the field of agriculture (Kabir et al., 2017; Schattman et al., 2020). The significance of equitable water distribution methods for sustaining agricultural operations and livelihoods is emphasized by the perspectives and recommendations of farmers (Khepar et al., 2000; Kabir et al., 2017). To ensure fair and equal access to water, it is essential to adopt a holistic approach that combines effective administration, well-designed policy frameworks, active involvement of communities, and a specific emphasis on meeting the requirements of marginalized populations. By placing a high importance on justice and inclusivity in the management of water resources, communities can move forward in their efforts to guarantee that every individual has sufficient and equal access to this essential resource.

Every organism on Earth, encompassing flora, fauna, and mankind, possesses the entitlement to obtain water. Every living organism has an inherent entitlement to an ample supply of uncontaminated water. Presently, around two billion individuals across the globe are encountering challenges in obtaining access to water. Private enterprises, anticipating a growing need for freshwater, lobby for the privatization of water, perceiving it as a profitable commodity. Nevertheless, the availability of water is an essential entitlement for all living organisms in the natural world and should never be seen as a commodity. By 2040, Turkey is projected to experience one of the most acute water shortages compared to other countries. Notwithstanding these predictions, the procedures for implementing essential actions in Turkey are progressing at a sluggish pace. Without prompt intervention, the progression of time draws us nearer to a future in which water scarcity will emerge as a substantial concern.

5. Water Policy and Management

Efficient water governance is essential for ensuring sustainable water management and tackling water-related issues. The process entails the synchronization of stakeholders, policies, and practices to effectively oversee the utilization of water resources. Water governance encompasses the systems and processes that determine the distribution of power, rights, decision-making, and priorities related to water resources and communities. It plays a crucial role in defining the way water is managed and utilized (Katusiime & Schütt, 2020). Water governance plays a crucial role in attaining sustainable development goals, advancing environmental sustainability, and enhancing social well-being (Ahmed & Araral, 2019).

Efficient water governance is crucial for attaining sustainable water management, encompassing economic, social, and environmental dimensions (Aparco et al., 2022). Sustainable water management entails the efficient control of water resources to avoid environmental harm and assure optimal utilization (Hidayat & Dewi, 2022). The cited study by Ashfaq et al. (2018) highlights the significant contribution of this factor in advancing environmental sustainability, societal well-being, and economic stability. It is imperative to implement sustainable water resource management in order to safeguard and rehabilitate water-related ecosystems and promote the effective utilization of natural resources (Díaz-Vázquez et al., 2021).

In order to attain sustainable water management, it is crucial to take into account the natural constraints and enhance societal welfare, while also addressing a wide range of water requirements (Poff et al., 2009). Creating frameworks for regional environmental flow standards can aid in the management of river flows to maintain or restore the ecological integrity of impacted ecosystems (Richter et al., 2003). Incorporating risk management strategies can provide motivation for efficient and enduring local water management (Grey-Gardner, 2008).

In addition, sustainable water management include the active involvement of stakeholders, the implementation of risk management measures, and the efficient provision of water to meet the demands of communities for their well-being (Widiarto et al., 2023). The approach described by Eller et al. (2016) is ongoing and aims to persuade decision-makers and stakeholders to implement behaviors that promote the long-term sustainability of water resources. Zhang and Xia (2009) argue that integrating hydrological and ecological processes is crucial for the successful implementation of sustainable water resources management, which is necessary to preserve ecological integrity and promote societal well-being.

The management of water resources is intricately linked to democratic values and human rights, underscoring the significance of democratic administration in guaranteeing universal access to uncontaminated water for every individual (Schiel et al., 2020).

Sustainable water management is a holistic approach that balances the economic, social, and environmental needs while guaranteeing the ongoing availability and quality of water resources through cooperation, minimizing risks, and ongoing enhancements.

Conclusion

With modern life, the processes of industrialization, agricultural irrigation, climate change, and population increase have collectively contributed to the decline in global water resources, resulting in a state of water scarcity.

Water pollution, wasteful use of water, and population growth increase our need for water and lead to water scarcity. By 2040, Turkey, with a projected population of over 100 million, is anticipated to face water scarcity, similar to other some nations.

The lack of water presents a complex and diverse danger to the worldwide economy, affecting various sectors such as agriculture, manufacturing, and home water provision. This phenomenon results in a decline in agricultural output, scarcity of food, and a rise in food costs, which harm the income of farmers and the regional gross domestic product.

Projections indicate that around 6 billion individuals may experience water scarcity by 2050, emphasizing the immediate necessity for action. The issue is worsened by factors such as population increase, consumption habits, climate change, and inadequate water management organizations. The limited availability of water also hampers the global trading system, highlighting the importance of sustainable water management for ensuring economic stability and progress. Addressing the issue of water shortage is crucial to reduce economic risks and guarantee long-term stability in the global economy.

To restrict water usage and safeguard freshwater reserves, it is imperative to enact national water regulations and guarantee sustainable management of domestic water resources. Emphasis should be placed on societal education to enhance knowledge of water conservation.

Water resources should never be privatized, and universities, civil society organizations, unions, professional associations, and municipalities should be included in water management bodies. Water ought to be acknowledged not as a commodity, but as a communal legacy, and water reserves should be diligently conserved. It is necessary to define and distribute legal regulations for the usage of wastewater. Agriculture should employ appropriate irrigation technologies, and farmers should receive comprehensive training in irrigation techniques.

Future water management endeavors will necessitate inventive ideas, cooperative alliances, and comprehensive approaches. By adopting these approaches, communities can strengthen their ability to withstand water-related challenges, preserve natural habitats, and ensure the availability of water for future descendants.

References

Abbaspour, K., Faramarzi, M., Ghasemi, S., & Yang, H. (2009). Assessing the impact of climate change on water resources in iran. Water Resources Research, 45(10). https://doi.org/10.1029/2008wr007615

Ahmed, M. and Araral, E. (2019). Water governance in india: evidence on water law, policy, and administration from eight indian states. Water, 11(10), 2071. https://doi.org/10.3390/w11102071

Alcamo, J., Flörke, M., & Märker, M. (2007). Future long-term changes in global water resources driven by socio-economic and climatic changes. Hydrological Sciences Journal, 52(2), 247-275. https://doi.org/10.1623/hysj.52.2.247

Aparco, R., Rincón, H., Cáceres, E., Mamani, G., Ruiz, R., Ferro, A., Arias, C. A., & Guzmán, N. P. (2022). Drinking water attribute preferences for sustainable management in Andahuaylas, Peru. Iop Conference Series Earth and Environmental Science, 968(1), 012005. https://doi.org/10.1088/1755-1315/968/1/012005

Ashfaq, M., Qiblawey, H., Zouari, N., Rodrigues, D., & Hu, Y. (2018). Use of dpsir framework to analyze water resources in qatar and overview of reverse osmosis as an environment friendly technology. Environmental Progress & Sustainable Energy, 38(4). https://doi.org/10.1002/ep.13081

Beale, D., Karpe, A., Ahmed, W., Cook, S., Morrison, P., Staley, C., Sadowsky, M.J., & Palombo, E.A. (2017). A community multi-omics approach towards the assessment of surface water quality in an urban river system. International Journal of Environmental Research and Public Health, 14(3), 303. https://doi.org/10.3390/ijerph14030303

Blennow, K., Persson, J., Tomé, M., & Hanewinkel, M. (2012). Climate change: believing and seeing implies adapting. Plos One, 7(11), e50182. https://doi.org/10.1371/journal.pone.0050182

Buh, E., Mbua, R., & Ngong, U. (2021). Potable water scarcity and options for effective provision in limbe municipality, southwest region, cameroon. Journal of Geography Environment and Earth Science International, 12-21. https://doi.org/10.9734/jgeesi/2021/v25i630290

Bulut, M. and Özden, C. (2023). Effects of climate change on animal husbandry. Black Sea Journal of Agriculture, 6(1), 87-94. https://doi.org/10.47115/bsagriculture.1216262

Chen, X., Zhou, W., Pickett, S., Liu, W., & Han, L. (2016). Spatial-temporal variations of water quality and its relationship to land use and land cover in beijing, china. International Journal of Environmental Research and Public Health, 13(5), 449. https://doi.org/10.3390/ijerph13050449

Dahri, G., Mangan, T., Nangraj, G. M., Talpur, A.B., Jarwar, A. I., Sial, M., Nangraj, A.N., & Aamir, Mr. (2021). Socio-economic impact and migration due to water shortage in district badin Sindh province of Pakistan. Journal of Economic Impact, 3(1), 01-11. https://doi.org/10.52223/jei3012101

Daud, M., Nafees, M., Ali, S., Rizwan, M., Bajwa, R., Shakoor, M., Arshad, MU., Chatha, SAS., Deeba, F., Murad, W., Malook, I., & Zhu SJ. (2017). Drinking water quality status and contamination in Pakistan. Biomed Research International, 2017, 1-18. https://doi.org/10.1155/2017/7908183

Dennis, I. and Dennis, R. (2012). Climate change vulnerability index for South african aquifers. Water Sa, 38(3). https://doi.org/10.4314/wsa.v38i3.7

Díaz-Vázquez, D., Carrillo-Nieves, D., Orozco-Nunnelly, D., Senés-Guerrero, C., & Gradilla-Hernández, M. (2021). An integrated approach for the assessment of environmental sustainability in agro-industrialwaste management practices: the case of the tequila industry. Frontiers in Environmental Science, 9. https://doi.org/10.3389/fenvs.2021.682093

Dorji, Y., Man, C., & Nidup, T. (2021). Climate change awareness among the teachers of higher secondary schools. Asian Research Journal of Arts & Social Sciences, 12-22. https://doi.org/10.9734/arjass/2021/v15i430263

Eller, M., Beck, J., Hedrich, M., & Urban, W. (2016). A new sustainability controlling approach for urban water systems: multidimensional risk identification and system analysis. Journal of Environmental Science and Engineering-A, 5(8). https://doi.org/10.17265/2162-5298/2016.08.005

Fältström, E. (2020). Towards the control of microplastic pollution in urban waters. https://doi.org/10.3384/lic.diva-171095

Fan, M., Kim, W., & Heldman, D. (2023). Effect of temperature, wall shear stress, and naoh concentration on cleaning effectiveness. Journal of Food Science, 88(4), 1523-1532. https://doi.org/10.1111/1750-3841.16493

Foster, J., Mujovic, S., Groele, J., & Blankson, I. (2018). Towards high throughput plasma based water purifiers: design considerations and the pathway towards practical application. Journal of Physics D Applied Physics, 51(29), 293001. https://doi.org/10.1088/1361-6463/aac816

Frey, S., Gottschall, N., Wilkes, G., Grégoire, D., Topp, E., Pintar, K., … & Lapen, D. (2015). Rainfall-induced runoff from exposed streambed sediments: an important source of water pollution. Journal of Environmental Quality, 44(1), 236-247. https://doi.org/10.2134/jeq2014.03.0122

Gong, X., Wang, X., & Zhou, X. (2023). Analysis of the impact of lake environmental water pollution on the health of outdoor swimmers based on stirpat environmental impact assessment model. 3c Tic Cuadernos De Desarrollo Aplicados a Las Tic, 12(1), 132-150. https://doi.org/10.17993/3ctic.2023.121.132-150

Green, T.R., Taniguchi, M., Kooi, H., Gurdak, J.J., Allen, D.M., Hiscock, K.M., Treidel, H. and Aureli, A. (2011) Beneath the Surface of Global Change: Impacts of Climate Change on Groundwater. Journal of Hydrology, 405, 532-560. https://doi.org/10.1016/j.jhydrol.2011.05.002

Grey-Gardner, R. (2008). Implementing risk management for water supplies: a catalyst and incentive for change. The Rangeland Journal, 30(1), 149. https://doi.org/10.1071/rj07046

Guo, Y. (2023). Design and performance of rh nanocatalysts for boosted h2 generation in alkaline media. Accounts of Materials Research, 5(1), 89-102. https://doi.org/10.1021/accountsmr.3c00146

Guy, S., Kashima, Y., Walker, I., & O'Neill, S. (2014). Investigating the effects of knowledge and ideology on climate change beliefs. European Journal of Social Psychology, 44(5), 421-429. https://doi.org/10.1002/ejsp.2039

Hamidi, M., Larabi, A., & Faouzi, M. (2021). Modeling and mapping of coastal aquifer vulnerability to seawater intrusion using seawat code and galdit index technique: the case of the rmel aquifer – larache, morocco. E3s Web of Conferences, 298, 05002. https://doi.org/10.1051/e3sconf/202129805002

Han, P., Tong, Z., Sun, Y., & Chen, X. (2022). Impact of climate change beliefs on youths' engagement in energy-conservation behavior: the mediating mechanism of environmental concerns.International Journal of Environmental Research and Public Health, 19(12), 7222. https://doi.org/10.3390/ijerph19127222

Hanif, M., Miah, R., Islam, M., & Marzia, S. (2020). Impact of kapotaksha river water pollution on human health and environment. Progressive Agriculture, 31(1), 1-9. https://doi.org/10.3329/pa.v31i1.48300

Haseena, M., Malik, M.F., Javed, A., Arshad, S., Asif, N., Zulfiqar, S. and Hanif, J. (2017) Water Pollution and Human Health. Environmental Risk Assessment and Remediation, 1, 16-19. https://doi.org/10.4066/2529-8046.100020

He, Z., Yue, Y., & Wang, Y. (2022). The hazards, treatment measures and sustainable development of electronic waste. Iop Conference Series Earth and Environmental Science, 1011(1), 012023. https://doi.org/10.1088/1755-1315/1011/1/012023

Herawati, H., Akbar, A., & Abdurrahman, T. (2021). Strategy for realizing regional rural water security on tropical peatland. Water, 13(18), 2455. https://doi.org/10.3390/w13182455

Hidayat, F. and Dewi, O. (2022). Strengthening sustainable context of water management in educational building universitas indonesia. Iop Conference Series Earth and Environmental Science, 1058(1), 012009. https://doi.org/10.1088/1755-1315/1058/1/012009

Hoekstra, A., Mekonnen, M., Chapagain, A., Mathews, R., & Richter, B. (2012). Global monthly water scarcity: blue water footprints versus blue water availability. Plos One, 7(2), e32688. https://doi.org/10.1371/journal.pone.0032688

Jindal, H., Kumar, S., & Kumar, R. (2020). Environmental pollution and its impact on public health: a critical review. The Asian Review of Civil Engineering, 9(1), 11-18. https://doi.org/10.51983/tarce-2020.9.1.2292

Kabir, J., Cramb, R., Alauddin, M., Roth, C., & Crimp, S. (2017). Farmers' perceptions of and responses to environmental change in southwest coastal bangladesh. Asia Pacific Viewpoint, 58(3), 362-378. https://doi.org/10.1111/apv.12165

Kamble, P. and Kamble, M. (2022). Health effects of water pollution. Epra International Journal of Economic and Business Review, 45-50. https://doi.org/10.36713/epra11200

Katusiime, J. and Schütt, B. (2020). Integrated water resources management approaches to improve water resources governance. Water, 12(12), 3424. https://doi.org/10.3390/w12123424

Khepar, S., Gulati, H., Yadav, A., & Brar, T. (2000). A model for equitable distribution of canal water. Irrigation Science, 19(4), 191-197. https://doi.org/10.1007/pl00006712

Khôi, Đ., Nguyen, V., Sam, T., H., N., Vuong, N., & Cuong, H. (2021). Assessment of climate change impact on water availability in the upper dong nai river basin, vietnam. Journal of Water and Climate Change, 12(8), 3851-3864. https://doi.org/10.2166/wcc.2021.255

Kumar, P., Mishra, V., Bhardwaj, S., Garg, S., Dumée, L., & Sharma, R. (2022). Five-wheel framework for system-based monitoring of heavy metal pollution in rivers. Environmental Quality Management, 32(4), 9-17. https://doi.org/10.1002/tqem.21918

Kumwenda, S. (2019). Challenges to hygiene improvement in developing countries.https://doi.org/10.5772/intechopen.80355

Kundzewicz, Z., Mata, L., Arnell, N., Döll, P., Jiménez, B., Miller, K., Oki, T., Şen, Z., & Shiklomanov, I. (2008). The implications of projected climate change for freshwater resources and their management. Hydrological Sciences Journal, 53(1), 3-10. https://doi.org/10.1623/hysj.53.1.3

Lama, G., Meijide, J., & Sanromán, Á. (2022). Heterogeneous advanced oxidation processes: current approaches for wastewater treatment. Catalysts, 12(3), 344. https://doi.org/10.3390/catal12030344

Lee, CG., Javed, H., Zhang, D., Kim, JH., Westerhoff, P., Li, Q., Alvarez, PJJ. Porous Electrospun Fibers Embedding TiO2 for Adsorption and Photocatalytic Degradation of Water Pollutants. Environ Sci Technol. 2018 Apr 3;52(7):4285-4293. doi: 10.1021/acs.est.7b06508. Epub 2018 Mar 23. PMID: 29553243.

Lestari, N. (2023). Climate change literacy of coastal disaster-prone communities in realizing climate action for sustainable physics learning. Journal of Physics Conference Series, 2623(1), 012029. https://doi.org/10.1088/1742-6596/2623/1/012029

Li, L., Shi, Y., Huang, Y., Xing, A., & Xue, H. (2022). The effect of governance on industrial wastewaterpollution in China. International Journal of Environmental Research and Public Health, 19(15), 9316. https://doi.org/10.3390/ijerph19159316

Li, Y., Lin, C., Huang, J., Chi, C., & Huang, B. (2020). Spectrally selective absorbers/emitters for solar steam generation and radiative cooling-enabled atmospheric water harvesting. Global Challenges, 5(1). https://doi.org/10.1002/gch2.202000058

Liu, L., Yang, H., & Xu, X. (2022). Effects of water pollution on human health and disease heterogeneity: a review. Frontiers in Environmental Science, 10. https://doi.org/10.3389/fenvs.2022.880246

Liu, W., Liu, X., Yang, H., Ciais, P., & Wada, Y. (2022). Global water scarcity assessment incorporating green water in crop production. Water Resources Research, 58(1). https://doi.org/10.1029/2020wr028570

Liu X., Du H., Zhang Z., Crittenden JC., Lahr ML., Moreno-Cruz J., Guan D., Mi Z., & Zuo, J. (2019). Can virtual water trade save water resources?. Water Research, 163, 114848. https://doi.org/10.1016/j.watres.2019.07.015

Loon, A. and Lanen, H. (2013). Making the distinction between water scarcity and drought using an observation-modeling framework. Water Resources Research, 49(3), 1483-1502. https://doi.org/10.1002/wrcr.20147

Loon, A. F., Gleeson, T., Clark, J., Van Dijk, A. I. J. M., Stahl, K., Hannaford, J., Di Baldassarre, G., Teuling, A. J., Tallaksen, L. M., Uijlenhoet, R., Hannah, D. M., Sheffield, J., Svoboda, M., Verbeiren, B., Wagener, T., Rangecroft, S., Wanders, N., & Van Lanen, H. A. J. (2016). Drought in the Anthropocene. Nature Geoscience, 9(2), 89-91. https://doi.org/10.1038/ngeo2646

Lu, Y., Song, S., Wang, R., Liu, Z., Meng, J., Sweetman, A. J., Jenkins, A., Ferrier, R. C., Li, H., Luo, W., & Wang, T. (2015). Impacts of soil and water pollution on food safety and health risks in China. Environment International, 77, 5-15. https://doi.org/10.1016/j.envint.2014.12.010

Martín-Carrasco, F., Garrote, L., Iglesias, A., & Mediero, L. (2012). Diagnosing causes of water scarcity in complex water resources systems and identifying risk management actions. Water Resources Management, 27(6), 1693-1705. https://doi.org/10.1007/s11269-012-0081-6

Masse, L., Mondor, M., Puig-Bargués, J., Deschênes, L., & Talbot, G. (2014). The efficiency of various chemical solutions to clean reverse osmosis membranes processing swine wastewater. Water Quality Research Journal, 49(4), 295-306. https://doi.org/10.2166/wqrjc.2014.008

Masse, L., Puig-Bargués, J., Mondor, M., Deschênes, L., & Talbot, G. (2015). The efficiency of EDTA, SDS, and Naoh solutions to clean ro membranes processing swine wastewater. Separation Science and Technology, 150629134718002. https://doi.org/10.1080/01496395.2015.1062395

Mathur, P. and Roy, S. (2021). Insights into the plant responses to drought and decoding the potential of the root-associated microbiome for inducing drought tolerance. Physiologia Plantarum, 172(2), 1016-1029. https://doi.org/10.1111/ppl.13338

Mattiuzi, C., Marques, G., & Medellín-Azuara, J. (2019). Reassessing water allocation strategies and conjunctive use to reduce water scarcity and scarcity costs for irrigated agriculture in southern Brazil. Water, 11(6), 1140. https://doi.org/10.3390/w11061140

Maxwell, J., Harley, G., Mandra, T., Yi, K., Kannenberg, S., Au, T., Robeson, S.M., Pederson, N., Sauer, P. E., & Novick, K. (2019). Higher CO2 concentrations and lower acidic deposition have not changed drought response in tree growth but do influence iwue in hardwood trees in the midwestern United States. Journal of Geophysical Research Biogeosciences, 124(12), 3798-3813. https://doi.org/10.1029/2019jg005298

Moncaleano, D., Pande, S., & Rietveld, L. (2021). Water use efficiency: a review of contextual and behavioral factors. Frontiers in Water, 3. https://doi.org/10.3389/frwa.2021.685650

Morin-Crini, N., Lichtfouse, E., Liu, G., Balaram, V., Ribeiro, A.R.L., Lu, Z., Stock, F., Carmona, E., Teixeira, M.R., Picos-Corrales, L.A., Moreno-Pirajan, J.C., Giraldo, L., Li, C., Pandey, A., Hocquet, D., Torri, G., & Crini, G. (2022). Worldwide cases of water pollution by emerging contaminants: a review. Environmental Chemistry Letters, 20(4), 2311-2338. https://doi.org/10.1007/s10311-022-01447-4

Murshed, S., Rahman, R., & Kaluarachchi, J. (2019). Changes in the hydrology of the Ganges delta of Bangladesh and corresponding impacts on water resources. Jawra Journal of the American Water Resources Association, 55(4), 800-823. https://doi.org/10.1111/1752-1688.12775

Nare, L., Love, D., & Hoko, Z. (2006). Involvement of stakeholders in the water quality monitoring and surveillance system: the case of Mzingwane catchment, zimbabwe. Physics and Chemistry of the Earth Parts a/B/C, 31(15-16), 707-712. https://doi.org/10.1016/j.pce.2006.08.037

Navarro-Ortega, A., Acuña, V., Bellin, A., Burek, P., Cassiani, G., Choukr-Allah, R., … & Barceló, D. (2015). Managing the effects of multiple stressors on aquatic ecosystems under water scarcity. the globaqua project. The Science of the Total Environment, 503-504, 3-9. https://doi.org/10.1016/j.scitotenv.2014.06.081

Nephawe, N., Mwale, M., Zuwarimwe, J., & Tjale, M. (2021). The impact of water-related challenges on rural communities food security initiatives. Agraris Journal of Agribusiness and Rural Development Research, 7(1), 11-23. https://doi.org/10.18196/agraris.v7i1.9935

Novruzova, A. (2022). Climate change impacts on water resources. Teka Komisji Politologii I Stosunków Międzynarodowych, 16(2), 23-35. https://doi.org/10.17951/teka.2021.16.2.23-35

Ogbomida, E. and Emeribe, C. (2013). Impact of urbanization on Nwaorie and Otamiri rivers in Owerri, imo state, Nigeria. Advances in Environmental Research, 2(2), 119-129. https://doi.org/10.12989/aer.2013.2.2.119

Pei, L., Wang, C., Zuo, Y., Liu, X., & Chi, Y. (2022). Impacts of land use on surface water quality using the self-organizing map in the middle region of the Yellow River basin, china. International Journal of Environmental Research and Public Health, 19(17), 10946. https://doi.org/10.3390/ijerph191710946

Poff, N., Richter, B., Arthington, A., Bunn, S., Naiman, R., Kendy, E., … & Warner, A. (2009). The ecological limits of hydrologic alteration (eloha): a new framework for developing regional environmental flow standards. Freshwater Biology, 55(1), 147-170. https://doi.org/10.1111/j.1365-2427.2009.02204.x

Qin, H., Su, Q., Khu, S., & Tang, N. (2014). Water quality changes during rapid urbanization in the Shenzhen river catchment: an integrated view of socio-economic and infrastructure development. Sustainability, 6(10), 7433-7451. https://doi.org/10.3390/su6107433

Randhir, T. and Genge, C. (2005). The watershed-based, institutional approach to developing clean water resources. Jawra Journal of the American Water Resources Association, 41(2), 413-424. https://doi.org/10.1111/j.1752-1688.2005.tb03745.x

Rangata, M. (2014). An overview of water pollution control strategy. Mediterranean Journal of Social Sciences. https://doi.org/10.5901/mjss.2014.v5n23p976

Abdallah, C., Mourad, K., & Cobbina, S. (2022). Advanced water pollution control strategies: a systematic review. https://doi.org/10.21203/rs.3.rs-1315815/v1

Ren, Q. and Li, H. (2021). Spatiotemporal effects and driving factors of water pollutants discharge in Beijing–tianjin–hebei region. Water, 13(9), 1174. https://doi.org/10.3390/w13091174

Richter, B., Mathews, R., Harrison, D., & Wigington, R. (2003). Ecologically sustainable water management: managing river flows for ecological integrity. Ecological Applications, 13(1), 206-224. https://doi.org/10.1890/10510761(2003)013[0206:eswmmr]2.0.co;2

Rijsberman, F. (2006). Water scarcity: fact or fiction?. Agricultural Water Management, 80(1-3),5-22. https://doi.org/10.1016/j.agwat.2005.07.001

Ross, A., Hotard, A., Kamalanathan, M., Nolen, R., Hala, D., Clay, L., … & Quigg, A. (2020). Awareness is not enough: frequent use of water pollution information and changes to risky behavior. Sustainability, 12(20), 8695.

Rumbau, M., Masse, L., Dubreuil, J., Mondor, M., Christensen, K., & Norddahl, B. (2016). Fouling of a spiral-wound reverse osmosis membrane processing swine wastewater: effect of cleaning procedure on fouling resistance. Environmental Technology, 37(13), 1704-1715. https://doi.org/10.1080/09593330.2015.1128002

Sahoo, S. and Goswami, S. (2024). Theoretical framework for assessing the economic and environmental impact of water pollution: a detailed study on sustainable development of india. Journal of Future Sustainability, 4(1), 23-34. https://doi.org/10.5267/j.jfs.2024.1.003

Sakawati, H., Yamin, M., Sulmiah, S., & Widyawati, W. (2019). Strategic human resource management in clean water management at district jeneponto, south sulawesi. Iapa Proceedings Conference, 48. https://doi.org/10.30589/proceedings.2019.221

Schattman, R., Niles, M., & Aitken, H. (2020). Water use governance in a temperate region: implications for agricultural climate change adaptation in the northeastern united states. Ambio, 50(4), 942-955. https://doi.org/10.1007/s13280-020-01417-6

Schiel, R., Langford, M., & Wilson, B. (2020). Does it matter: constitutionalisation, democratic governance, and the human right to water. Water, 12(2), 350. https://doi.org/10.3390/w12020350

Schulz, R. (2004). Field studies on exposure, effects, and risk mitigation of aquatic nonpoint-source insecticide pollution: a review. Journal of Environmental Quality, 33(2), 419-448. https://doi.org/10.2134/jeq2004.4190

Setegn, S., Rayner, D., Melesse, A., Dargahi, B., & Srinivasan, R. (2011). Impact of climate change on the hydroclimatology of lake tana basin, ethiopia. Water Resources Research, 47(4).https://doi.org/10.1029/2010wr009248

She, Y. (2024). Evaluating losses from water scarcity and benefits of water conservation measures to intercity supply chains in china. Environmental Science & Technology, 58(2), 1119-1130. https://doi.org/10.1021/acs.est.3c07491

Shi, Y., Zhang, C., Li, R., Zhuo, S., Jin, Y., Shi, L., … & Wang, P. (2018). Solar evaporator with controlled salt precipitation for zero liquid discharge desalination. Environmental Science & Technology, 52(20), 11822-11830. https://doi.org/10.1021/acs.est.8b03300

Thorslund, J., Bierkens, M., Scaini, A., Sutanudjaja, E., & Vliet, M. (2022). Salinity impacts on irrigation water-scarcity in food bowl regions of the us and australia. Environmental Research Letters, 17(8), 084002. https://doi.org/10.1088/1748-9326/ac7df4

Touseef, M., Chen, L., & Yang, W. (2021). Assessment of surface water availability under climate change using coupled swat-weap in hongshui river basin, china. Isprs International Journal of Geo-Information, 10(5), 298. https://doi.org/10.3390/ijgi10050298

Ullah, M., Sarfraz, M., Ullah, H., Rahman, Z., Gul, Z., Khan, M., Iqbal, R., Kanwal, M., Gulzar, A., Sadiq, T., & Rabnawaz, A. (2022). Water and air pollution as an emerging problem for Pakistan: a review. Journal of Plant and Environment, 4(1), 87-92. https://doi.org/10.33687/jpe.004.01.3992

Unicef (2017). Annual Report, https://www.unicef.org/m dia/47861/file/UNICEF_Annual_Report_2017-ENG.pdf

Veldkamp, T., Wada, Y., Aerts, J., Döll, P., Gosling, S., Liu, J., Masaki, Y., Oki, T., Ostberg, S., Pokhrel, Y., Satoh, Y., Kim, H., & Ward, P. (2017). Water scarcity hotspots travel downstream due to human interventions in the 20th and 21st centuries. Nature Communications, 8(1). https://doi.org/10.1038/ncomms15697

Wang, W., Liu, X., Wang, Y., Guo, X., & Lu, S. (2015). Analysis of point source pollution and water environmental quality variation trends in the nansi lake basin from 2002 to 2012. Environmental Science and Pollution Research, 23(5), 4886-4897. https://doi.org/10.1007/s11356-015-5625-x

Wang, X., Sun, M., Zhao, Y., Wang, C., Ma, W., Wong, M., & Elimelech, M. (2020). In situ electrochemical generation of reactive chlorine species for efficient ultrafiltration membrane self-cleaning. Environmental Science & Technology, 54(11), 6997-7007. https://doi.org/10.1021/acs.est.0c01590

Warner, M., Zhang, X., & Rivas, M. (2020). Which states and cities protect residents from water shutoffs in the covid-19 pandemic?. Utilities Policy, 67, 101118. https://doi.org/10.1016/j.jup.2020.101118

White, S., Kuper, H., Itimu-Phiri, A., Holm, R., & Biran, A. (2016). A qualitative study of barriers to accessing water, sanitation and hygiene for disabled people in malawi. Plos One, 11(5), e0155043. https://doi.org/10.1371/journal.pone.0155043

Widiarto, A., Fadli, M., Rahmawan, T., Putra, M., Al-Fatih, S., & Wibowo, A. (2023). The drafting of village regulations concerning the management of agricultural water resources. Journal of Community Service and Empowerment, 4(1), 18-24. https://doi.org/10.22219/jcse.v4i1.23906

Widyastuti, D. and Suprayitno, D. (2020). Effectiveness of kangkungan (ipomea crassicaulis) to reduce bod levels of tofu waste using the phytoremediator method. International Journal of Research and Studies Publishing, 10(10), 60-64.https://doi.org/10.29322/ijsrp.10.10.2020.p10611

Woodhouse, P. and Müller, M. (2017). Water governance—an historical perspective on current debates. World Development, 92, 225-241. https://doi.org/10.1016/j.worlddev.2016.11.014

Xu, N., Zhang, H., Lin, Z., Li, J., Liu, G., Li, X., ... & Zhu, J. (2021). A scalable fish-school inspired self- assembled particle system for solar-powered water-solute separation. National Science Review, 8(10). https://doi.org/10.1093/nsr/nwab065

Yavuz, N. (2021). The response of dry bean to water stress at various growth cycles in a semi-arid region. Selcuk Journal of Agricultural and Food Sciences, 35(2), 91-100.https://doi.org/10.15316/sjafs.2021.234

Zhang, X. and Xia, J. (2009). Coupling the hydrological and ecological process to implement the sustainable water resources management in hanjiang river basin. Science China Technological Sciences, 52(11), 3240-3248. https://doi.org/10.1007/s11431-009-0363-2

Zhang, X., Warner, M., & Grant, M. (2022). Water shutoff moratoria lowered covid-19 infection and death across U.S. states. American Journal of Preventive Medicine, 62(2), 149-156. https://doi.org/10.1016/j.amepre.2021.07.006

Zhao, Z., Wang, H., Bai, Q., Wu, Y., & Wang, C. (2020). Quantitative analysis of the effects of natural and human factors on a hydrological system in the Zhangweinan Canal basin. Water, 12(7), 1864. https://doi.org/10.3390/w12071864

Zhou, C., Yu, L., Zhou, Y., & Liu, Y. (2019). Hydrological and ecological effect of Caohai watershed regulation project based on swat model. Applied Ecology and Environmental Research, 17(1), 427-436. https://doi.org/10.15666/aeer/1701_427436

Zindi, B. and Shava, E. (2022). COVID-19 and the attainment of sustainable development goal 6 (clean water and sanitation) in south africa. Journal of Local Government Research and Innovation, 3. https://doi.org/10.4102/jolgri.v3i0.58