environmental sciences proceedings

MDPI

Proceeding Paper

Water Security and Environmental Impact Assessment: A Study for Developing Economies †

Muhammad Bilal [1], Muhammad Usman [1], Mehwish Nadeem [2] and Syyed Adnan Raheel Shah [3,*]

[1] Department of Agriculture, Forest and Range Management, Bahauddin Zakariya University, Multan 66000, Pakistan; bilal679.edu@gmail.com (M.B.); usmanisrite@gmail.com (M.U.)
[2] Department of Civil Engineering, Bahauddin Zakariya University, Multan 66000, Pakistan; mehwishnadeem@piet.edu.pk
[3] Department of Civil Engineering, NFC-Institute of Engineering & Technology, Multan 66000, Pakistan
* Correspondence: syyed.adnanraheelshah@uhasselt.be; Tel.: +92-300-791-4248
† Presented at the 7th International Electronic Conference on Water Sciences, 15–30 March 2023; Available online: https://ecws-7.sciforum.net/.

Abstract: Both ecosystems and human societies acknowledge the importance of water. The impact of human activities on both land and water has become more apparent due to various global changes. These include climate change, urbanization, socioeconomic development, and population growth. Although it is widely believed that water security is the key to sustainable development, studies on its evolution and various environmental factors are still in the early stages of development. This study aims to provide an overview of the concept. This concept aims to provide all people with safe water. It goes beyond merely providing adequate supplies to every person in the world, and it also aims to ensure healthy and productive lives. Despite the technological advancements being made in the water resource management industry, the lackadaisical approach to addressing the various challenges associated with water security continues to be a major issue globally. This study will provide an overview of the various facets of the water security concept and its evolution in developing countries due to the environmental changes that have occurred. It also explores the multiple sustainable methods that can be used to address these issues.

Keywords: water security; water scarcity; climate change; socioeconomic changes; sustainable development

Citation: Bilal, M.; Usman, M.; Nadeem, M.; Shah, S.A.R. Water Security and Environmental Impact Assessment: A Study for Developing Economies. *Environ. Sci. Proc.* **2023**, *25*, 90. https://doi.org/10.3390/ECWS-7-14325

Academic Editor: Luis Garrote

Published: 3 April 2023

1. Introduction

Water is essential for everyone and the basis of life. Global freshwater is under tremendous anthropogenic strain [1], which is primarily caused by human population expansion and climate change. Freshwater availability and distribution, as well as the effects of water-related disasters such as floods and droughts, are projected to change because of climate change, which will also likely increase the demand for river water [2] and have an effect on groundwater availability [3]. Water security, a perennial human problem, has consequently emerged as a crucial area of policy for the Anthropocene [4,5]. Whether originally seen from a biophysical or sociological standpoint, the concept of "water security" is complicated, contentious, and dynamic. To define and realize it, complex and dynamic thinking or adaptive thinking is required. As part of the transition from water government to water governance, adaptive approaches to water management and governance have been pushed for at least three decades [6].

Assessments of economic development, ecological services [4], and their interaction [7,8] prominently include water challenges. However, assessments of water resources on a global scale [9] frequently use data that are fragmented and expressed as statistics at the country level, which severely restricts the attempts to prioritize their preservation and restoration [10]. Although there is a clear demand, high-resolution spatial analyses have

not yet been used in the official assessment process for freshwater resources [9]. This is despite the fact that they have advanced understanding of the human impact on the world's oceans [11,12] and the human imprint on land [13]. Finding a balance between the use of human resources and the preservation of ecosystems is essential to the success of integrated water management strategies [9,14–16]. Systematic accounting is necessary to evaluate how far this target has come in the world and to determine how valuable it might be in the future.

Climate change, population growth, and economic development are all contributing factors to the increasing vulnerability of water resources to variable and extreme flows. These changes can also affect the availability and use of water. These have also had an impact on water-dependent ecosystems' ability to provide ecosystem services. Satisfying human demands is frequently achieved at the expense of the environment [14,17], with long-term consequences for socioecological systems as a whole. Water issues can often—but not always—be traced to governance shortcomings as opposed to the state of the resource base itself. Governmental failures range in scope from the local to the global, are numerous, and have diverse effects on industrialized and developing nations. Additionally, they are impacted by factors that operate concurrently at several levels of governance [18]. Poor governance, which includes a lack of efficiency and effectiveness of current resource-constrained governing systems, allegations of corruption, and the absence of civil society, pose challenges for all forms of development in many developing nations [7,19]. The lack of resources is a problem for emerging nations regardless of their institutional, economic, or physical conditions. In fact, some are regarded as failed states. Most of these nations have failed to provide for fundamental human needs as well as the demands of their own civilizations in terms of health and education and there is paradigm change in water management [20]. Many industrialized nations, however, struggle with the excessive regulation brought on by stiff bureaucracy, industry fragmentation, unsustainable consumption patterns, and a general preference for economic over environmental concerns [21].

The complexity of water systems' interconnections is often accompanied by uncertainties and risks. For instance, with difficult hydrology, which is characterized by the combination of flood vulnerability, natural aridity, and significant intra- and interannual variability, the interconnections become more complex. The complexity of the water systems' interconnections increases the risk that they will not be able to meet their customers' needs. This is especially true in developing regions, where the lack of resources and infrastructure is the most common issue [22].

This study covers the water security issue and environmental impact assessment for developing continents. It explores the utilization of water and the right to secure water with reference to continent-wise populations.

2. Materials and Methods

Water security is a critical issue that affects populations across the world. Different continents face different challenges when it comes to water security, and a significant factor in this regard is the population and water share of each continent. Developing continents, such as Africa and Asia, face significant water security challenges due to their high population growth rates and limited access to freshwater resources. The following analysis provides an overview of the water security issues facing these continents based on their population and water share. So, the analysis included comparative assessment of continents to evaluate the share of each continent. This analysis was based on the population and the freshwater availability in different continents. However, a framework can be utilized to analyze the water security issue as shown in Figure 1. The critical factors can be population, the density of the population, and the available freshwater percentage. Africa has a population of over 1.3 billion people, and the continent is home to some of the fastest-growing economies in the world. However, despite its vast water resources, Africa faces significant water security challenges due to its limited access to freshwater.

Similarly, Asia is the most populous continent in the world, with a population of over 4.6 billion people. The region is home to some of the fastest-growing economies and is facing significant water security challenges due to its high population growth rates and limited access to freshwater resources. The average water availability per capita in Asia is just 3920 cubic meters, well below the global average. So, these continents are critical for analysis and study.

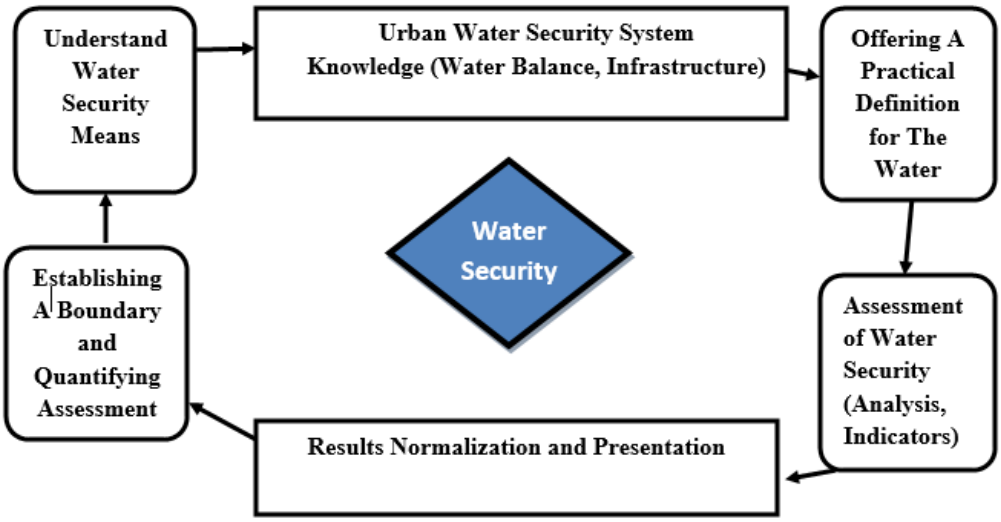

Figure 1. Methodology framework.

3. Results and Analysis

The increasing economic growth and standards for water-secure continents have changed the societal measures of the risk associated with water-related issues. This has resulted in the emergence of competing environmental and social tradeoffs that are becoming more challenging to manage.

Water consumption is different in different continents, based on the freshwater availability according to their population. Asia is a major portion of land consisting of higher freshwater density than other continents. It is more than the entire calculation for Africa, Australia, Europe, and the Americas, respectively, which was 8%, 7%, 13%, and 26% + 11% of the total, as shown in Figure 2.

Developing countries often face challenges in managing their limited water resources and balancing economic development with environmental protection.

In developing countries, access to clean and reliable water can be limited due to a lack of infrastructure and investment. This can lead to water scarcity and increased competition for resources, which can exacerbate existing social and economic inequalities. The statistics shown in Table 1 explain that freshwater availability is a major issue in Africa, which covers the majority of underdeveloped countries.

Table 1. Water consumption with respect to the population of continents.

Continent	World Population%	Density (p/km^2)	Fresh Water%
Asia	59.54%	150	35
Africa	17.2%	45	8
Australia	0.55%	5	7
South America	5.53%	25	26
North America	7.6%	28	11
Europe	9.59%	34	13

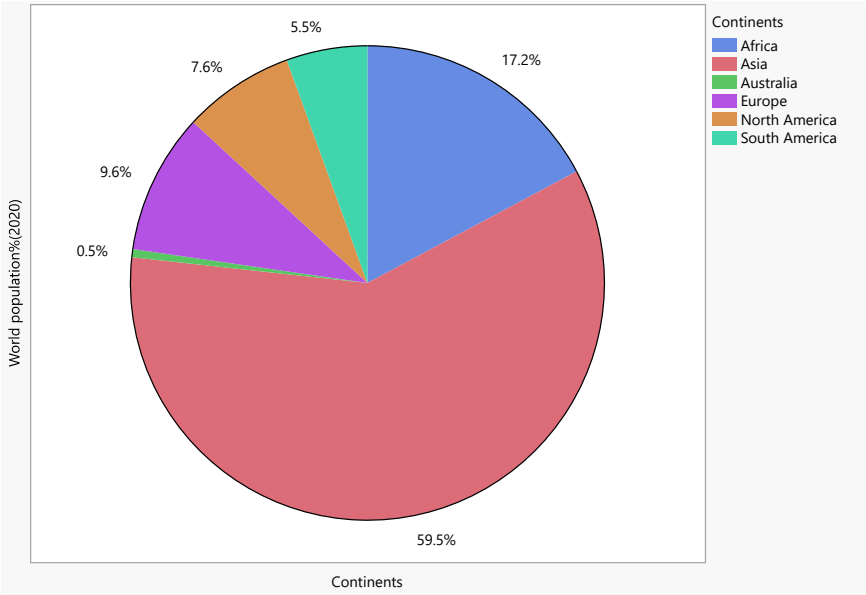

Figure 2. World population in different continents.

Water security is a significant issue in Africa, as many countries on the continent face challenges in managing their limited water resources and providing access to clean and reliable water for human and environmental needs.

One of the main challenges facing Africa is the high level of water scarcity on the continent, as shown in Figure 3. Many countries have limited water resources, and as populations grow and economies develop, competition for water resources is increasing. Climate change is also exacerbating this problem, as it leads to changes in precipitation patterns, increased evaporation, and more extreme weather events, all of which can impact water availability.

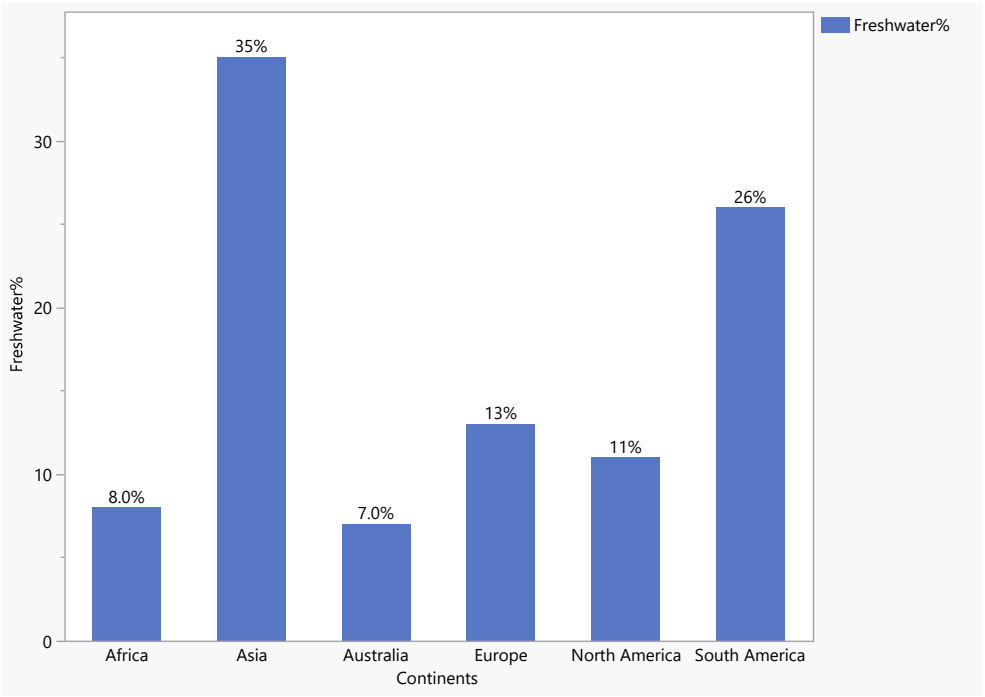

Figure 3. Division of the population and fresh water in the world, by continent.

Further study, the application of fresh science-based approaches, and the adoption of integrated water resources management concepts are all necessary to meet these challenges and sustainably resolve the diverse water-related problems. Understanding and managing water availability and quality is crucial everywhere but especially in developing nations.

4. Discussion

This study demonstrates that freshwater systems are directly endangered by human activities and could be further impacted by anthropogenic climate change; water is often regarded as the most important of all natural resources. Because freshwater is a limited resource, many countries around the world are experiencing water scarcity as water demand rises. Many countries have developed national and regional water management plans to address the growing water crisis. We discovered that nearly 80% of the world's population (4.8 billion) lives in areas where the human water security threat exceeds the 75th percentile (for 2000). Due to the intense agriculture and dense population, the USA, almost all of Europe, and significant sections of central Asia, the Middle East, the Indian subcontinent, and eastern China have a high incident hazard. Central Mexico, Cuba, North Africa, Nigeria, South Africa, Korea, and Japan all have smaller contiguous zones with a high threat of occurrence. The world's growing population is the primary cause of contaminated water. A large portion of fresh water is used in agricultural practices, which also causes a drop in the groundwater level. The 'global' imperative is a recent addition to the discourse of water security. Both the International Water Resources Association (IWRA) and the World Water Congress (WWC) are currently promoting a water strategy for global and continental water security that promotes adaptive approaches and Integrated Water Resources Management.

5. Conclusions

For these problems to be successfully solved, it is necessary to conduct additional research, implement new scientifically based approaches, and support the principles of integrated water resources management. Especially for the African and Asian continents, it is necessary to review the water security policy. Understanding and managing water availability and quality is crucial everywhere but especially in developing nations. Without first achieving a water-secure world, it will not be possible to achieve the United Nations Sustainable Development Goals 2030.

Author Contributions: Conceptualization, M.B.; Data curation: M.U.; Formal analysis: M.B.; Methodology: M.U.; Validation; M.N. and S.A.R.S.; Writing—Original draft: M.B.; Writing—Review and Editing, M.U. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data are available on suitable demand.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Rockström, J.; Steffen, W.; Noone, K.; Persson, Å.; Chapin, F.S.; Lambin, E.F.; Lenton, T.M.; Scheffer, M.; Folke, C.; Schellnhuber, H.J.; et al. A safe operating space for humanity. *Nature* **2009**, *461*, 472–475. [CrossRef] [PubMed]
2. Tir, J.; Stinnett, D.M. Weathering climate change: Can institutions mitigate international water conflict? *J. Peace Res.* **2012**, *49*, 211–225. [CrossRef]
3. Mitchell, M.; Curtis, A.; Sharp, E.; Mendham, E. Directions for social research to underpin improved groundwater management. *J. Hydrol.* **2012**, *448*, 223–231. [CrossRef]
4. Vörösmarty, C.J.; McIntyre, P.B.; Gessner, M.O.; Dudgeon, D.; Prusevich, A.; Green, P.; Glidden, S.; Bunn, S.E.; Sullivan, C.A.; Liermann, C.R.; et al. Global threats to human water security and river biodiversity. *Nature* **2010**, *467*, 555–561. [CrossRef] [PubMed]

5. Cook, C.; Bakker, K. Water security: Debating an emerging paradigm. *Glob. Environ. Change* **2012**, *22*, 94–102. [CrossRef]
6. Pahl-Wostl, C. Transitions towards adaptive management of water facing climate and global change. *Water Resour. Manag.* **2007**, *21*, 49–62. [CrossRef]
7. Sullivan, C.; Meigh, J. Targeting attention on local vulnerabilities using an integrated index approach: The example of the climate vulnerability index. *Water Sci. Technol.* **2005**, *51*, 69–78. [CrossRef] [PubMed]
8. Esty, D.C.; Emerson, J.W. From crises and gurus to science and metrics: Yale's Environmental Performance Index and the rise of data-driven policymaking. In *Routledge Handbook of Sustainability Indicators*; Routledge: London, UK, 2018; pp. 93–102.
9. UNESCO; World Water Assessment Programme (United Nations). *UN-Water: Water in a Changing World*; United Nations: New York, NY, USA, 2009.
10. Vörösmarty, C.J.; Green, P.; Salisbury, J.; Lammers, R.B. Global water resources: Vulnerability from climate change and population growth. *Science* **2000**, *289*, 284e288. [CrossRef] [PubMed]
11. Halpern, B.S.; Walbridge, S.; Selkoe, K.A.; Kappel, C.V.; Micheli, F.; d'Agrosa, C.; Bruno, J.F.; Casey, K.S.; Ebert, C.; Fox, H.E.; et al. A global map of human impact on marine ecosystems. *Science* **2008**, *319*, 948–952. [CrossRef] [PubMed]
12. Halpern, B.S.; Ebert, C.M.; Kappel, C.V.; Madin, E.M.; Micheli, F.; Perry, M.; Selkoe, K.A.; Walbridge, S. Global priority areas for incorporating land–sea connections in marine conservation. *Conserv. Lett.* **2009**, *2*, 189–196. [CrossRef]
13. Sanderson, E.W.; Jaiteh, M.; Levy, M.A.; Redford, K.H.; Wannebo, A.V.; Woolmer, G. The human footprint and the last of the wild: The human footprint is a global map of human influence on the land surface, which suggests that human beings are stewards of nature, whether we like it or not. *BioScience* **2002**, *52*, 891–904. [CrossRef]
14. Vidal, F.; Sedan, D.; D'Agostino, D.; Cavalieri, M.L.; Mullen, E.; Parot Varela, M.M.; Flores, C.; Caixach, J.; Andrinolo, D. Recreational exposure during algal bloom in Carrasco Beach, Uruguay: A liver failure case report. *Toxins* **2017**, *9*, 267. [CrossRef] [PubMed]
15. Koetz, T.; Farrell, K.N.; Bridgewater, P. Building better science-policy interfaces for international environmental governance: Assessing potential within the Intergovernmental Platform for Biodiversity and Ecosystem Services. *Int. Environ. Agreem. Politics Law Econ.* **2012**, *12*, 1–21. [CrossRef]
16. Dudgeon, D.; Arthington, A.H.; Gessner, M.O.; Kawabata, Z.I.; Knowler, D.J.; Lévêque, C.; Naiman, R.J.; Prieur-Richard, A.-H.; Soto, D.; Stiassny, M.L.J.; et al. Freshwater biodiversity: Importance, threats, status and conservation challenges. *Biol. Rev.* **2006**, *81*, 163–182. [CrossRef] [PubMed]
17. Zeggini, E.; Scott, L.J.; Saxena, R.; Voight, B.F.; Marchini, J.L.; Hu, T.; de Bakker, P.W.; Abecasis, G.R.; Almgren, P.; Andersen, G.; et al. Meta-analysis of genome-wide association data and large-scale replication identifies additional susceptibility loci for type 2 diabetes. *Nat. Genet.* **2008**, *40*, 638–645. [CrossRef] [PubMed]
18. Gupta, G.; Tarique, K. Prevalence of Musculoskeletal Disorders in Farmers of Kanpur-Rural. *India. J. Community Med. Health Educ.* **2013**, *3*, 2161-0711. [CrossRef]
19. Pahl-Wostl, C.; Lebel, L.; Knieper, C.; Nikitina, E. From applying panaceas to mastering complexity: Toward adaptive water governance in river basins. *Environ. Sci. Policy* **2012**, *23*, 24–34. [CrossRef]
20. Pahl-Wostl, C.; Jeffrey, P.; Isendahl, N.; Brugnach, M. Maturing the new water management paradigm: Progressing from aspiration to practice. *Water Resour. Manag.* **2011**, *25*, 837–856. [CrossRef]
21. Orlowsky, B.; Hoekstra, A.Y.; Gudmundsson, L.; Seneviratne, S.I. Today's virtual water consumption and trade under future water scarcity. *Environ. Res. Lett.* **2014**, *9*, 074007. [CrossRef]
22. Grey, D.; Sadoff, C.W. Sink or swim? Water security for growth and development. *Water Policy* **2007**, *9*, 545–571. [CrossRef]