2024 i-WSSM Regional Report on Water Security

unesco
Centre
Under the auspices
of UNESCO

i-WSSM
International Centre for
Water Security and
Sustainable Management
유네스코 물 안보 및 지속가능 물 관리
국제연구교육센터

> The title of this report, '2024 i-WSSM Regional Report on Water Security,'
> represents the year of the data collection and key activities discussed within its chapters.
> While these findings focus on the year 2024, the report itself was published
> in January 2025 to ensure thorough analysis and review.

2024 i-WSSM Regional Report on Water Security

Published by	i-WSSM, 883, Gongnyong-ro, Songsan-myeon, Hwaseong-si, Gyeonggi-do, Republic of Korea
Published in	January 2025
Executive Publisher	Bongwoo Shin
Edited by	Sooyoung Park, Yeong-gwang Oh
Layout and Design	Taeilsa

2024 i-WSSM Regional Report on Water Security

Contents

2024 i-WSSM Regional Report
on Water Security

Regional Report. 3

Kenya

Challenges, Ongoing Efforts and Innovative Practices in Groundwater Management in Kenya:
Towards Sustainable Water Use

By Sharlet Alice Ndede

Geologist, Regional Centre on Groundwater Resources Education, Training, and Research

Regional Report. 4

Bangladesh

Water Security & Women:
A Case Study in a Floating Slum of Dhaka City, Bangladesh

By Sumaiya Binte Islam, M.Sc.

Master of Science in Water Resource Development, Bangladesh University of Engineering and Technology

Assistant Engineer of Dhaka Water Supply & Sewerage Authority

Regional Report. 5

Kyrgyzstan

Sustainable Water and Energy Management in Central Asia:
International Cooperation and Experience

By. Atai Namatbaev

Kyrgyzstan Resident Fellow
Korea-Central Asia Cooperation Forum Secretariat
The Korea Foundation

Foreword

2024 i-WSSM
Regional Report
on Water Security

Water is essential for life. This universal truth resonates profoundly throughout this report, which highlights the intricate interplay between water resources, climate resilience, gender equality, and sustainable development. From Bolivia's strategies for managing hydrological extremes in the Andes to Nepal's efforts to integrate gender perspectives into water governance, each chapter emphasizes the critical need for local solutions to tackle global challenges. In Kenya, we observe advancements in groundwater management, while the experiences of Kyrgyzstan demonstrate how regional cooperation can transform water conflicts into opportunities for prosperity. The case study from Bangladesh illuminates the intersection of water security and social equity, particularly among marginalized communities.

This report exemplifies the mission of the International Centre for Water Security and Sustainable Management (i-WSSM) to serve as a catalyst for knowledge exchange and international cooperation by bringing together diverse voices and insights that underscore the collective nature of water challenges and the critical importance of inclusive, equitable, and sustainable solutions.

As you explore these pages, I encourage you to reflect on the stories and strategies presented here and to join us in cultivating a world where water security is a reality for everyone. Together, we can build a more resilient, inclusive, and sustainable future.

With sincere gratitude,

Bongwoo Shin

Director
International Centre for Water Security and
Sustainable Management (i-WSSM) under the auspices of UNESCO


Sustainable Water and Energy Management
in Central Asia:
International Cooperation and Experience
Kyrgyzstan
Nepal
Bangladesh
Kenya
Boliva
Nepal's Reports
on Water Security,
Gender and WASH
Water Security Transitions
in Bolivia under a Context of
Climate Change
Challenges, Ongoing Efforts and
Innovative Practices in Groundwater
Management in Kenya:
Towards Sustainable Water Use
Water Security & Women:
A Case Study in a Floating Slum
of Dhaka City, Bangladesh

Regional Report. 1

Boliva

Water Security Transitions in Bolivia under the Context of Climate Change

By. Marco A. Limachi Cahuaya, M.Sc.

Email: antonio.limachi@gmail.com

Master of Science in Water Resources Management at Yeungnam University, South Korea.

Appointed on official commission by the National Meteorology and Hydrology Service (SENAMHI) - Ministry of Environment and Water of Bolivia (MMAyA). 2023-2024.

1. Introduction

The Plurinational State of Bolivia acknowledges that water resources, in all their forms, are finite, vulnerable, and strategically significant. These resources serve essential social, cultural, and environmental functions. Consequently, the State bears the responsibility to formulate plans for the utilization, conservation, management, and exploitation of water resources. Furthermore, the climatic conditions across Bolivia's national territory exhibit considerable variability in both extent and spatial scale, complicating the feasibility of conducting a comprehensive analysis of the diverse hydro-climatic conditions present (CPE, 2009).

Bolivia is situated within three continental basins: the Endorheic Region (Region 0), the Amazon Region (Region 4), and the La Plata Region (Region 8), all of which encompass areas within Bolivian territory (see Figure 1). Additionally, Bolivia has a minor hydrological connection to the Pacific Ocean, exemplified by the Silala River (Lehner & Grill, 2013).

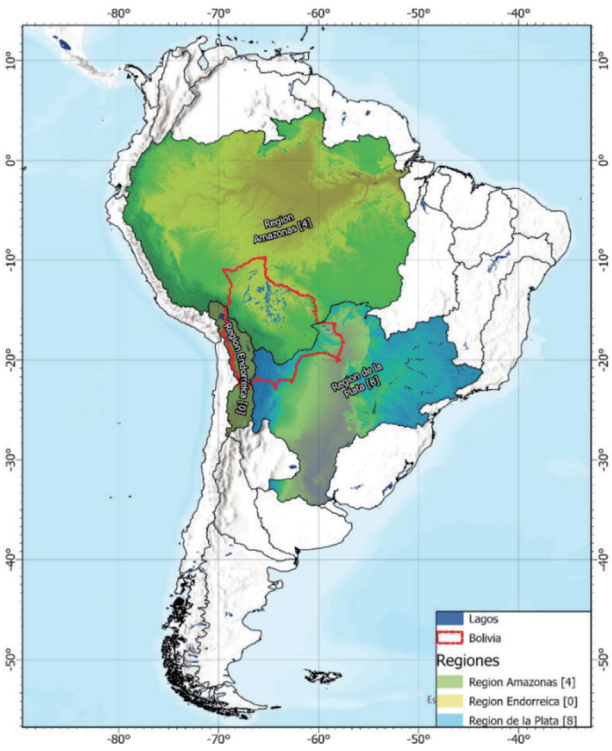


Figure 1. Bolivia within the framework of Level 1 hydrographic regions in South America (Source: Adapted from data generated by HydroBASINS4, MMAyA 2024)

Amazon River or Northern Basin

The area encompasses 724,792 km², accounting for 65.61% the total The rivers within the basin typically exhibit meandering flows, which results in the formation of numerous lagoons, including Murillo Lagoon, located in the Pando department (see Figure 2). The main principal tributary in Bolivia, the Mamoré River, extends for 2,000 km and flows northward until it converges the Beni River, which measures 1,113 km long. The average annual rainfall precipitation in this part of region was recorded at 1,814 mm/year (HydroBASINS & G., 2009).

La Plata or the Southern Basin

The area encompasses 225,492 km², which constitutes 20.53% of the total territory (see Figure 2). The tributaries in this region are generally less abundant compared to those of the Amazon River. The primary rivers include the Paraguay, Pilcomayo, and Bermejo. Notable lagoons in this area are Uberaba and Mandioré, both situated in the Bolivian Pantanal region. The average annual precipitation in this part of the territory is 854 mm/year (HydroBASINS & G., 2009).

Endorheic or Lacustrine Basin

The Altiplano encompasses an area of 151,722 km², accounting for 13.81% of the total territory (see Figure 2). This region is characterized by a significant number of rivers, lakes, lagoons, and springs that do not discharge into the ocean, as they are confined by the Andean Mountain Range that delineates the area. The most prominent river in the Altiplano is the Desaguadero, which, at 436 km in length, is the longest river within this region (see Figure 3).

The river originates in Lake Titicaca, which is situated at an elevation of 3,810 meters above sea level and flows southeast into Lake Poopó, located at an elevation of 3,686 meters above sea level. This hydrological system is comprised of Lakes Titicaca and Poopó, the River Desaguadero, and extensive salt flats, including Coipasa and Uyuni. The average annual precipitation in this region is 421 mm (HydroBASINS & G., 2009).

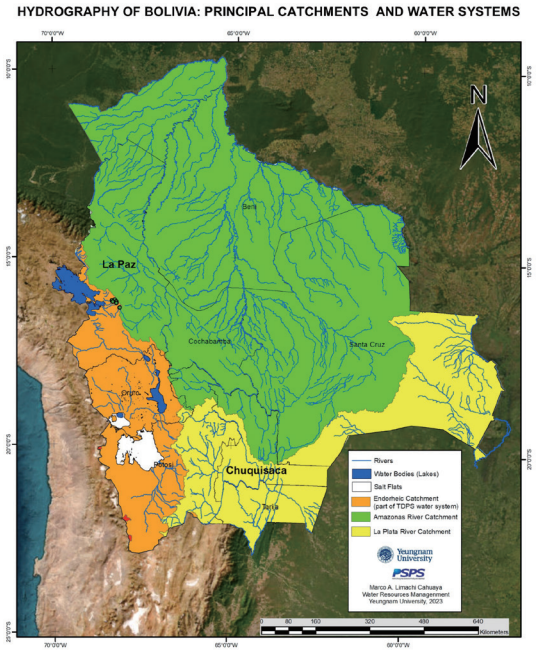


Figure 2. Bolivia exhibiting three continental basins (Source: Marco A. Limachi Cahuaya, based on data from Geo Bolivia, 2023).

The Titicaca-Desaguadero-Poopó-Salar de Coipasa (TDPS) system is classified as a closed or endorheic system. Furthermore, the organization responsible for the regulation and monitoring of the TDPS system is the Lake Titicaca Binational Authority (ALT). The most recent study conducted by the ALT referred to as the Master Plan, was completed in 1993, and since that time, the data about the water balance have not been updated.

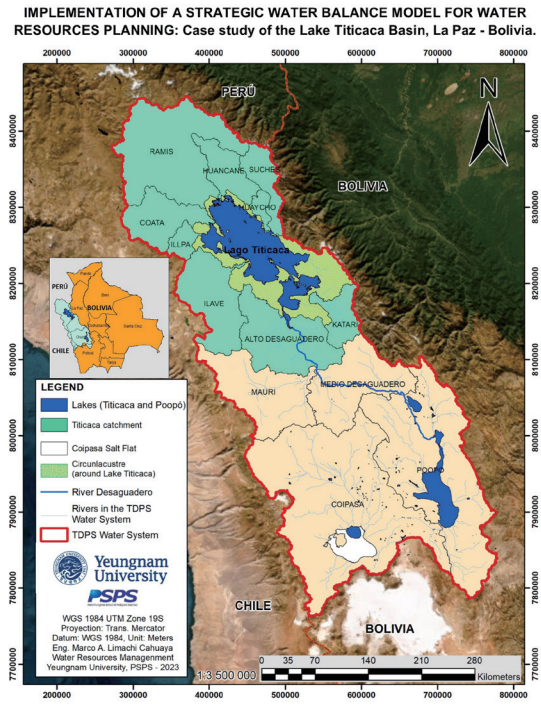


Figure 3. Endorheic or Lacustrine Basin Component of the TDPS.

2. Current Status

Bolivia is among the countries most significantly impacted by the effects of climate change. This phenomenon disrupts the hydrological cycle, resulting in heightened water scarcity, as well as an increase in floods, prolonged droughts, and other extreme weather events. In light of the escalating water crises and associated conflicts, the Bolivian government is keen to obtain support for its initiatives aimed at managing water resources in an efficient manner that is sensitive to the challenges posed by climate change.

The impacts of global climate change on freshwater systems are anticipated to be profound. According to the most recent assessment by the Intergovernmental Panel on Climate Change (IPCC), there is a predicted increase in the risk of significant flooding, a decline in the availability of renewable water resources, and a deterioration in water quality. This situation is likely to exacerbate competition for water across various sectors, including agriculture, ecosystems, urban settlements, industry, and energy production, thereby threatening water, food, and energy security in specific regions. Furthermore, it may lead to heightened tensions between nations regarding water management practices (Klare, M., 2020).

Water is essential to Bolivia's national climate change development objectives. Adequate water resources are necessary to guarantee universal access to basic services, enhance food security, and facilitate the decarbonization of the energy sector. However, Bolivia is currently facing a water crisis characterized by limited supply and increasing demand driven by population growth and heightened water usage in agriculture, industry, and the energy sector. The government aims to elevate the proportion of electricity generated from hydropower plants to 70 percent by 2025 and to expand the irrigated area from approximately 520,000 hectares in 2020 to over 1 million hectares by 2030. Additionally, there are plans to develop lithium mining, which will also require water for extraction and processing purposes.

Simultaneously, climate change is exerting additional pressure on water resources. In certain regions of the Altiplano, as well as in the valleys and El Chaco in the southeastern part of the country, the situation of water scarcity is deteriorating due to alterations in weather patterns, an increase in the frequency of droughts (see Figure 4), and the retreat of glaciers. Conversely, the northeastern plains of Bolivia are becoming increasingly susceptible to flooding. Climate data reveal that the Bolivian Andes are experiencing a rate of warming that is significantly higher than the global average, and climate models predict that this trend will persist, ultimately leading to the disappearance of glaciers and the consequent loss of vital water sources for the Altiplano. Furthermore, water quality is jeopardized by factors such as mining activities, deforestation, urbanization, and the discharge of untreated sewage.

Despite the escalating pressures exerted by climate change on the water systems of Bolivia, significant modifications have been implemented within the country's legal and institutional water framework over the past two decades. Many of these alterations were catalyzed by 2000 as a series of protests were ignitedby the rise in water tariffs following the privatization of the Cochabamba water utility. Notable changes include the establishment of the Ministry of Environment and Water (MMAyA), which is tasked with over-

Figure 4. illustrates that the River Desaguadero exhibits significantly low water levels, which adversely impacts the flow that drains downstream into Lake Poopó, an endorheic or lacustrine basin. Source: Limachi Cahuaya, M. A. (2023).

seeing water policy at the national level, as well as the formal acknowledgment of traditional water management practices (Perreault, T., 2008).

The Bolivian government has implemented integrated water resources management (IWRM), a widely recognized decision-making approach that fosters the coordinated development and management of water, land, and associated resources across all watersheds. Additionally, Bolivia has embraced a complementary strategy known as integrated river basin management (IRBM), which emphasizes the sustainable utilization of land and other natural resources within watersheds. Within the existing policy framework, both IWRM and IRBM are regarded as essential components for attaining water security.

3. Vision and Primary Challenge

Although modifications in water management strategies in Bolivia since the Water War[1)] have contributed to the resolution of certain issues related to equity, productivity, and sustainability, inequities and challenges continue to exist (Water War of 2000). These issues stem from both enduring problems inherited from prior management systems and new challenges arising from the power dynamics established by the current system. Adopting a just transition approach may help identify and address these inequities and challenges.

Access to Water

Efforts have been made to provide all Bolivians with access to clean water, whether in rural upstream areas or urban downstream environments. While progress has been observed, challenges remain in ensuring that water access is both equitable and sustainable. For instance, Farmers can enhance their resilience to climate change through adequate infrastructure, training, and advanced technology; however, disparities persist in distributing and managing these resources.

1) The Bolivia Water War was a series of protests in Cochabamba in 2000, triggered by the privatization of the city's water supply and increased tariffs by Aguas del Tunari, a multinational subsidiary. The protests highlighted issues of water access and governance, leading to violent clashes and the cancellation of the privatization contract. This event raised global awareness of water as a human right and prompted significant reforms in Bolivia's water management, including the creation of the Ministry of Environment and Water and the integration of traditional practices into national policies.

Water distribution systems throughout Bolivia are highly fragmented, encompassing a spectrum from small-scale, community-managed networks to large-scale, publicly administered infrastructure. This fragmentation complicates the coordinated planning and implementation of necessary reforms to address water security challenges. Marginalized communities, in particular, often encounter significant barriers, including limited access to natural resources, weak social networks, and inadequate educational opportunities, which hinder their ability to influence decision-making processes or advocate for change.

Moreover, there is an urgent need for high-quality hydro-meteorological data to inform water management strategies and support effective adaptation to climate change. Strengthening data systems and ensuring the inclusion of vulnerable groups in decision-making processes are essential steps toward reducing inequalities and enhancing Bolivia's resilience to water-related challenges.

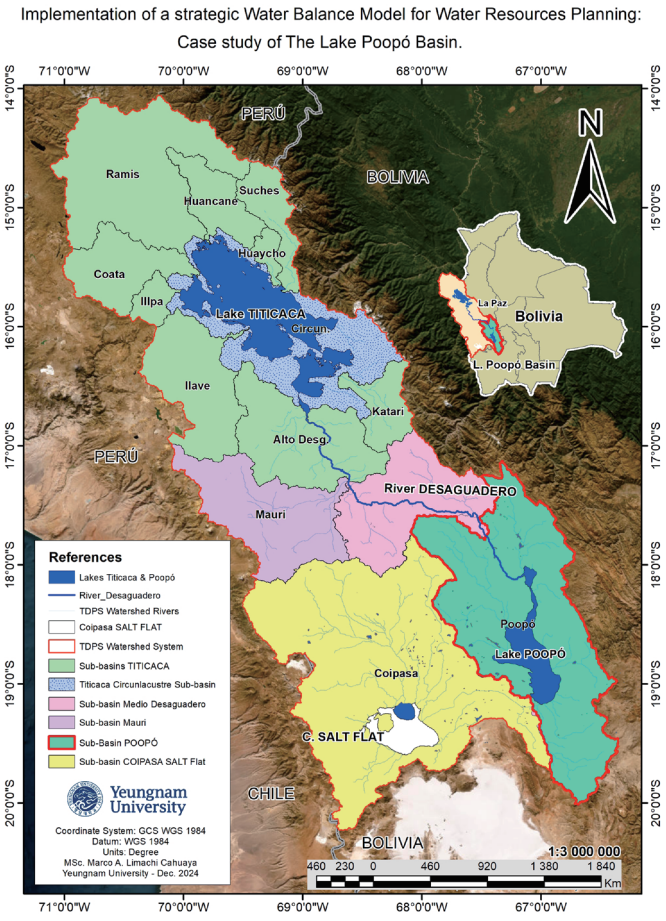


Figure 5. Area of Analysis for the TDPS Water System.

In the TDPS (Titicaca–Desaguadero–Poopó–Salares) System, the regional rivers are predominantly intermittent, connecting Lake Titicaca and Lake Poopó primarily during the rainy season. Throughout the remainder of the year, the limited water flow results in the formation of small deltas at the outlets of the basins situated in the eastern mountainous region. The rainfall pattern is concentrated between December and March, which only partially meets the high evaporation demands of the water surface.

The contribution of Lake Titicaca is significantly seasonal, primarily due to the regulatory structures constructed at its outlet. However, the Binational Authority of Lake Titicaca (ALT) has conducted numerous studies on the hydrology and regulation of the system, asserting that it possesses the requisite tools for effective management. For further details, please refer to Figure 5 (Limachi, M.A., 2024).

The Quality of Water

Activities that contribute to pollution continue to pose a significant challenge, despite ongoing efforts to mitigate their impacts. Restoring watersheds is essential for improving access to clean water for communities and enhancing resilience to climate change.
However, the enforcement of environmental laws and regulations remains inadequate. Extractive industries, which significantly contribute to economic growth and serve as a major source of tax revenue, often take precedence over environmental considerations. Furthermore, there is a lack of awareness regarding the broader environmental and social impacts of industrial and technological processes, including those associated with clean energy value chains. Both domestic and international ethical standards must be strengthened to ensure sustainable practices across all sectors.

Disputes over Water Resources

Institutional and legal frameworks have been established in Bolivia to promote the equitable distribution of water among various sectors, user groups, and ecosystems, even during periods of scarcity. However, the lack of a comprehensive and up-to-date water law to govern usage across all sectors in an integrated manner presents significant challenges. This legal gap results in ambiguity regarding institutional responsibilities, undermines inter-agency coordination, and exacerbates water management issues, particularly in rural areas where historical and structural disparities heighten tensions surrounding water allocation.

Traditional water usage customs are often utilized by communities as a negotiating tool to assert their historical rights and cultural significance in water management. These practices are frequently referenced to claim priority access to resources, resist reforms, or influence policy decisions beyond the water sector. While such strategies can empower marginalized groups by generating moral and social pressure, they may also obstruct constructive dialogue and delay necessary reforms. To address these tensions, efforts must balance structural reforms with the recognition of local and traditional knowledge, while also strengthening institutional frameworks, clarifying roles, and fostering inclusive decision-making to achieve equitable and sustainable water management.

Social Inclusion

Disadvantaged groups are increasingly encouraged to participate in all aspects of water management. Community organizations play a pivotal role in developing and implementing Basin Master Plans (BMPs), contributing to the identification of key issues, setting priorities, and monitoring their execution. Furthermore, efforts are being made to integrate local and traditional knowledge into the decision-making processes of water management.

However, significant barriers persist. Structural conditions, including patriarchal values and multidimensional poverty, restrict the capacity of many marginalized groups to participate meaningfully in water governance. Furthermore, overlaps or conflicts between the coordination mechanisms of IWRM and local management frameworks, such as irrigation associations or municipal authorities, can hinder efforts to achieve cohesive and inclusive water management.

The institutionalization of traditional water use practices has enhanced the capacity of certain rural communities to manage and control water resources. However, these advancements may inadvertently perpetuate existing inequalities, as they often favor farmers who already possess access to irrigation infrastructure. Furthermore, the absence of accessible and reliable climate data continues to pose a significant barrier to effective societal participation in water-related decision-making processes. Addressing these challenges is essential for achieving genuine social inclusion in water governance.

4. Recommendations and Actions

This report aims to provide recommendations that promote equitable transitions toward sustainable water management in Bolivia and beyond, thereby enhancing water security.

Establishing Assessment Frameworks for Equitable Transitions

To ensure equitable outcomes in policy and project implementation, it is essential to establish robust mechanisms for assessing the distributional effects of associated risks, losses, and benefits. These evaluations should utilize tailored indicators for ongoing monitoring and evaluation, both during and after implementation. While existing safeguard policies and frameworks provide foundational support, they often fall short in addressing the complexities of equitable transitions. A comprehensive approach is required to mitigate risks, minimize losses, and ensure a fair distribution of benefits among all affected stakeholders.

Addressing Root Causes of Inequality in International Equity Initiatives

Internationally funded projects often prioritize compensating groups affected by transition policies; however, this approach may overlook the root causes of marginalization and vulnerability, potentially exacerbating these issues over time. To achieve sustainable change, projects should be anchored in a comprehensive understanding of the local political economy, including the historical, institutional, and power dynamics that contribute to inequality. By emphasizing structural reforms and fostering local ownership, these initiatives can transcend superficial solutions to tackle systemic disparities, thereby promoting long-term resilience and empowerment for marginalized communities.

Strengthening Adaptive Capacity Through Improved Access to Climate Data

Enhancing the quantity, quality, and transparency of hydro-meteorological data and information systems, while also increasing their accessibility, can assist key institutions and communities in making more informed and inclusive decisions that promote equitable distribution of water resources.

Integrating Indigenous and Local Knowledge for Just Transitions

Supporting just transitions necessitates the acknowledgment and utilization of diverse knowledge sources, particularly those stemming from local communities and indigenous populations. Engaging with local knowledge, interests, values, and aspirations is essential for comprehending the challenges associated with just transitions and for identifying suitable responses.

This necessitates transcending exclusively top-down methodologies that predominantly depend on data as well as the perspectives of experts and government officials.

Balancing Mitigation and Adaptation in Just Climate Transitions

A just transition necessitates a comprehensive evaluation of the risks and opportunities associated with adaptation in relation to both national and international mitigation strategies, with the aim of equitably distributing costs and benefits.

This encompasses entities linked to projected rises in the demand for minerals and other natural resources, including biofuels, which may exert considerable pressure on water systems as the transition to a global low-carbon economy intensifies (SIE, 2023, Evaluation and Learning, Climate Investment Funds).

References

1. *CPE: Political Constitution of the State, Plurinational State of Bolivia, 2009.*
2. *HydroBASINS & Guide for the delimitation and codification of hydrographic units in Bolivia, 2009.*
3. *Klare, M., 2020. "Climate Change, Water Scarcity, and the Potential for Interstate Conflict in South Asia". Journal of Strategic Security 13 (4). doi:10.5038/1944-0472.13.4.1826.*
4. *Lehner, B., Grill G., 2013. Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. Hydrological Processes, 27(15): 2171–2186.*
5. *Limachi, M.A., 2024. Implementation of a strategic Water Balance Model (WEAP) for Water Resources Planning: Case study of the Lake Poopó Basin, Oruro - Bolivia.*
6. *Perreault, T., 2008. "Custom and Contradiction: Rural Water Governance and the Politics of Usos y Costumbres in Bolivia's Irrigators' Movement." Annals of the Association of American Geographers 98 (4): 834–54. doi:10.1080/00045600802013502.*
7. *SIE, 2023, Evaluation and Learning, Climate Investment Funds, Supporting just transitions to sustainable water sector. https://www.cif.org/evaluation-and-learning*

Nepal's Reports on Water Security, Gender and WASH

By Prativa Dawadi
prativadawadi777@gmail.com
Y-Adapt Facilitator Nepal Red Cross Society

1. Introduction

Nepal is a landlocked nation located between the majestic peaks of the Himalayas and the expansive plains of the Terai region in South Asia (see Picture 1). Despite its geographical diversity and rich water resources, Nepal encounters considerable challenges in water management and sustainability. The country ranks among the most water-abundant nations worldwide, featuring approximately 6,000 rivers that drain an area of about 194,471 km², with 74% of this area situated within its borders. Collectively, these rivers discharge an estimated 225 billion cubic meters of water annually, presenting significant potential for hydropower generation, irrigation, and domestic consumption. The theoretical hydropower potential of Nepal is estimated to be around 83,000 MW; however, only a small fraction of this potential has been harnessed to date.

Picture 1. Nepal Map

According to the 2021 National Population Census, the population of Nepal is approximately 29.29 million. However, the Ministry of Water Supply and Sanitation reports that only 27% of this population has access to safe drinking water. Although around 80% of the population has access to drinking water, a significant portion of it is deemed unsafe due to pollution and contamination.

Approximately 42% of Nepal's cultivated agricultural land is irrigated, which provides a crucial foundation for agricultural productivity. However, only 19% of these irrigated areas receive a reliable year-round water supply. This limitation presents a significant challenge to sustaining agricultural development and meeting the increasing demands for food.

The rugged terrain, fragile environment, geological characteristics, and monsoon climate of Nepal contribute to elevated rates of runoff, erosion, and sedimentation, which adversely affect the lower regions. Furthermore, increasing population pressure and the rising demand for water intensify these challenges.

Water Resource Strategy (WRS, 2002)

Nepal's Water Resource Strategy, which was introduced in 2002, is categorized into three distinct time frames.

- **Short-term (5 years):** Enhance access to water to fulfill the basic needs of the Nepalese population.
- **Medium-term (15 years):** Promote sustainable water utilization and improve living conditions.
- **Long-term:** Optimize the benefits derived from water resources while ensuring their sustainability.

Objectives of the WRS

- Mitigate poverty, unemployment, and underemployment.
- Ensure access to safe and sufficient drinking water and sanitation facilities in order to promote public health.
- Safeguard the environment and preserve biodiversity within natural habitats.
- Prevent and mitigate disasters caused by water.

Development Principles

The WRS framework emphasizes the necessity of aligning water resource development with sustainable social and economic progress. The core principles include:

- **Social Development**:
  - Ensure equitable participation of both men and women within the water sector.
  - Guarantee long-term food security for Nepal.
- **Environmental Sustainability:**
  - Prioritize the protection and management of the Churia, Siwalik, and Bhabar Zones to enhance forest cover, conserve soil, and promote groundwater recharge.
    soil conservation, and groundwater recharge.

2. Current Status

In Nepal, wetlands have demonstrated efficacy in mitigating water security challenges. Nevertheless, the escalating effects of climate change, pollution, rapid population growth, urbanization, contamination, and the proliferation of invasive species have rendered the situation increasingly precarious.

In the western region of Nepal, the Girls Matter Project facilitates access to safe water and sanitation for marginalized communities, with the objective of preserving the dignity of local residents (UNICEF, 2024). In a similar vein, the Municipality Level Vulnerability and Risk Assessment (MULVAR) Dashboard, created by the International Water Management Institute, evaluates vulnerabilities within the Water, Sanitation, and Hygiene (WASH) sector at the municipal level. This tool is instrumental in ensuring that the issues faced by marginalized communities are prioritized in significant policy discussions.

The Government of Nepal has enacted multiple policies aimed at promoting gender equality within the water sector. A notable achievement in this endeavor is the establishment of gender and social inclusion units across various ministries, which represents a significant advancement in the integration of a gender perspective into water resource management.

Research institutions, such as the International Water Management Institute, have conducted studies that underscore the necessity for targeted gender programming to address the dynamics of gender within the water sector. The findings indicate that local power structures and social relations require interventions that are specifically focused on gender. Additionally, various organizations are actively engaged in efforts to empower women to assume leadership roles in their communities concerning water management issues.

The Karnali Water Activity promotes safe water and sanitation initiatives through the installation of solar-powered lifting and gravity-flow water infrastructure. These initiatives are designed to improve security, enhance the quality of life, and bolster climate resilience for residents across Nepal's Karnali River Basin.

In Naulakot, a village located in the Kailali district of Nepal, water shortages represent a persistent challenge. Notably, even during the monsoon season, the availability of clean water remains limited. However, recent initiatives undertaken by the local administration in collaboration with Karnali Water Action have led to the establishment of solar water lifting stations. Consequently, every household and educational institution in the area now has access to clean water via individual taps (globalwater.org).

Nepal's agricultural sector is primarily dependent on rainfall, rendering it particularly susceptible to fluctuations in climate. Recent surveys suggest that:

- A total of 78.3% of households indicated a decrease in the number of rivulets and streams.
- Approximately 55% of households reported a decrease in the availability of wells, springs, and stone spouts, which can be attributed to inadequate rainfall and the prevalence of prolonged drought conditions.

Economic losses in the agricultural sector over the past five years are estimated to be 415.44 billion Nepalese rupees (NPR)[1)], underscoring the critical necessity for the implementation of resilient agricultural practices and the enhancement of irrigation infrastructure.

Nepal possesses significant hydropower potential, with ambitions to generate 30,000 megawatts (MW) by 2035. However, climate change poses considerable challenges to hydropower production. Climate-induced disasters, such as floods and landslides, have led to the destruction of infrastructure and negatively affected water availability for power generation.

Climate change has significant implications for the water resources of Nepal. There is a growing prevalence of extreme weather events, such as frequent floods and droughts. Over the past 25 years, households have reported observable changes in water resources attributed to climate variability.

- Approximately 44.87% of households reported experiencing the impacts of droughts.
- Approximately 13.87% of households reported experiencing the effects of flooding.

1) It is equivalent to approximately 3 billion USD.

These challenges highlight the necessity for adaptive strategies aimed at mitigating the impacts of climate change on water resources and ensuring long-term sustainability.

3. Challenges

- Lack of Public Awareness and Participation: There is a significant lack of public engagement and voluntary involvement in water management projects, often stemming from conflicts within these initiatives.
- Disproportionate Burden on Women: In both rural and urban areas, women predominantly shoulder the responsibility of fetching water. This task consumes a considerable amount of time, especially in low-income communities, thereby restricting women's opportunities for education and income-generating activities
- Weak Representation of Women in Water Governance: Policies designed to enhance women's participation in water governance, such as the 30% quota for women in local bodies responsible for managing water resources, have been implemented. Nevertheless, women's voices continue to be largely marginalized in decision-making processes.
- Intersectionality of Gender with Other Social Gender-related challenges are intricately linked to factors such as caste, ethnicity, and class. Women from marginalized groups encounter compounded barriers that restrict their access to water resources and exclude them from decision-making processes.
- Health and Hygiene Challenges: The lack of reliable access to clean water results in significant health and hygiene complications for women, heightening health risks and perpetuating social stigma.
- Infrastructure Challenges: Many regions lack adequate storage and distribution infrastructure, resulting in seasonal access issues. The existing systems are frequently outdated and poorly maintained.
- Urban vs. Rural Disparities: Urban areas experience significant water pollution and resource depletion as a result of rapid growth, whereas rural communities frequently contend with limited access to clean drinking water and sanitation facilities.

4. Recommendation

To address the challenges of water management and to promote sustainable and equitable practices, the following recommendations are proposed:

- Enhance Inclusive Participation: Strengthen community-based initiatives in water management by empowering local populations, particularly women, to actively engage in decision-making processes concerning water resources.
- Invest in Rainwater Collection and Groundwater Recharge: The government should increase investments in the development and promotion of rainwater harvesting systems and groundwater recharge initiatives to mitigate seasonal shortages and enhance resilience to climate change.
- Revise Existing Policies: Update policies to more effectively address gender issues and the impacts of climate change. Clearly define the roles of federal, provincial, and local authorities to enhance governance in the water sector.
- Promote Nature-Based Solutions: Implement initiatives for watershed restoration, reforestation, and soil conservation to ensure sustainable management of water resources.
- Provide Economic Incentives: Create incentives for farmers and industries to adopt sustainable water usage practices.
- Leverage Public-Private Partnerships (PPPs) to bridge the gap between public needs and private sector innovation, thereby fostering advancements in water management technologies.
- Adopt Advanced Sensor Technologies: Utilize sensor technologies and big data analytics to enhance the efficiency of monitoring both water quantity and quality.

References

1. *WWF Nepal. (n.d.). Water resources of Nepal: A strategic analysis.*
2. *Only 27 percent population has access to pure drinking water. (n.d.). https://myrepublica.nagariknetwork.com/news/only-27-percent-population-has-access-to-pure-drinking-water/*
3. *Water in crisis - Spotlight Nepal. (n.d.). The Water Project. https://thewaterproject.org/water-crisis/water-in-crisis-nepal*
4. *Asian Disaster Preparedness Center (ADPC). (2022). Water sector policies and guidelines of Nepal.*
5. *Water and Energy Commission Secretariat (WECS). (2011). Water resources and climate change. Water and Energy Commission Secretariat, Singha Durbar, Kathmandu, Nepal.*
6. *Strengthening water security, building climate resilience, and changing lives in Nepal | Globalwaters.org. (2024, June 10). Strengthening Water Security, Building Climate Resilience, and Changing Lives in Nepal | Globalwaters.org. https://www.globalwaters.org/resources/assets/strengthening-water-security-building-climate-resilience-and-changing-lives-nepal*
7. *Nepal's agriculture, water resources under climate threat. (2024, May 15). The Kathmandu Post. https://kathmandupost.com/money/2024/05/15/nepal-s-agriculture-water-resources-under-climate-threat*
8. *Government of Nepal, Ministry of Energy, Water Resources and Irrigation. (2023). Position paper for the UN 2023 Water Conference. Department of Water Resources and Irrigation, Kathmandu, Nepal.*
9. *Water and Energy Commission Secretariat (WECS). (2011). Response strategy for water resources management. Water and Energy Commission Secretariat, Singha Durbar, Kathmandu, Nepal.*
10. *Nepal, S., Neupane, N., Belbase, D., Pandey, V. P., & Mukherji, A. (2019). Achieving water security in Nepal through unravelling the water-energy-agriculture nexus. International Journal of Water Resources Development, 37(1), 67–93. https://doi.org/10.1080/07900627.2019.1694867*
11. *Government of Nepal, Office of the Prime Minister and Council of Ministers, National Statistics Office. (2024). National Climate Change Survey 2022. National Statistics Office, Ramshah Path, Thapathali, Kathmandu, Nepal.*
12. *UNICEF Nepal. (n.d.). Safe water, dignity. Retrieved January 13, 2025, from the UNICEF Nepal website. https://www.unicef.org/nepal/stories/safe-water-dignity*
13. *Unravelling gendered practices in Nepal's public water sector. (2020, September 28). Water, Land and Ecosystems. https://archive.iwmi.org/wle/thrive/2020/09/24/unravelling-gendered-practices-nepals-public-water-sector/index.html*
14. *Iwmi. (2023, November 22). Gender solutions for sustainable water management in Western Nepal - IWMI. International Water Management Institute (IWMI). https://www.iwmi.cgiar.org/blogs/gender-solutions-for-sustainable-water-management-in-western-nepal/*

Challenges, Ongoing Efforts and Innovative Practices in Groundwater Management in Kenya: Towards Sustainable Water Use

By Sharlet Alice Ndede

sharlet.alice@gmail.com

Geologist, Regional Centre
on Groundwater Resources Education,
Training, and Research

1. Introduction

Kenya is a water-scarce country with a limited supply of renewable freshwater, measuring less than 1,000 cubic meters per capita per year. Approximately 85% of its territory consists of arid and semi-arid land. The pressures on its already constrained freshwater resources have intensified in recent decades due to a rapidly growing population, urbanization, and increasing climate variability.

These prevailing circumstances underscore the critical importance of groundwater as a vital water resource. As the country grapples with droughts and diminishing surface water supplies, groundwater serves as a reliable—and often the only—source of water for millions. This report examines the challenges facing groundwater management in Kenya, highlights ongoing efforts to address these challenges, and showcases innovative practices aimed at ensuring the sustainability of this precious resource.

1.1. Key Facts about Water Resources in Kenya

- Total Annual Renewable Water Resources: 20.2 billion cubic meters (United Nations Environment Programme, 2020).
- Dependency on Groundwater: Over 41% of the population relies on groundwater for drinking, agriculture, and industrial purposes (Ministry of Water, 2023).
- Climate Vulnerability: Eighty percent of Kenya is classified as arid and semi-arid land (ASAL), where irregular rainfall significantly impacts groundwater recharge rates.

2. Current Status of Groundwater in Kenya

2.1. Overview of Groundwater Resources

Kenya's hydrogeology is highly complex, characterized by multiple aquifers distributed across diverse terrains. Key groundwater regions include the Coastal Aquifers, the volcanic zones of the Rift Valley, the fractured rock systems of the Central Highlands, and the deep aquifers of arid and semi-arid lands (ASAL), such as Turkana. These aquifers exhibit varying recharge rates and potentials, influenced by factors such as geology, climate, and land use patterns.

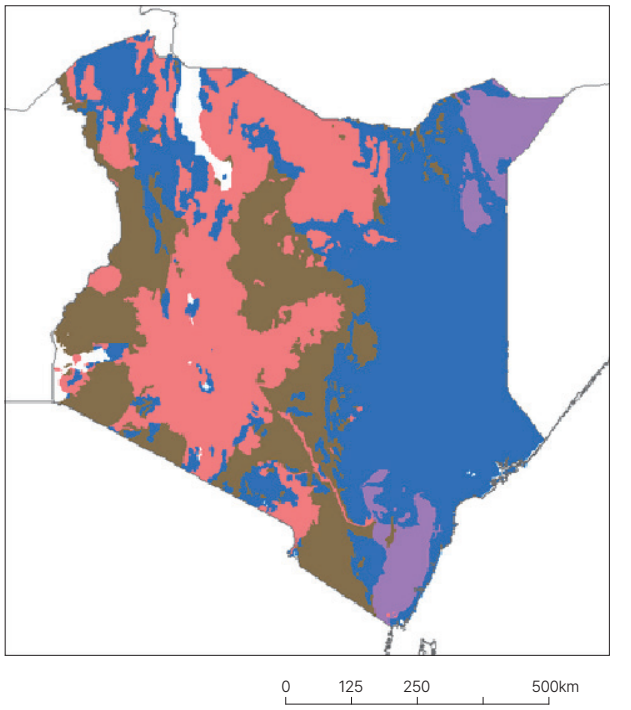


Figure 1. Map showing Kenya's aquifer types and productivity (Source: http://earthwise.bgs.ac.uk/index.php/Hydrogeology_of_Kenya)

2.2. Groundwater Utilization by Sector

Groundwater constitutes an essential resource for multiple sectors in Kenya. Urban centers, including Nairobi, significantly depend on boreholes to satisfy their water requirements. In rural regions, groundwater is widely utilized for agricultural irrigation and livestock husbandry. Furthermore, industrial zones, particularly those surrounding Athi River, are increasingly reliant on groundwater to facilitate their production activities.

Sector	Percentage of Total Use (%)	Main Regions
Domestic Use	35%	Nairobi, Coastal Region, Central Highlands
Agriculture	40%	Rift Valley, ASALs, Central Kenya
Industrial Use	15%	Nairobi, Athi River Industrial Zone
Livestock	10%	

Table 1: Sectoral Utilization of Groundwater in Kenya (2024)

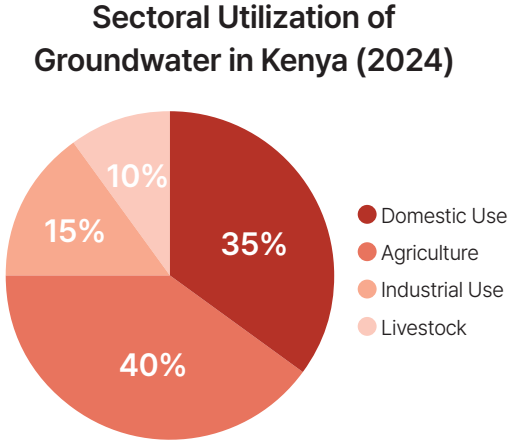


Figure 2. Groundwater utilization by sector (note: data utilized in making the chart; State of Water Resources in Kenya: 2023 Report)

3. Main Challenges in Groundwater Management

3.1. Over-Abstraction and Groundwater Depletion

Over-abstraction of groundwater resources presents a critical challenge in both urban and agricultural areas of Kenya. The swift urbanization of Nairobi has placed substantial stress on the Nairobi Aquifer System, leading to a decline in groundwater levels by approximately 4 to 5 meters each year. This issue is further intensified by unregulated drilling practices, insufficient enforcement of abstraction limits, and the increasing demand for irrigation in ASAL regions.

Table 2: Annual Groundwater Level Decline in Nairobi Aquifer (2000-2024)

Year	Average Decline (m)	Major Cause
2000	-1.5	Early urbanization
2010	-3.0	Increased industrial use
2020	-4.2	Agricultural irrigation
2024	-5.0	Combined urban/agricultural pressure

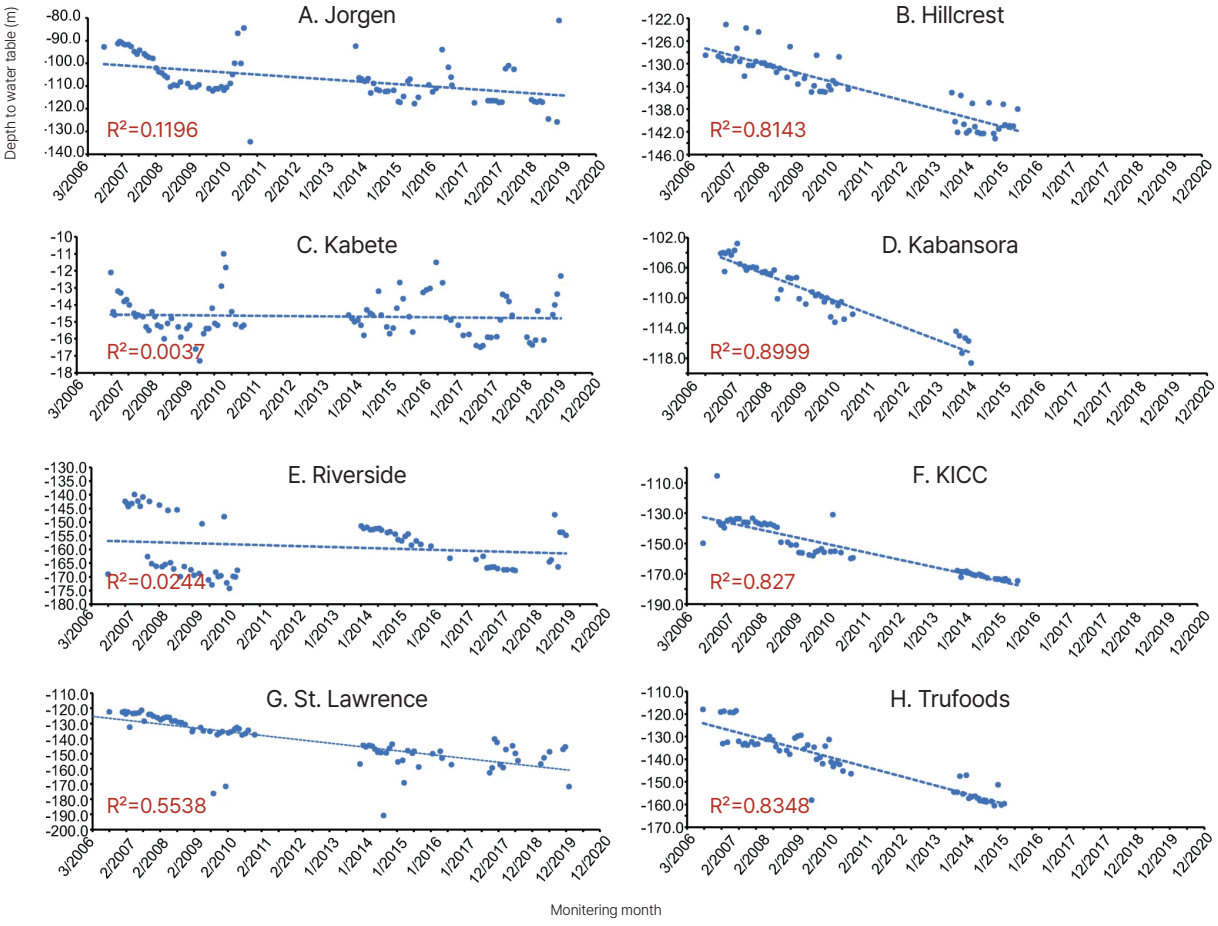


Figure 3. Long-term trends of declining groundwater levels (with linear trendline and corresponding R2 values) as revealed by 2007–2020 monthly records of depth to groundwater level measured in eight representative monitoring boreholes of the WRA characterised by minimal influence of short-term pumping schedules (Source: Oiro, R., et al. 2020)

3.2. Groundwater Contamination

Groundwater quality in Kenya is significantly threatened by pollution from industrial discharges, agricultural runoff, and inadequate waste management. In areas such as Athi River and certain parts of Nairobi, concentrations of heavy metals (e.g., lead and cadmium) and nitrates exceed the safety limits established by the World Health Organization (WHO), posing serious risks to public health and the environment.

3.3. Impacts of Climate Change

Climate change has intensified the vulnerability of water resources in Kenya. The ASAL regions, which rely heavily on intermittent rainfall for groundwater recharge, are increasingly impacted by prolonged droughts and erratic weather patterns. These changes lead to diminished groundwater recharge rates, thereby exerting additional pressure on aquifers in semi-arid areas.

---

4. Ongoing Efforts in Groundwater Management

4.1. Policy Reforms and Institutional Strengthening

Kenya has implemented policy reforms to improve the governance of groundwater resources. The enactment of the 2016 Water Act marked a significant change by establishing the Water Resources Authority (WRA), which is responsible for regulating drilling activities, enforcing abstraction limits, and ensuring equitable access to groundwater resources. Additionally, the State Corporations Act Cap 446, as outlined in Legal Notice No. 252, established the Regional Centre for Groundwater Resources Education, Training, and Research (RCGW). This centre is dedicated to conducting groundwater research, providing training, and enhancing capacity building to inform policies that promote sustainable groundwater development.

Figure 5.
Attendees at the groundwater mapping capacity building programme conducted by RCGW

4.2.Investment in Groundwater Monitoring

Efforts to modernize groundwater monitoring systems encompass the utilization of remote sensing, satellite imagery, and Geographic Information System (GIS)-based tools. These advanced technologies enable more precise evaluations of groundwater availability, usage, and quality. Furthermore, Kenya has strengthened its research capabilities through international collaborations with organizations such as the International Groundwater Resources Assessment Centre (IGRAC) and the United Nations Environment Programme (UNEP).

Figure 6.
Kenya and Danish governments entering a partnership that would see increased investment in Kenya's water sector

Table 3: Key Monitoring Projects and Innovations in Kenya (2018-2024)

Project Name	Year Started	Focus	Achievements
KENASA Groundwater Project	2018	Remote sensing and recharge mapping	Enhanced regional aquifer data accuracy
Nairobi Borehole Monitoring Network	2020	Real-time water level data	Improved regulation of abstraction

4.3. Promoting Community-Led Initiatives

Community participation is essential for the effective management of groundwater resources. In regions such as Laikipia and Narok, local communities actively engage in monitoring groundwater levels, reporting unauthorized drilling activities, and participating in decision-making processes. These initiatives cultivate a sense of ownership among community members and promote the adoption of sustainable practices in groundwater management.

5. Innovations for Sustainable Groundwater Use

5.1. Managed Aquifer Recharge (MAR) Techniques

Managed Aquifer Recharge (MAR) projects, which encompass sand dams and infiltration basins, have proven to be effective in augmenting groundwater recharge in semi-arid regions. These methodologies are not only economically viable but also provide enduring advantages, particularly in the counties of Kitui and Makueni.

Table 4: Results from Managed Aquifer Recharge Projects (2010-2024)

Region	Method	Increase in Recharge (%)	Cost per m^3 (USD)
Kitui	Sand Dams	25%	1.1
Makueni	Recharge Ponds	20%	1.3

5.2. Adoption of Smart Monitoring Technologies

Kenya is increasingly implementing artificial intelligence (AI)-driven tools for groundwater management to improve decision-making processes. These tools utilize real-time data obtained from monitoring boreholes and satellites to predict trends, thereby enabling proactive regulation and more efficient use of groundwater resources.

5.3 Integrating Sustainable Agriculture Practices

Introducing efficient irrigation technologies, such as drip irrigation, and promoting drought-resistant crop varieties are pivotal in reducing groundwater abstraction for agriculture. Demonstration projects in Eastern Kenya have shown promising reductions in water usage, contributing to the sustainable management of groundwater resources.

6. Recommended Actions for Enhancing Groundwater Sustainability

6.1. Policy Recommendations

- **Strengthen Regulation:** Implement stricter controls on borehole drilling and establish abstraction limits, particularly in over-exploited urban areas.
- **Expand Monitoring:** Increase investment in AI-based monitoring tools and extend the reach of groundwater research centers to underserved areas.

6.2 Technical Innovations

- **Boost MAR Implementation:** Expand successful MAR projects to additional ASAL regions.
- **Integrate Climate-Smart Technologies:** Develop models to predict the impact of climate change on groundwater resources and implement adaptive management strategies.

7. Conclusion

Groundwater management in Kenya is at a critical juncture. The pressing challenges of over-extraction, pollution, and climate change necessitate a coordinated, multi-stakeholder approach. By implementing effective policies, fostering innovation, and strengthening community engagement, Kenya can pave the way for sustainable groundwater use, thereby safeguarding this vital resource for future generations.

References

1. *Dulo, S. O., et al. (2020). Groundwater contamination sources in peri-urban Kenya. Environmental Monitoring and Assessment, 192(5), 307.*

2. *Githinji, P. M., et al. (2019). Impacts of urbanization on groundwater resources in Nairobi. Water Research and Development, 35(4), 421-433.*

3. *MacDonald, A. M., et al. (2012). Groundwater availability and use in Sub-Saharan Africa: A review. Journal of Hydrology, 488, 237-251.*

4. *Ministry of Water, Kenya (2023). State of Water Resources in Kenya: 2023 Report. Nairobi, Kenya: Government of Kenya.*

5. *Mwangi, K., & Ibraimo, A. (2020). Evaluation of sand dams for managed aquifer recharge in Kitui. Hydrology and Earth System Sciences, 24(6), 2931-2945.*

6. *Mutua, F., & Bottrell, S. (2020). Heavy metal contamination of groundwater in Kenya. Journal of Water Chemistry and Technology, 42(3), 159-170.*

7. *Oiro, R., et al. (2023). Sustainable groundwater utilization in arid regions: A Kenyan perspective. Journal of Arid Environments, 155, 12-25.*

Challenges, Ongoing Efforts and Innovative Practices in Groundwater Management in Kenya:

Towards Sustainable Water Use

Water Security & Women: A Case Study in a Floating Slum of Dhaka City, Bangladesh

By Sumaiya Binte Islam, M.Sc.

sumaiyace13001@gmail.com

Master of Science in Water Resource Development, Bangladesh University of Engineering and Technology

Assistant Engineer of Dhaka Water Supply & Sewerage Authority

1. Introduction

Access to safe, sufficient, and affordable water is recognized as a fundamental human right (UN, 2002). Countries such as South Africa and Ecuador enshrine this right in their constitutions, while nations like the Maldives and Algeria implement policies to ensure universal access to water and sanitation. Although Bangladesh's constitution does not explicitly recognize water rights, the National Water Policy (1990) mandates access to water for all citizens. However, the existing Water Acts and Rules require further legal refinement to align with this mandate.

Bangladesh has made significant progress toward Sustainable Development Goal (SDG) 6. As of 2022, 59% of the population had access to safely managed drinking water, while 31% had access to safe sanitation. Despite these achievements, urban areas, particularly Dhaka, face considerable challenges, including a limited piped water supply, frequent E. coli contamination, and inadequate sanitation infrastructure.

Dhaka, a major migration hub with an unplanned daytime population nearing 18 million and growing at a rate of 5% annually, faces significant challenges in accommodating climate-induced migrants. Approximately 500,000 individuals migrate to Dhaka each year due to cyclones, flooding, and rising sea levels. Many of these migrants settle in slums, which constitute 40% of the city's population (approximately 3.5 million). These slums often lack essential services, exacerbating violations of water-related rights and gender disparities.

Projections suggest that by 2050, Bangladesh could

face up to 20 million climate refugees, underscoring the urgent need for inclusive and sustainable strategies to ensure access to water and protect human rights.

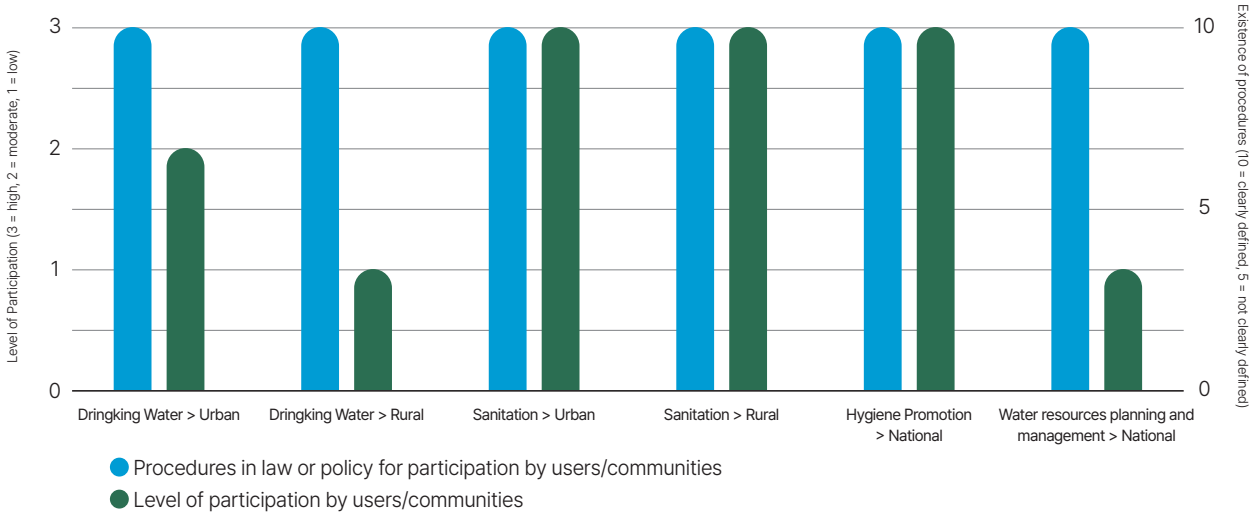


Figure 1. Procedures in Policy for Participation by Users and Level of Actual Participation

2. Slums in Dhaka City

According to UNICEF, Dhaka is home to more than 5,000 slums, which collectively accommodate approximately 4 million individuals. Despite these informal settlements constituting nearly 40% of the city's population, they occupy only 5.1% of the total land area. Notable slums include Begun Bari, Bhola, City Palli, Driver Colony, Duaripara, Korail, Lalbagh, and Mohammadpur, among others, which are distributed across Dhaka North, Dhaka South, and Gazipur.

The Ministry of Local Government, Rural Development, and Cooperatives (LGRD) indicates that 33.62% of slum areas are concentrated within the Dhaka North (11.80%), Dhaka South (12.59%), and Gazipur (9.23%) City Corporations. Slums are classified into two categories: fixed and floating.[1)] Floating slums face five to ten evacuations each year due to monsoonal conditions and management changes.

The transient nature and frequent relocation of floating slums complicate the accurate tracking of their population. According to reports from the Dhaka City Corporation, the prevalence of floating slums is significant and on the rise. The dynamic characteristics of these settlements pose considerable challenges for authorities in monitoring and addressing the needs of their inhabitants.

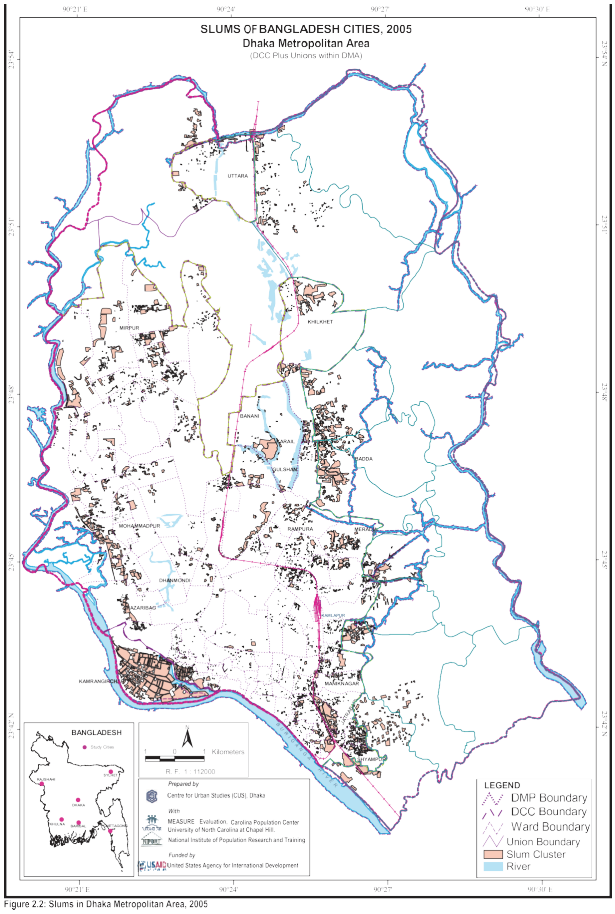
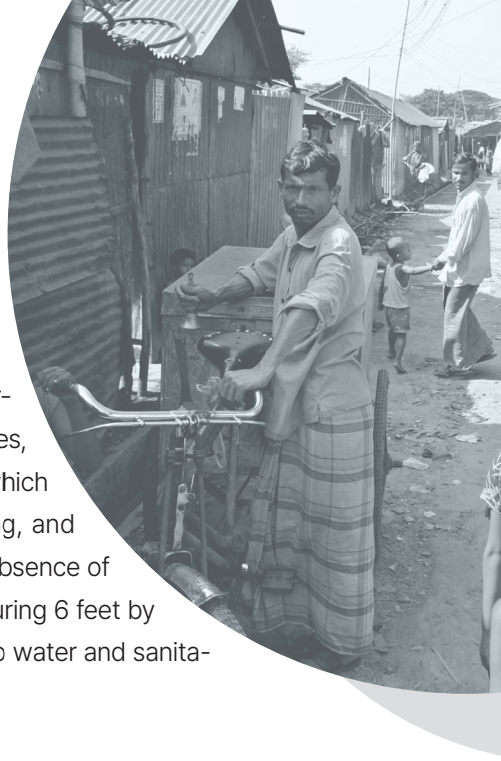


Figure 2.2: Slums in Dhaka Metropolitan Area, 2005

Figure 2. Locations of Slums in Dhaka (CUS, NIPORT, & MEASURE Evaluation, 2006)

1) Fixed slums are permanent informal settlements without infrastructure and sanitation, while floating slums near water bodies are vulnerable to flooding and climate change. Both need tailored policies for sustainable development and water security.



3. Water Supply & Sanitation Practices in Floating Slums

Tejgaon railway slum represents a form of floating slum situated in the central region of Dhaka City. The management of water supply within the Tejgaon slums involves a diverse array of stakeholders, including the Dhaka Water Supply and Sewerage Authority (DWASA or Dhaka WASA), the railway authority, vendors, intermediaries, and political figures. A total of six water points were available to the residents, of which five were deemed illegal. Each water point offered facilities for sanitation, bathing, and water collection. The housing conditions within the slum are characterized by the absence of toilets or bathing facilities, with residences consisting solely of a single room measuring 6 feet by 7 feet. These prevailing conditions contribute to pronounced disparities in access to water and sanitation services.

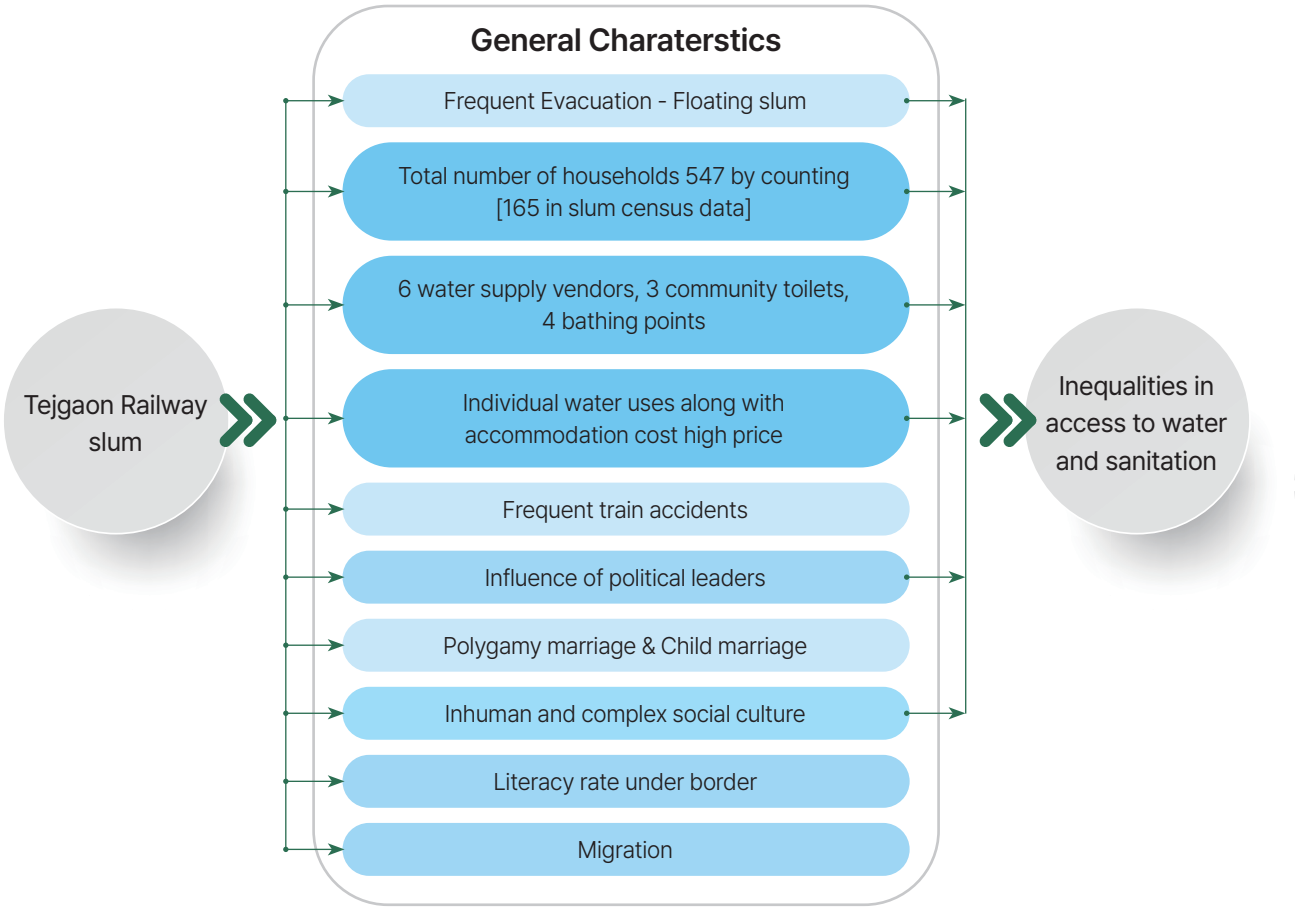


Figure 3: General Characteristics of Slum Leading to Inequalities in Access to Water and Sanitation

The participation of intermediaries has had a substantial effect on the pricing of water provided to slum areas. A typical household in a residential neighborhood incurs an average monthly expenditure of approximately 1,200 Tk[2] for water, whereas households residing in the floating slum face costs of around 3,000 Tk[3] per month—nearly three times higher. Field surveys reveal that residents allocate approximately 19% of their total expenditures to water consumption, which includes drinking, cooking, sanitation, cleaning, washing, and bathing.

Among various expense categories—including food, fuel, electricity, housing rent, and emergency needs—slum residents considered water consumption practices to be the most flexible in their efforts to reduce overall costs.

2) Equivalent to 10 USD 3) Equivalent to 25 USD

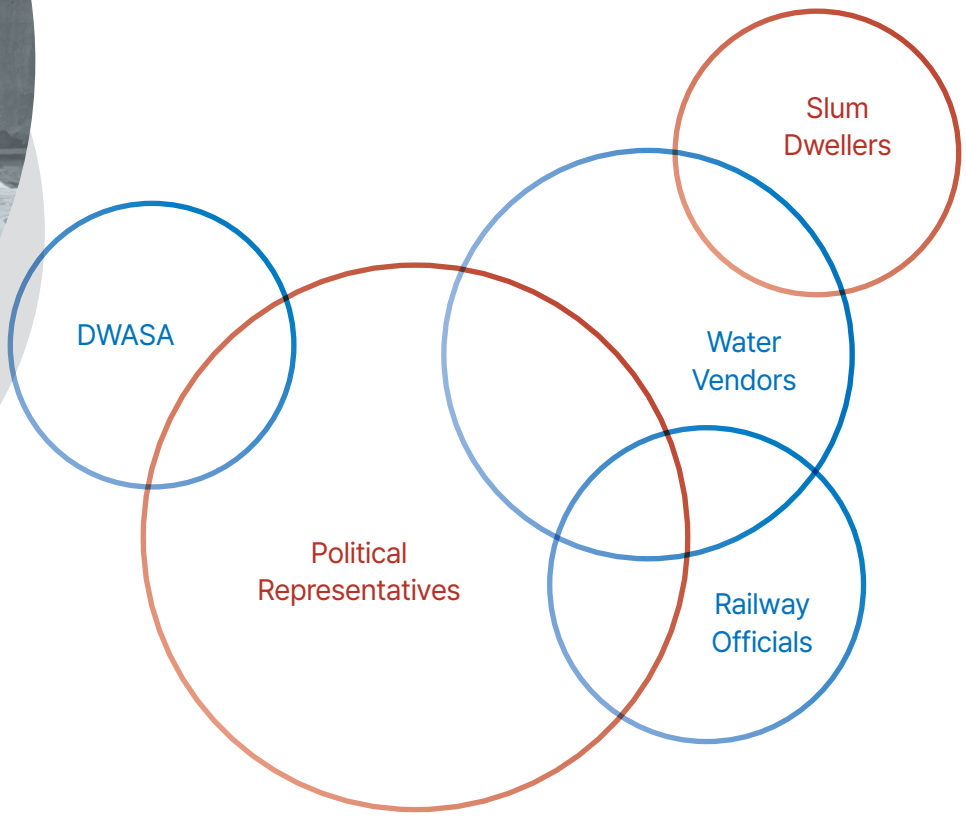


Figure 4. Van Diagram of Water Supply Stakeholder Relations

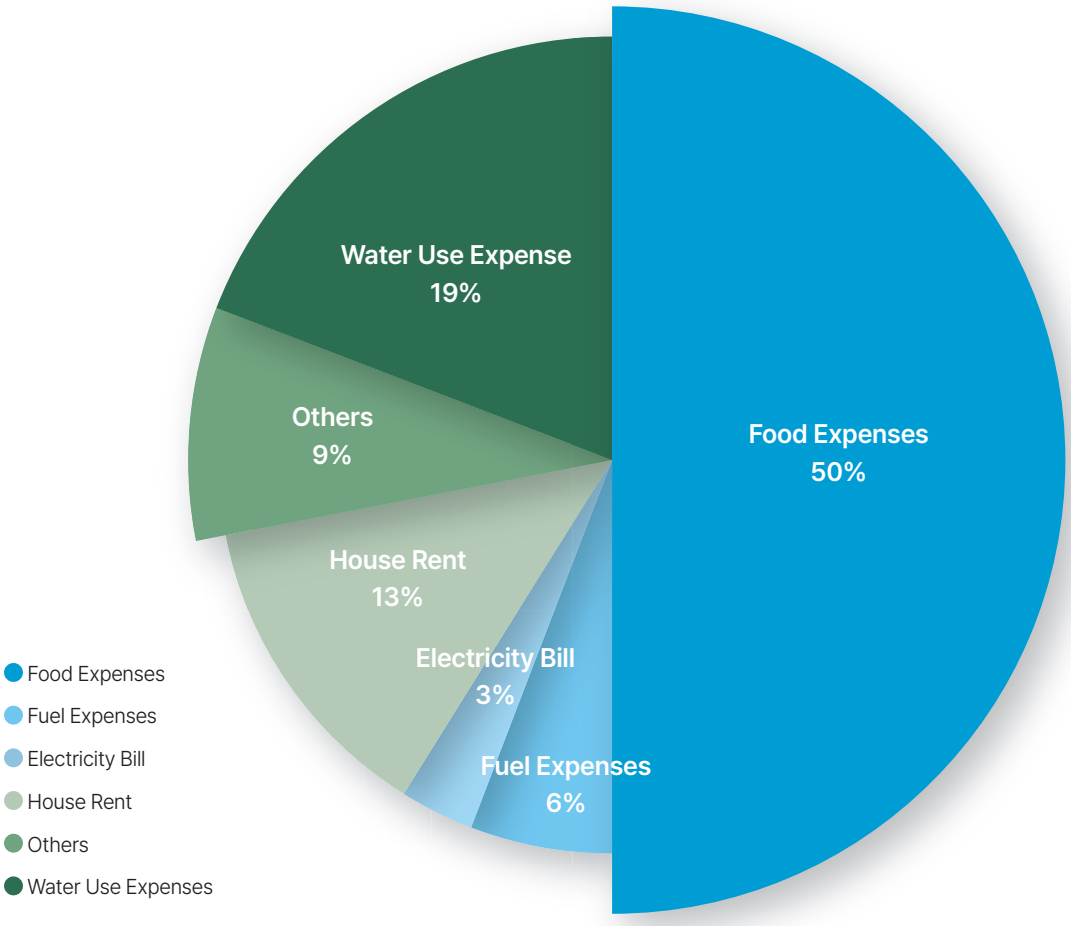


Figure 5. Monthly Expense Distribution of a Typical Household of the Slum

Figure 6. Typical Water Collection Point in Tejgaon Slum

Figure 7. Cooking Practice in Tejgaon Slum

Figure 8. Water Collection in Tejgaon Slum

Figure 9. Paid Washroom Service in Tejgaon Slum

4. Role of Water Management: A Gender Perspective

Access to clean water and adequate sanitation is fundamental to the realization of basic human rights and is intricately connected to social determinants, including gender roles. Women, who predominantly bear the responsibility for managing water, hygiene, and sanitation, encounter substantial obstacles in accessing these essential services. This inequality is especially evident in low-income communities, where restricted educational and decision-making opportunities further intensify gender disparities.

4.1 Economic Factors

The elevated cost of water supply in the Tejgaon Railway Slum significantly intensifies gender inequality. Limited household income often leads to a prioritization of men's access to sanitation and bathing facilities, thereby compelling women to compromise their personal hygiene. In the absence of adequate toilet facilities, women frequently resort to using polybags and minimal water for sanitation, often limiting their water intake following urination. Bathing occurs every two to four days, with frequency influenced by seasonal variations, which frequently results in skin diseases and irritation.

During menstruation, women face additional challenges, as male heads of households frequently regard regular hygiene practices as an "extra cost." Common waterborne diseases reported in slum areas include diarrhea, cholera, urinary tract infections, and typhoid fever.

4.2 Social Factors

In the Tejgaon Railway Slum, the responsibility of water collection is predominantly assigned to women, as men perceive this task as undignified. Six water points provide a total of 12 bathing and sanitation facilities, with men having unrestricted access to all and women limited to seven. Furthermore, women are prohibited from utilizing the water points located at mosques, which are deemed inappropriate for female presence. Additionally, women often refrain from using water points situated in commercial areas due to their considerable distance and the prevalence of overcrowding.

Women who endeavor to contest these societal norms frequently encounter verbal abuse and, in certain instances, physical violence. Educational and employment opportunities for women are often devalued, with an emphasis placed on domestic responsibilities. A significant number of women acquiesce to this burden, perceiving it as justified by prevailing societal expectations.

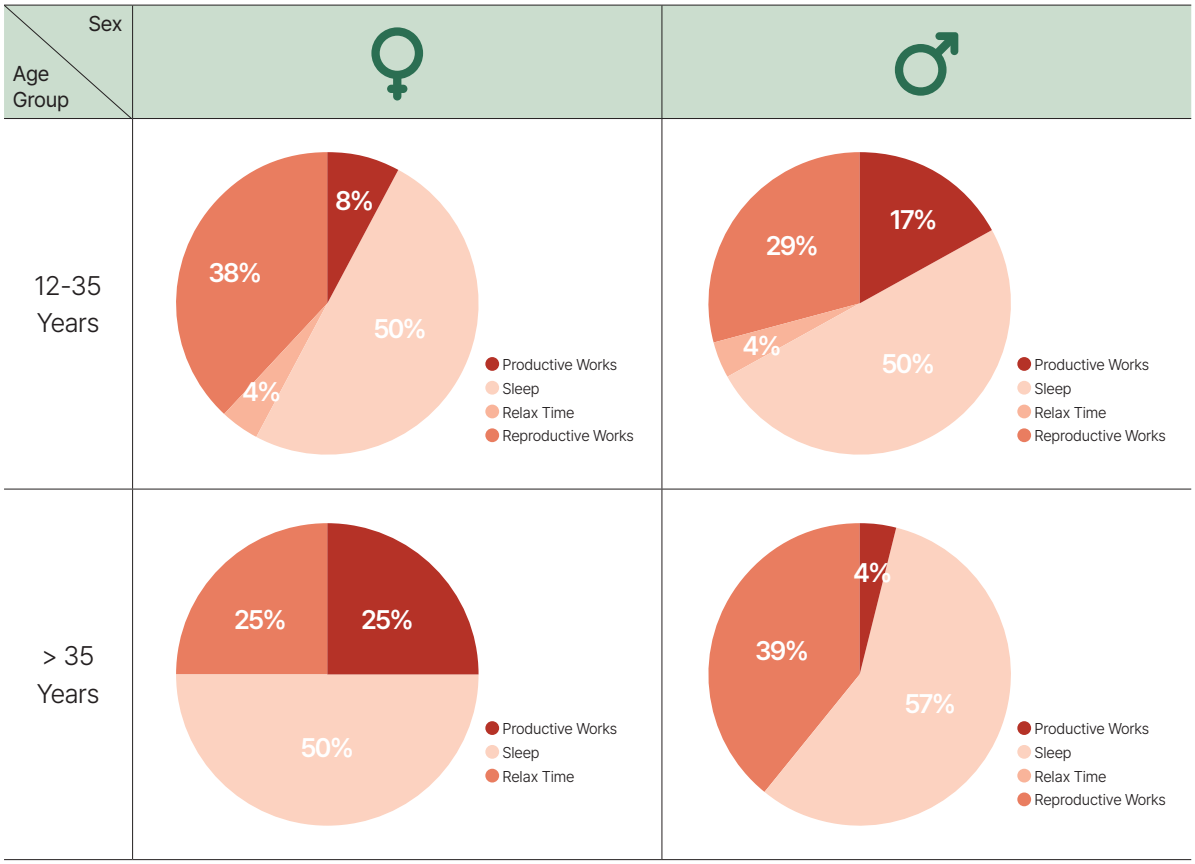


Figure 10. Comparative Analysis of Daily Life Activities Timetable for Men and Women Residing in the Slum

4.3 Physical

Women residing in slum areas serve as the principal managers of household water, undertaking responsibilities related to its collection, distribution, and utilization. In the Tejgaon Railway Slum, women have reported experiencing bodily discomfort and injuries resulting from the transportation of heavy water pitchers over extended distances—a burden they bear from childhood through to old age. Inadequate nutrition, which frequently contributes to the development of osteoporosis, further intensifies their physical suffering.

Women allocate approximately 42% of their household time to the management of water resources, which encompasses activities such as fetching, storing, and distributing the limited supply for various domestic tasks. In contrast, men frequently exhibit a lack of awareness regarding the execution of these responsibilities. Furthermore, numerous women have reported experiencing urinary infections, constipation, and kidney stones as a result of inadequate water intake, which exacerbates their health issues.

5. Policy initiative of DWASA

Dhaka WASA is responsible for providing safe, affordable water and proper sewerage facilities in Dhaka City. Legal restrictions prevented Dhaka WASA from delivering services to slums until November 2010. To address this, the Low-Income Community (LIC) project was launched under Dhaka WASA's turnaround program. Subsequently, a dedicated division called the Community Program and Consumer Relations (CPCR) was established. The LIC program operates through NGOs and Community-Based Organizations (CBOs), serving as intermediaries between Dhaka WASA and slum residents. While the LIC project has improved access in many slums, implementation remains limited in floating slums due to frequent evacuations, though efforts are ongoing.

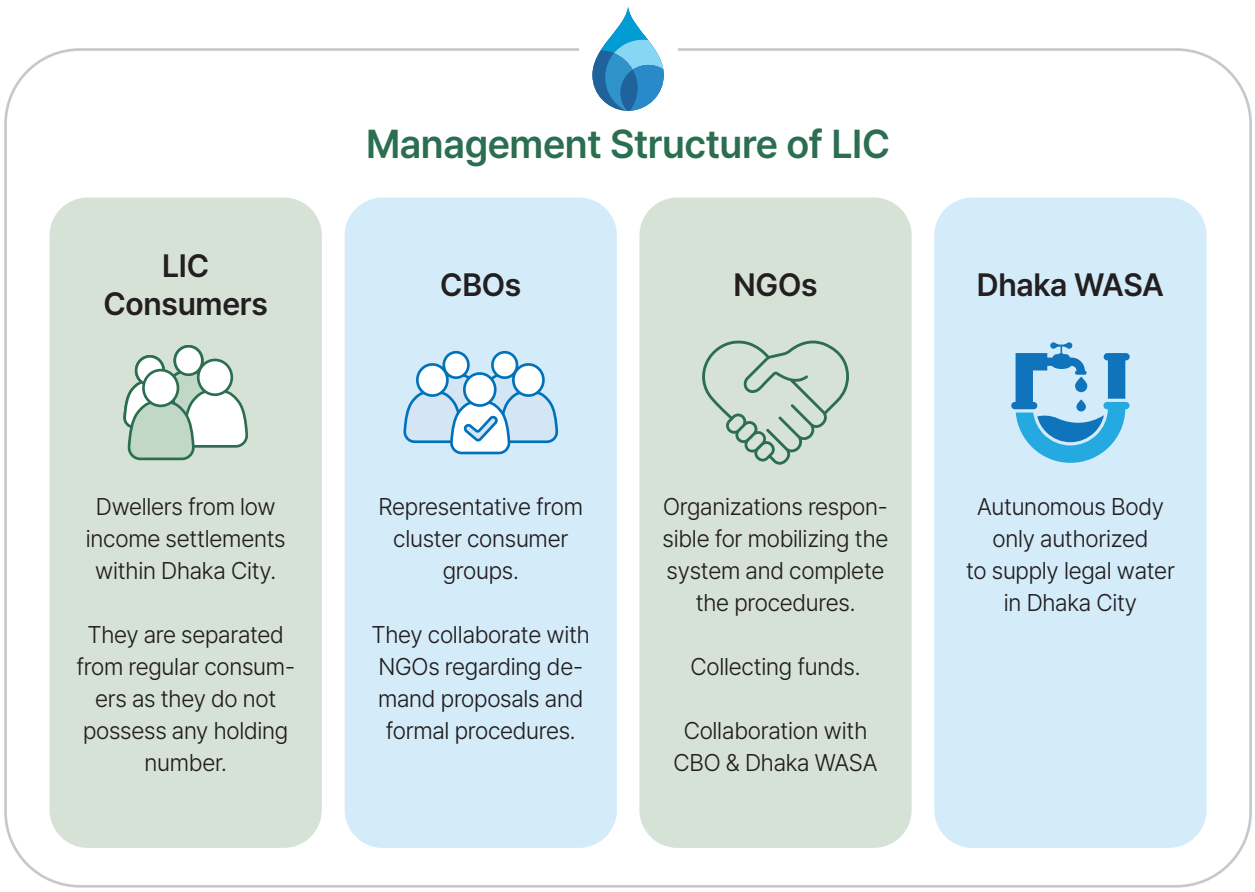


Figure 11. Management Structure of the LIC Water Supply

Four non-governmental organizations (NGOs)—Dushtha Shasthya Kendra (DSK), Bangladesh Association for Social Advancement (BASA), Nagar Daridra Basteebashir Unnayan Sangstha (NDBUS), and Nagorik Seba Foundation (NSF)—play essential roles in the operations of the Local Investment Committee (LIC). The Dhaka Water Supply and Sewerage Authority (WASA) has entered into a memorandum of understanding (MOU) with these

organizations, which clearly outlines their respective roles and responsibilities in alignment with Dhaka WASA's revenue zones. Dhaka WASA is responsible for the installation of bulk meters within the LICs, while the NGOs are tasked with establishing service connections that include individual sub-meters. Additionally, consumer committees formed by the NGOs are responsible for collecting monthly revenue based on the readings obtained from these sub-meters.

In 2020, Dhaka WASA introduced an environmentally sustainable dewatering device to support low-income communities (LICs) and implemented a fecal sludge management system. This system utilizes vacuum tankers leased to private organizations, such as Gulshan Clean and Care, Healthy Tank, and Lily's Family, as well as non-governmental organizations (NGOs) like DSK and Water and Sanitation for the Urban Poor (WSUP).

To assist transient populations, Dhaka WASA collaborates with Dhaka North City Corporation (DNCC), Dhaka South City Corporation (DSCC), the Water Operators' Partnership (WOP), and WaterAid Bangladesh to construct, rehabilitate, and maintain public toilet facilities across the city. These populations also gain access to potable water through initiatives such as Mobile Water Vans and Water ATMs, developed by Dhaka WASA in partnership with local NGOs.

Awarenss Activities

Figure 12. Activities of Dhaka WASA Under the LIC Project in the Slum Areas of Dhaka City

6. Conclusions

Access to safe water is crucial for holistic development. However, in the Tejgaon Railway slum, women disproportionately bear the burden of household responsibilities, which are often perceived as obligations rather than challenges. Their health and productivity are significantly affected by inadequate sanitation and hygiene conditions. Additionally, early marriages and polygamy are prevalent in slum areas, as families resort to these practices to mitigate financial strains. These societal norms and cultural expectations impede women's direct participation in the economy, further marginalizing them from income-generating activities and restricting overall economic growth.

The implementation of Sustainable Development Goal (SDG) 6 through the LIC project aligns with and reinforces the achievement of SDGs 1, 2, 3, 4, 5, 8, and 10. Ensuring fundamental rights to clean water and adequate sanitation serves as a cornerstone for community progress and overall well-being, thereby fostering sustainable development.

References

1. *United Nations. (2002). The right to water, general comment no. 15 of the Economic and Social Council. Retrieved January 21, 2021, from https://www.refworld.org/pdfid/4538838d11.pdf*

2. *Government of the People's Republic of Bangladesh. (1999). National water policy. Ministry of Water Resources. Retrieved from https://faolex.fao.org/docs/pdf/bgd146075.pdf*

3. *UNICEF Bangladesh. (2022). Bangladesh consolidated emergency report 2022, UNICEF. Retrieved from https://open.unicef.org/sites/transparency/files/2023-05/Bangladesh%20CER%202022*

4. *Centre for Urban Studies (CUS), National Institute of Population Research and Training (NIPORT), & MEASURE Evaluation. (2006). Slums of urban Bangladesh: Mapping and census, 2005. Dhaka: CUS, NIPORT, and MEASURE Evaluation. Retrieved from https://www.measureevaluation.org/resources/publications/tr-06-35.html*

5. *Bangladesh Bureau of Statistics (BBS). (2022). Population and housing census 2022 national report (Volume 1). Retrieved from https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/b343a8b4_956b_45ca_872f_4cf9b2f1a6e0/2023-11-20-05-20-e6676a7993679bfd72a663e39ef0cca7.pdf*

2) SDGs 1, 2, 3, 4, 5, 6, 8, and 10 focus on eradicating poverty (SDG 1), achieving zero hunger (SDG 2), ensuring good health and well-being (SDG 3), providing quality education (SDG 4), promoting gender equality (SDG 5), ensuring access to clean water and sanitation (SDG 6), fostering decent work and economic growth (SDG 8), and reducing inequalities (SDG 10). These goals are interlinked and aim to build a sustainable and equitable future for all.

Water Security & Women:
A Case Study in a Floating Slum
of Dhaka City, Bangladesh

Sustainable Water and Energy Management in Central Asia: International Cooperation and Experience

By. Atai Namatbaev

atainamatkgz@gmail.com

Kyrgyzstan Resident Fellow
Korea-Central Asia Cooperation
Forum Secretariat
The Korea Foundation

Introduction

The contemporary system of water allocation among Central Asian nations was established during the Soviet era as part of a cohesive economic framework. This system has led to an uneven distribution of water resources, predominantly benefiting downstream countries such as Kazakhstan and Uzbekistan, which have developed irrigated agriculture, particularly for water-intensive crops like cotton. Conversely, the upstream countries, Kyrgyzstan and Tajikistan, were primarily utilized for the construction of water-regulating infrastructure to ensure a reliable supply of water to the downstream re-

gions. In exchange, Kyrgyzstan, for example, received energy resources, including gas, fuel oil, and other fuels.

Following the dissolution of the Soviet Union, Kyrgyzstan continued to manage water accumulation and release to satisfy the irrigation needs of neighboring countries. However, downstream nations began supplying fuel and energy resources only on the condition of payment at prevailing global market rates. As a result, the financial responsibility for maintaining hydraulic structures of interstate significance fell solely on Kyrgyzstan's state budget. This shift rendered the previously established water distribution framework among Central Asian countries ineffective. Consequently, Kyrgyzstan was compelled to procure energy resources independently and gradually reoriented the operations of the Toktogul hydroelectric power station from irrigation to energy production.

Mechanism of Water and Energy Cooperation in Central Asia (1998-2006)

A new regional framework for cooperation in water and energy management between upstream and downstream nations was established in the late 1990s. On March 17, 1998, Kazakhstan, Kyrgyzstan, and Uzbekistan, with Tajikistan joining in 1999, entered into an intergovernmental agreement concerning the utilization of water and energy resources within the Syr Darya River Basin.[1)] This agreement implemented compensation mechanisms aimed at regulating water resources in the Toktogul and Kairakkum reservoirs.[2)]

Under Article 4 of the agreement, Kyrgyzstan was entitled to compensation in the form of energy resources—such as coal, gas, fuel oil, and electricity—as well as other products, services, or monetary payments. This arrangement was designed to assist Kyrgyzstan in maintaining the annual and long-term water reserves required to meet the irrigation needs of neighboring countries.

Tajikistan assumed responsibility for managing the Kairakkum Reservoir in accordance with the terms agreed upon by the parties involved. During the water accumulation phase, Kazakhstan and Uzbekistan were obligated to provide electricity to Tajikistan in equal shares. In return, Tajikistan supplied the agreed-upon equivalent volume of electricity during the summer months.

Although this agreement remains legally valid, it has not been operational since 2006 for reasons that are still unclear. Given the current challenges and realities in the region, revisiting and updating this cooperation mechanism could offer an effective solution to address contemporary issues.

Successful Water Management Cooperation in Central Asia: Lessons from Kyrgyzstan, Kazakhstan, and Uzbekistan

Since 2000, Kyrgyzstan and Kazakhstan have made significant progress in their collaborative management of the Chu and Talas rivers. Both countries share the financial responsibilities for operating and maintaining interstate water management facilities and other jointly agreed initiatives, in proportion to the volume of water each nation receives. These efforts are coordinated by the Interstate Chu-Talas Water Management Commission.

1) The Syr Darya River, one of Central Asia's major rivers, flows through Kyrgyzstan, Uzbekistan, and Kazakhstan, serving as a vital water source for agriculture, energy, and ecosystems in the region.
2) The Toktogul Reservoir, located in Kyrgyzstan, is managed by the Kyrgyz government, while the Kairakkum Reservoir, situated in Tajikistan, is overseen by the Tajik government. Both play key roles in regional water and energy management.

In 2019, the Kyrgyz-Uzbek Commission on the Interstate Use of the Orto-Tokoi (Kasansai) Reservoir began its operations. This commission is responsible for overseeing joint financing for the reservoir's operation and maintenance on a quarterly basis. These instances of mutually beneficial cooperation among Kyrgyzstan, Kazakhstan, and Uzbekistan illustrate a potential model for expanding such collaborative frameworks to other river basins in the region.

Water and Its Economic Value

Kyrgyzstan is home to vital water management facilities of interstate significance, which facilitate the accumulation, conservation, regulation, and distribution of water to neighboring countries for irrigation purposes. Each year, a considerable portion of Kyrgyzstan's state budget is allocated to the maintenance and operation of these facilities. Given the essential services they provide, water resources undoubtedly hold economic value, making it imperative for Kyrgyzstan to receive equitable compensation for the associated costs.

While some scholars suggest that unresolved water usage issues in Central Asia—exacerbated by population growth and industrial development—could lead to interstate conflicts, water should instead serve as a unifying force in the region. Achieving this goal requires constructive negotiations and the establishment of a shared consensus.

Positive Examples from International Practices

There are numerous examples worldwide of mutually beneficial water resource management that could serve as models for Central Asia.

- **The United States and Canada** entered into a treaty for the collaborative management of water resources within the Columbia River Basin. Under this agreement, Canada constructed three reservoirs with a combined capacity of 19.1 billion cubic meters. In return, the United States compensates Canada $64.4 million annually to support flood control efforts and mitigate the impacts of inundation on Canadian territory.

- **The United States and Mexico** entered into a treaty concerning the Colorado and Tijuana Rivers, as well as the Rio Grande. This treaty stipulates that both governments are responsible for sharing the costs related to the construction, operation, and maintenance of international dams and other collaborative projects in accordance with the benefits each country derives from them.

- **Turkey and Bulgaria** formalized an agreement that allows Bulgaria to sell irrigation water to Turkey in designated quantities. The financial arrangement stipulates that Turkey will compensate Bulgaria at a rate of $0.012 per cubic meter of water, culminating in a total payment of $1,903,920 for the procurement of 15,865,000 cubic meters. The volume of water transferred is subject to verification at the border control station.

The Impact of Climate on Water and Energy Security: Solutions

In recent years, climate change has resulted in reduced water levels, the melting of glaciers, drought conditions, and desertification across Central Asia. These challenges adversely affect water, energy, and food security, as well as the overall socio-economic stability of the region.

Kyrgyzstan has consistently faced challenges related to electricity shortages, necessitating the import of power from neighboring countries. Agreements with Kazakhstan, Uzbekistan, and Turkmenistan ensure the provision of electricity to Kyrgyzstan during the autumn and winter months, with repayment occurring in the summer. In addition, Kyrgyzstan supplies water for agricultural purposes to both Kazakhstan and Uzbekistan.

Kambarata HPP-1: The First Major Regional Project in Central Asia

The persistent water and energy crisis in Central Asia has instigated negotiations among Kyrgyzstan, Kazakhstan, and Uzbekistan. These discussions resulted in an agreement to collaboratively construct one of the largest hydroelectric power plants in the region, known as Kambarata HPP-1. The project was inaugurated by Kyrgyz President Sadyr Zhaparov in June 2022.

- **Specifications:**
  - Capacity: 1,860 MW
  - Reservoir Volume: 5.4 billion cubic meters
  - Dam Height: 256 meters
  - Annual Electricity Output: 5.6 billion kWh
  - Construction Timeline: 8 to 10 years, with the first unit expected to be operational in 4 years.

In April 2024, the three governments established a joint venture to oversee the project, which is projected to cost between $5 billion and $6 billion. Upon completion, the shares and assets of the facility will be owned by Kyrgyzstan.

The International Energy Investment Forum, convened in Vienna in June 2024 with the support of the World Bank, culminated in a trilateral agreement among the energy ministries of Kyrgyzstan, Kazakhstan, and Uzbekistan aimed at advancing the project. Additionally, the forum established a Coordinating Donor Committee, which comprises the World Bank, the OPEC Fund, the Asian Development Bank, the Asian Infrastructure Investment Bank, the Islamic Development Bank, and the European Bank for Reconstruction and Development.

The World Bank has committed to providing a $500 million interest-free loan to Kyrgyzstan for this project. According to the feasibility study, the total estimated cost of the project is $3.6 billion. The Kambarata Hydropower Plant-1 (HPP-1) is expected to alleviate electricity shortages in Kyrgyzstan while also contributing to the resolution of water shortages in Kazakhstan and Uzbekistan.

Sustainable Water and Energy Management in Central Asia:

International Cooperation and Experience

2024

i-WSSM

Regional Report on Water Security

UNESCO International Center for Water Security and Sustainable Management
18221, 883 Gongnyong-ro, Songsan-myeon, Hwaseong-si, Gyeonggi-do, Republic of Korea
Tel. +82-31-8050-4205
Fax. +82-31-8050-4004
email. iwssm@unesco-iwssm.org