

URBAN WATER BODY MANAGEMENT AND ENVIRONMENTAL ISSUES: A CASE STUDY OF KABUL CITY IN AFGHANISTAN

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ABSTRACT: Urban water bodies play a key role in promoting public health and safety, disaster risk reduction as well as in environmental conservation. The expansion of cities into vast informal settlements and slums, poor infrastructure levels characterized by lack of piped water and sanitation services and the expected increase in the frequency of extremes due to climate change are some of the factors that are threatening urban water bodies in developing countries. To identify patterns within sustainable strategies for the management of urban water bodies (UWBs) in Kabul City and related environmental issues was the aim of this research. The research reviews current management processes, evaluates state of surface and groundwater resources, points out main challenges like pollution, solid waste disposal issues, discharge of untreated wastewater and over- exploitation of groundwater. It states how quality and quantity are determined by social parameters such as wealth or poverty; they refer to changes brought about by climate change among them prolonged droughts as well as unpredictable intense rains. The findings show there are significant gaps in the existing physical infrastructure, governance frameworks, and enforcement mechanisms. As part of the study on UWB sustainability within Kabul city recommendations provided here focus on IWRM principles adoption as a priority area; pollution abatement measures need to be given high priority along with capacity building activities for improved operations/ maintenance (O&M) practices systematization.

Keywords: Urban Water Bodies; Water Management; Environmental Issues; Urbanization; Climate Change; Natural Drainage Issues, Kabul City; Afghanistan.

1. INTRODUCTION

The environmental problems in the city of Kabul have been exacerbated on account to the fast-paced urbanization of the city, prolonged fighting, poor infrastructure and increasing climate change. As civilization populace grows its effects are felt on several areas such as solid waste management, drainage systems, water supplies and sanitation which have all been overstrained. Increase in temperatures, rapid decrease of rainfalls (or their complete absence), long dry periods with no rains at all and flooding are signs of climate change that aggravate the situation concluded above.

Groundwater contributes to almost 85% of the water supply for Kabul City inhabitants, due to over exploitation and pollution the groundwater is severely depleted. Consequently, municipal water legislations and population management measures are needed (M.Khalil2020) The challenges of pollutions and over exploitation caused by urbanization and industrialization create impediment for proper groundwater management in Kabul City. Monitoring systems must be put in place to ensure sustainable utilization as well as transboundary aquifers should be managed (Ghulam Mohammad Asim et al.,2025) Urbanization is overtaking water delivery infrastructure creating severe water shortage in Kabul. In order to arrest falling groundwater levels, sustainable management of ground water through conservation, effective irrigation and water price becomes sine-qua-non (Sediqullah Reshteen et al., 2024) Rapid depletion (2.1 m/year) and pollution/that above WHO guidelines in Districts 11, 4, 12,13 ,18 and the others are the result of urbanization in Kabul city and its vicinity (Mirwais Sediqmal et al., 2022) In Kabul City there is no centralized sewage network so it depends on septic tanks and pit latrines which affects wastewater management /and groundwater quality poses problems for the overall system. Environmental consequences are evaluated using EIA (Paiman, Z., & Noori, A.R. 2019) Lack of better sanitation facilities, insufficient wastewater treatment facilities, and bad administration are the main causes of Kabul City's problems with domestic wastewater management. Decentralized treatment technology and better governance are two possible remedies. To collect data, the study included questionnaires, field observations, and document reviews (H. Rahmani, A. Anuar 2019) Water quality in Kabul City is greatly impacted by rapid urbanization, with variables like as population expansion, rainwater, and poor sanitation contributing to this degradation, according to a study of 429 inhabitants (Safiullah Zahid et al. ;2021) Groundwater-level statistics and modeling from 2004 to 2012 show that while rural regions have witnessed minor rises owing to normal precipitation, Kabul City's groundwater levels have declined due to increased water usage and insufficient recharge, raising sustainability issues. Due to low flow, the Kabul River becomes extremely filthy in the winter, although Kheshki Lake is contaminated all year round; samples are analyzed using standard techniques (Khan, K.A 1985) A master plan for future water resources has been created since Kabul's water supply is in danger owing to over-abstraction

and pollution, with diminishing groundwater levels and poor water quality beyond WHO criteria (Zaryab, A et al 2017) Kabul City is experiencing severe water shortages as a result of urbanization exceeding the infrastructure for local water supplies. This calls for sustainable groundwater management strategies including water conservation and effective irrigation methods (Sediqullah Reshteen et al. 2024) Rapid development and population increase have resulted in a groundwater deficit in Kabul City. Rooftop rainwater collection may supply a sizable amount of water for household consumption, potentially saving 2.08 MCM annually through low-flow fixtures and promoting sustainable water management (J. Shokory, E. Rabanizada 2020) Significant problems with water pollution exist in Kabul; a pond storage model is suggested as a substitute to enhance urban water supplies. Data was gathered from 120 families and was motivated by a successful model in Japan (Omid, S.M., et al., 2020) Afghanistan faces serious issues with water scarcity and destroyed infrastructure, which affect both urban and rural regions. Drought has a tremendous negative influence on the ecosystem (Habib, H. 2014).

2. LITERATURE REVIEW

The body of literature on the management of urban water bodies in Kabul City and environmental challenges in the region consistently points towards a trend of increased crises in the region resulting from rapid urbanization, poor infrastructural facilities, poor governance, and the increased consequences of climate change. More recent literature on the subject also points towards similar conclusions on the interconnected crises in the region related to urban water body management, natural drainage systems, and the consequences of poor sanitation facilities. The body of literature on the subject collectively points towards the urban water bodies in Kabul City being in a state of self-reinforcing crises related to depletion, pollution, and degradation of the natural environment. Such a state of crises is a result of systemic governance crises in the region. Though the body of literature on the subject is quite informative on the different dimensions of the crises in the region, few of the literature works on the subject are comprehensive in their approach towards addressing the crises in the region. Therefore, the urgent need of the hour is to develop comprehensive strategies on the subject that are also resilient towards the consequences of climate change in the region.

2.1 SANITATION CHALLENGES IN KABUL CITY UNDER CLIMATE CHANGE IMPACTS AND THEIR INFLUENCE ON URBAN WATER BODIES

The most severe effect of climate change in Afghanistan is water insecurity, which has significant effects on urban sanitation, especially in Kabul City. Kabul City has serious, complex sanitation issues that put the public's health and the sustainability of the environment at serious danger. The quantity and quality of water have been significantly affected by protracted droughts, rising temperatures, and environmental pollution, directly endangering public health and sanitation systems. Vulnerable groups, particularly women and children, are disproportionately impacted by these pressures. Record-breaking and frequent droughts have forced tens of thousands of households to relocate in quest of clean water for cooking, drinking, and personal hygiene. Urbanization is overtaking water delivery infrastructure creating severe water shortage in Kabul. In order to arrest falling groundwater levels, sustainable management of ground water through conservation, effective irrigation and water price becomes sine-qua-non (Sediqullah Reshteen et al., 2024) Rapid depletion (2.1 m/year) and pollution/that above WHO guidelines in Districts 11, 4, 12, 13, 18 and the others are the result of urbanization in Kabul city and its vicinity (Mirwais Sediqmal et al., 2022) In Kabul City there is no centralized sewage network so it depends on septic tanks and pit latrines which affects wastewater management /and groundwater quality poses problems for the overall system. As temperatures rise, contaminants in surface and subsurface water sources accumulate more quickly due to decreased river levels and groundwater recharge. This reduces water availability and deteriorates water quality, making the current sanitation system dangerous or inefficient. Groundwater pollution in Kabul's informal settlements is made worse by the lack of sewage systems and the use of subpar latrines.

As temperatures increase, contaminants in surface and subsurface water sources increase rapidly as river levels drop. This limits the availability of water and compromises its quality, making the sanitation system dangerous or inefficient. Water contamination in informal settlements like those in Kabul City is exacerbated by the absence of a sewerage system, coupled with the use of low-grade latrines. Children's vulnerability to health issues related to climate change has been exacerbated by the absence of access to clean water for domestic, educational, and health institutions. Water-borne diseases are exacerbated by the increase in rates of malnutrition, which are caused by the absence of water and low agricultural productivity. These conditions often mean that children miss school, limiting their access to services, which maintains the cycle of poverty.

It has also been observed that there are gender differences with respect to water and sanitation insecurity. In Kabul, women and girls are mostly responsible for collecting water, which requires a lot of time and affects their economic and

educational opportunities. They are also in charge of caring for family members who have illnesses brought on by inadequate sanitation. Unhealthy coping strategies, like early marriage for girls, have resulted from food and water shortages as families struggle to survive in worsening environmental conditions. Afghanistan's capacity to address issues related to poor sanitation and climate change has been severely hampered by decades of violence. Currently, a third of its citizens do not have access to basic drinking water services. Growing competition for water supplies, notably from outside its boundaries, has raised the likelihood of social disputes and confrontations in Kabul.

Conflicts over shared water supplies with neighboring nations provide as more evidence of the geopolitical aspects of the water and sanitation dilemma, which is being made worse by climate change. All things considered, Kabul City's sanitation problem is a crucial confluence of socioeconomic vulnerability, public health risk, urban planning failure, and climate change. Children and vulnerable people in the city will continue to experience increasing deprivation, insecurity, and long-term developmental implications in the absence of integrated, climate-resilient sanitation and water management solutions. Due to inadequate housing, little resources, a lack of management structures, problems with waste management and drainage, and the recent civil war, Kabul City has severe sanitary concerns (Safi, M. 1998). The overwork, low community involvement, and cleanliness concerns plaguing Kabul's waste management system may be addressed by relocating trash cans and launching community outreach initiatives. Several stakeholders and indicators participated in a thorough social life cycle evaluation that served as the basis for this (A. Azimi, et al 2020). With 60% of the population without access to centralized services, Kabul's water and sanitation systems are badly disrupted by conflict and stress from returnees, necessitating community-based solutions (Pinera, J., & Rudge, L. 2005). A research employing surveys, field observations, and document reviews found that Kabul City has serious sanitation difficulties because of inadequate wastewater treatment facilities and upgraded toilets, which cause serious health and environmental hazards (Hizbullah Rahmani, Aznah Nor Anuar 2019). The lack of an established municipal sewage infrastructure in Kabul exacerbates sanitary problems brought on by the city's fast population expansion; case studies and a review of the literature provide proof (Mohammadbager Karimi, et al 2020). With 86% of the population utilizing pit latrines and no centralized sewer system, Kabul City suffers from poor sanitation and E. coli pollution of groundwater sources. The research evaluates environmental implications using an EIA checklist (Paiman, Z., & Noori, A.R. 2019). Due to Kabul's high population density, plastic waste creation is a major sanitation problem. Based on a survey and literature research, workable solutions to minimize, reuse, and recycle plastic trash are suggested (Nazari, N, et al 2020). In Kabul, improper solid waste disposal—landfilling is a popular method poses serious risks to the environment and public health, compromising groundwater quality. The goal of the study is to determine the variables influencing environmental preservation and groundwater quality. Site visits and library research are part of the methodology. Neither participant numbers nor the strength of the evidence are specified (Satar, P.J. 2025). Due to rising water consumption and inadequate recharge, Kabul City's groundwater levels have dropped, creating serious sanitary issues (Thomas J. et al ; et al 2013). Inadequate wastewater treatment is one of the most serious sanitation issues. Approximately 100% of residential wastewater in Kabul is released into the environment untreated, and over 50% of homes lack upgraded toilet facilities (Rahmani & Anuar, 2019). There is hardly any sewerage infrastructure. Simple pit toilets are used by almost 80% of Kabul's population, allowing human waste to seep into the groundwater and soil. (Humphrey, 2025). A high water table in certain places and clogged and badly built surface drainage systems are the main causes of Kabul's severe sanitary issues (Safi, M. 1998).

2.2. NATURAL DRAINAGE ISSUES IN KABUL CITY

The Kabul River, its tributaries, seasonal streams, and natural valleys make up the majority of Kabul City's natural drainage system. These features have historically helped in the transport of storm runoff and the maintenance of hydrological equilibrium in the urban area. Nevertheless, the capability of these natural drainage features to function naturally has been adversely impacted by the rapid rate of urbanization, environmental degradation, and climate change. The change and incursion of natural water channels is one of the issues impacting Kabul City's natural drainage. The area's urban growth and fast rate of urbanization have caused the natural drainage routes to become smaller or completely clogged. Consequently, the drainage channels' inherent capacity is diminished, leading to an overflow during a downpour.

There have been significant alterations to the Kabul River. It acts as the city's primary natural drainage canal. A reduction in the river's hydraulic efficiency has been caused by sedimentation, solid waste dumping, and the release of untreated wastewater. As a result, the river's ability to transport precipitation during peak seasons has significantly decreased. The likelihood of flooding along the riverbanks may rise as a result. Another significant issue is the lack of natural penetration sites. Because of development, impermeable surfaces have taken the role of permeable surfaces like green spaces, floodplains, and open areas.

Peak flows in natural drainage systems are increased when the systems are altered during periods of high rainfall. Climate change has increased the frequency of flash floods, prolonged droughts, and heavy rainfall events, making natural drainage challenges even more serious.

While decreased base flows during dry spells encourage sediment accumulation and channel obstruction, short-duration, high-intensity precipitation overwhelms natural channels. Natural drainage pathways have deteriorated more quickly due to a lack of institutional management and legal protection. Because they are frequently left out of official urban planning frameworks, natural streams and floodplains are susceptible to abuse and invasion. The consequences of climate change, loss of infiltration zones, blockage of seasonal streams, and deterioration of riverine systems are the main causes of Kabul City's natural drainage problems. In Kabul, natural drainage networks must be preserved and restored, blue-green infrastructure must be integrated, and climate-resilient Because there are no designed stormwater and sewage systems, Kabul City has serious drainage issues, especially in informal areas.

When drainage infrastructure is inadequate, uncontrolled runoff, waterlogging during the rainy season, and stormwater and wastewater mixing result, contaminating groundwater and endangering public health. According to survey results, 83.5% of locals consider the lack of sewage and drainage systems to be a high-impact urban environmental issue, underscoring the necessity of integrated infrastructure development and drainage planning (Rezayee et al., 2019).

The Kabul River is an important socioeconomic resource for Afghan communities, but industrial effluents and the building of numerous dams are compromising its water quality and quantity, endangering irrigation systems, aquatic ecosystems, and traditional water uses (Nafees, M. 2010) The insufficient and poorly connected drainage system in Kabul City is closely associated with urban floods. Even though the Wazerabad Canal, the primary drainage canal, has the capacity to discharge rainfall, studies reveal that flooding persists because of inadequate secondary drainage systems, a lack of maintenance, mixed drainage structures, and unplanned urban growth. Rapid surface runoff increases brought on by the conversion of pervious land to impermeable surfaces have overwhelmed local drainage systems and have caused urban floods (Manawi, S. et al., 2020) A combination of the stormwater management model (SWMM) and watershed modeling system (WMS) revealed that the implementation of a vegetative swale is the most promising way to control excessive rainfall in Urmia City, Iran (Reza Mehdizadeh Anvigh et al., 2024) The study emphasizes low public awareness and recommends enhancing early warning systems to control floods in Kabul, thereby indirectly addressing natural drainage issues (Hayatullah Mashwaani et al., 2021) The Kabul Basin's groundwater sustainability is at risk due to declining water levels in the south, while higher recharge rates in the north indicate fewer issues; this is determined by hydrogeologic investigations, chemical and isotopic analysis, and groundwater flow modeling (Mack, T.J et al., 2014) Unsustainable growth, poor drainage systems, and major land use changes—particularly the expansion of impervious surfaces and the decrease of green spaces—are the main causes of urban floods in Kabul. In order to assess these factors, the study used hydrological modeling with CHIRPS rainfall data and historical imagery (Sayed Mir et al., 2020) Inadequate infrastructure and services, such as drainage systems, are essential for urban upgrading projects and integrating into citywide stormwater management systems (Parkinson, J.N., et al., 2007).

2.3. WATER RESOURCES ISSUES IN KABUL CITY

Due to careless groundwater exploitation linked to increasing urbanization, Kabul City is facing a severe water deficit that is overwhelming local water delivery infrastructure. Creating a sustainable groundwater management plan is essential to addressing declining groundwater levels (Reshteen et al., 2024) Concerns over the sustainability of Kabul's water supplies have been raised by increased demand and possible mining operations. While higher recharge rates in the northern basin predict less long-term sustainability issues, model simulations suggest that withdrawals from deep aquifers may have less of an impact than withdrawals from shallow sources (Mack, T.J et al., 2014) Groundwater levels in Kabul have significantly decreased as a result of illegal drilling, excessive use, urbanization, and decreased rainfall. As a result, groundwater management is necessary to avoid shortages in the future (Noori, K., & Nasimi, M.N. 2019) Due to a lack of hydrological data, land degradation, water pollution, and overcrowding, the Kabul River Basin has serious water resource problems that make it difficult to use available water for domestic needs in cities like Kabul and Jalalabad (Dilshod Bazarov et al., 2023) Only 40% of the groundwater in the Kabul Basin is considered good quality based on analysis from 15 observation points (Hussain Ali Jawadi, et al., 2020) The Kabul River's yearly inflow shows no discernible trend; the water quality has problems with dissolved oxygen; it is unfit for drinking but suitable for agriculture and aquatic life; and the built-up and cultivated areas along the river have significantly increased (Akhtar, S., & Iqbal, J. 2017) Kabul city has serious problems managing its domestic wastewater because it lacks adequate sanitation facilities, wastewater treatment plants, and drainage systems, which can result in serious health and environmental problems. Evidence for the study was collected using questionnaires, field observations, and document reviews (Hizbullah Rahmani and Aznah Nor Anuar 2019) The Kabul River basin is a key source of water resources. However, there is currently no cooperation mechanism in

Afghanistan. This lack of trust hampers development. A benefits-sharing framework is proposed to address this issue (Shams, A.K., & Muhammad, N.S.2022). Population growth and deterioration of water quality from waste and industrial effluents, exacerbated by armed conflict, necessitate sustainable management strategies (Alim, A.K.2006). Although surface waters are underutilized, groundwater is the main source of water in the Kabul River basin, providing 55% of the demand; extensive calculations and analysis were carried out to assess risks and develop management recommendations (Glazunova, I.V et al., 2021). Rooftop rainwater harvesting is a feasible solution to address water scarcity in Kabul New City, with estimates based on 10 years of rainfall data and current water use patterns (Rahimi, O., & Murakami, K., 2017). Because Kabul City lacks groundwater, water-saving measures like low-flow fixtures and rainwater collection may drastically cut down on water use and supply alternate sources of water (J A N Shokory and E Rabanizada 2003).

4. RESEARCH GAP

Although Kabul City's serious environmental problems have been well documented, the literature that is currently available is still dispersed, with most studies looking at problems with drainage, pollution, water scarcity, and sanitation in isolation rather than as interrelated parts of a larger, complex system. Although prior studies have effectively identified individual pressures, such as groundwater depletion, inadequate wastewater infrastructure, and the effects of rapid urbanization, there are notably few studies that combine these factors to examine their combined and synergistic effects on the city's urban water bodies.

The research has not sufficiently addressed a critical assessment of how these problems are not being handled by the present institutional capabilities, enforcement mechanisms, and overall system of governance. This study attempts to bridge that gap by providing a comprehensive overview of Kabul's current urban water management issue by integrating various data types on water sources, natural drainage, and sanitation that are methodically related. By doing this, it transcends the mere identification of issues and reaches a level of information synthesis that is used to offer thorough, practical, and climate-resilient management recommendations that are currently lacking from the conversation.

5. OBJECTIVES OF RESEARCH

1. To evaluate the institutional frameworks and current urban water body management practices in Kabul City.
2. To evaluate the present condition of surface water resources, such as the Kabul River, and groundwater resources, including the rate of recharge, depletion, and quality degradation.
3. To investigate the city's environmental problems and difficulties, including pollution from untreated water, overuse of groundwater, obstruction of natural water channels, and the consequences of climate variability, such as droughts and heavy rainfall.
4. To examine the role of socio-economic factors, such as poverty, inequality in wealth, gender, and vulnerable groups, in the management of water, its quality, quantity, and the associated environmental health risks.
5. To examine the gaps in governance, enforcement, and institutional fragmentation in the management of water in Kabul City.
6. To develop recommendations for the management of water in Kabul City, based on the principles of IWRM, such as pollution control, decentralized water treatment, artificial recharge, rainwater harvesting, river development, and the effects of variability in the climate.

6. METHODOLOGY

In order to understand the present state of the water bodies in Kabul City, the present study is designed to incorporate a comprehensive literature review, along with qualitative research methods, to analyse the state of water bodies in the city. The methodology is divided into three sections, namely:

A. A Comprehensive Review Literature

Through the study of government publications, international NGO databases, and existing academic papers, a secondary data analysis was conducted (2013-2025). This stage focused on identifying past trends in:

1. The Kabul Basin's groundwater depletion rates.
2. How natural drainage systems are affected by unplanned urbanization.

3. The current sanitary infrastructure in informal settlements is inadequate.

B. Field Observations and Site Surveys

Site inspections carried out in significant hydrological nodes, particularly along the Andrabai Road in Kabul city and nearby riverfronts, validated the conclusions from the literature.

1. Visual Documentation: The Kabul River bed's condition was recorded using high-resolution photography, with particular focus on the accumulation of solid debris, the locations of wastewater discharge, and the presence of seasonal flows.

2. Analysis of Observations: The relationship between the local population and the water sources was the primary focus of the field observations, the manual collection and transportation of water by women and children, known as the "Jerrycan Economy," was reported as a substitute for the collapse of municipal piped water infrastructure.

7. STUDY AREA

Kabul city is largest city in Afghanistan is the research area for this examination of urban water body management and environmental issues. The city is one of the highest capitals in the world, reaching around 1,791 meters (5,876 feet) above sea level and situated in a tiny valley of the Hindu Kush mountain range in the eastern side of the nation. The Kabul River physically surrounds the city and flows through its center. Historically, the river has served as the primary natural drainage channel for the metropolitan landscape.

Kabul, which is separated into 22 municipal districts for governance reasons, serves as both the provincial capital and a municipality in terms of administration. The entire area of the city is 383.1 km², although the larger Kabul Metropolitan Area (KMA), which includes the projected Kabul New City (Dehsabz region) as well as the current city, is around 1,763 km². Kabul has seen tremendous population increase; projections place its population at 4.95 million in 2025, accounting for more than 40% of Afghanistan's entire urban population. With its mountainous location and the Hindu Kush range encircling it, Kabul boasts a diverse topography that includes steep slopes, valleys, and floodplains. This rapid urbanization has made Kabul the nation's primate city and its political, cultural, and economic centerpiece. With scorching summers that surpass 30°C and chilly winters that often fall below freezing, the city has a cold semi-arid climate (Köppen classification BSk). The majority of the limited and seasonal precipitation falls between late winter and early spring, followed by protracted dry summers that exacerbate the problems associated with water shortages. The city is inherently vulnerable to water shortages during dry spells and flash flooding during periods of heavy rainfall due to its high elevation and mountainous topography. As the primary hydrological system of the city, the river and its tributaries, including as the Logar and Panjshir rivers, make up the Kabul River basin's natural drainage system. Groundwater aquifers beneath the city are the main source of water for 85% of the population. However, the threat posed by excessive use and pollution of these resources is increasing. Kabul provides an important case study for examining the complex relationships among increasing urbanization, water availability, environmental degradation, and climate change in the context of a growing urban environment because of its distinct urbanization process and distinctive geographical and hydrological features.

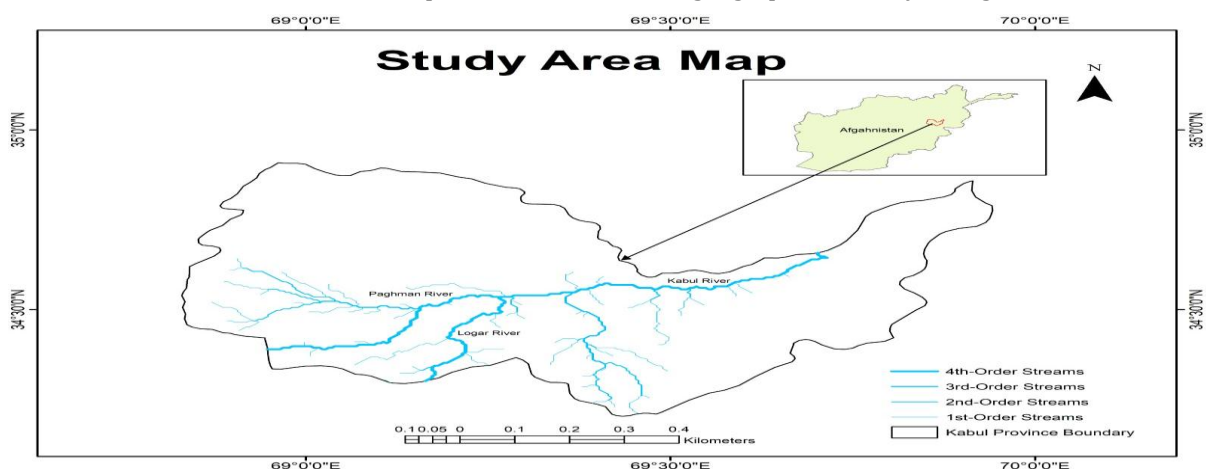


Figure 1: Study area map Kabul City
Source: Compiled by the authors

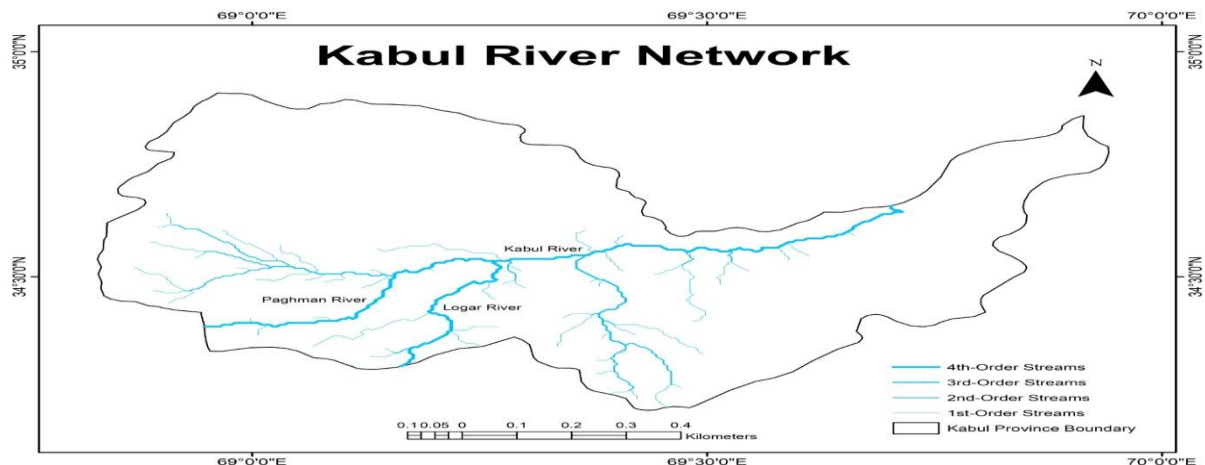


Figure 2: River network of Kabul City
Source: Compiled by the authors

8. RESULTS AND DISCUSSION

According to the study's findings, Kabul City's serious water management issue is indicated by pollution, groundwater depletion, the decline of the Kabul River, and the failure of natural drainage systems. The observations and secondary data clearly show that the groundwater level has dropped by 25 to 30 meters over the last ten years due to excessive extraction, the usage of private borewells, and insufficient recharge. The lack of a centralized sewage infrastructure means that untreated wastewater is dumped into the environment, which allows pollutants to pass into the shallow reservoirs that provide around 85% of the water used for drinking in the city. According to earlier studies, a large number of water sources have excessive levels of nitrates, microbiological contaminants, and other the quality of water standards that exceed WHO recommendations, endangering the public's health. Once the primary natural drainage stream and environmental feature of the city, the Kabul River is now more susceptible to flooding due to its diminished hydraulic capacity.

Rapid development has further reduced recharge of ground water and increased runoff from the surface during periods of heavy rainfall by substituting impermeable surfaces for permeable terrain. Unpredictability in the climate, poor infrastructure, a lack of institutional coordination, and lax enforcement of regulations have all led to a feedback loop in which water shortages and environmental degradation reinforce one other. These findings show that Kabul's water problems are interconnected governance-related environmental, and socioeconomic problems that need for coordinated water management in cities and climate-resilient design initiatives rather than being the product of discrete technology failures.

8.1 CURRENT STATUS OF THE KABUL RIVER

Once the city's lifeblood, the Kabul River has essentially devolved into a dirty, seasonal drainage canal. The Afghan capital's Kabul River section serves as a crucial marker of the basic breakdown of urban the management of water. The picture below depicts the bed of the river that has been turned into a huge, sluggish landfill where the normal hydrological flow is blocked by solid waste, primarily single-use plastics and domestic detritus. Toxins seep into the shallow aquifer as a result of this waste buildup, producing a "toxic sponges" effect.

As a result, the river is chemically dangerous and biologically dead even if it seems to be flowing. The local community faces a direct humanitarian catastrophe as a result of this environmental deterioration. Because of the absence of proper town infrastructure, the people are obliged to carry the water from far-off places, which are usually polluted sources of groundwater, thus keeping the people in a state of water poverty. Apart from revealing the hard work involved in living life, the fact that children are used for the transportation of the water in wheelbarrows and jerricans also reveals the socioeconomic implications of a generation of school hours missed because of the daily "quest for water." The story reveals that the river would still act as a vector for disease instead of life unless proper waste disposal is addressed.



Figure 3: filed visit the natural drainage in Kabul City

Source: compiled by the authors

8.2 PRESENT WATER EMERGENCY AND ITS SEVERITY

By 2025, the almost six million inhabitants of Kabul would face a critical and complex problem related to water that could affect their health. In fact, in the last ten years, more than 44 million cubic meters of water have been extracted annually compared to natural recharge, and the groundwater level has declined as much as 25 to 30 meters in aquifers in Kabul. UNICEF predicts that Kabul's aquifers might run out entirely by 2030, forcing up to three million people to evacuate if current trends continue. Nearly half of Kabul's boreholes, the city's primary source of drinking water, have already dried up. Due to extensive industrial and agricultural withdrawals, as well as more than 120,000 uncontrolled private bore wells, groundwater is being drained at a pace that is about double that of natural replenishment. Pervasive pollution makes the problem worse. Studies show that up to 80% of Kabul's groundwater is tainted with pollution, sewage, and hazardous amounts of arsenic and nitrates, endangering the city's residents' health. Due to the pollution and shortage, schools and medical services have been forced to close in some neighborhoods. For households without private wells, the price of purchasing water has gone up dramatically, making financial stresses worse. In the meantime, private water companies have been marketing groundwater, which they subsequently resell to residents at huge prices. Water shortage is now another element contributing to community tensions; in a 2008 Oxfam survey, 40% of respondents stated that water was an important issue in neighborhood and tribe clashes.

8.3 GROUNDWATER CRISIS IN KABUL CITY

Approximately 85% of Kabul City's population depends on groundwater as their main source of household water. However, there is a serious overexploitation of aquifer systems as a result of population development, urbanization, and lax enforcement of regulations. Groundwater levels have allegedly decreased by 25–30 meters over the last ten years, with certain regions seeing an average yearly depletion rate of about 2.1 meters. Kabul Basin is facing a major problem of hydrological imbalance due to current abstraction rates, which are expected to be 44 million cubic meters per year higher than natural recharge. Unsustainable abstraction is also a problem that has been exacerbated in recent times as a result of the estimated 120,000 uncontrolled private bore wells in the city. As a result of this problem, citizens are having to dig deeper bore wells at an increasing cost to themselves, as it is reported that almost half of the existing shallow wells in several areas have already run dry. A cause for concern for sustainability is also provided by this problem, as it indicates a move away from shallow aquifers to deeper groundwater abstraction. Another equally important aspect of the situation is the deteriorating level of water quality. Untreated domestic wastewater seeps into the subsurface environment because of the absence of a centralized sewage system and the extensive use of pit latrines and septic tanks. According to different studies, heavy metals, arsenic, E. coli, and nitrates are some of the substances detected in up to 80% of the groundwater sources in different regions that are above WHO drinking water standards. The hydrological link between the shallower aquifers and the affected surface areas, such the Kabul River valley, increases the degree of pollution. These problems are made worse by the effects of climate change. While the increase in impermeable surfaces brought about by urbanization reduces infiltration rates, prolonged droughts reduce recharge rates. The effect of seasonal recharge is further mitigated by the decline in snow in alpine catchments. The aquifer network is slowly running out of water due to unchecked runoff and decreasing recharge rates. Therefore, rather than being a result of resource constraints, Kabul City's groundwater dilemma is a structural problem.

However, insufficient hydrogeological data, disjointed institutional duties, weak monitoring systems, and loose enforcement of borewell licenses can make management less successful.

There is a danger of a tipping point for Kabul when aquifer recovery is no longer technically or financially viable unless integrated groundwater regulations, artificial recharge strategies, wastewater strategies, and demand-side management strategies are implemented immediately. There has been a transformation in the groundwater resource in Kabul from a sustainable resource to a resource that is under severe stress and becoming increasingly polluted. There are serious concerns for public health, urban stability, and sustainable development as it appears to be moving towards a state of long-term water insecurity.

8.4 DRINKING WATER ISSUES IN KABUL

The serious drinking water crisis in Kabul City, which was characterized by the total collapse of urban water management, was addressed by Kabul City Drinking Water Issues. The serious challenge is the fact that the majority of the population is now obliged to engage in the manual collection of water because of the catastrophic collapse of the urban piped water supply. The "jerrycan economy" is exemplified by the locals, especially children, who engage in the manual transport of cumbersome cargo through the use of a wheelbarrow.

The deterioration of the ecosystem is a constant threat to the availability of drinking water. Once a crucial natural resource, the Kabul River is now a periodic drainage system because it is full of solid waste and raw sewage. Because there is no centralized sewage system and all household water waste is untreated, the contaminants in the water and soil from this trash-filled riverbed seep straight into the shallow aquifers. There is now a "toxic link" where water pollutants like metals such as mercury seep into groundwater, which is the main source of water for drinking for 85% of the population. The drinking water crisis in Kabul City is a systematic problem brought on by unchecked growth and neglect of infrastructure. The water table itself has become hazardous both chemically and biologically. The most vulnerable residents are struggling for their daily existence every day as a result of the present "water bankruptcy," drinking from polluted and depleted boreholes that no longer meet basic safety standards.

The report's conclusions indicate that Kabul City is experiencing an overall hydrologic decline, with urban bodies of water deteriorating and a crisis-level shortage of drinkable water. The Kabul River was once a rich resource for nature, but because of the unchecked accumulation of solid garbage and the direct release of untreated wastewater, it has grown into a source of pollution.

As the pollutants from the riverbed seep into the shallow aquifers from which 85% of the population extracts its drinking water, this environmental degradation creates a "toxic link" with the drinking water supply. The resulting "water bankruptcy" forces the most at-risk populations in particular, children into a labour-intensive "jerrycan economy" in which long-term growth and education are sacrificed for survival. In the absence of an integrated management plan that places a high priority on decentralized wastewater treatment, pollution control, and climate-resilient infrastructure, Kabul runs the risk of completely running out of useable water resources, endangering the lives of its millions of residents. Unplanned urbanization surpassing infrastructure is the cause of Kabul's water issue, as shown in the below figure. The river, which ought to be a natural drainage system and a source of life, has been turned into a source of poison, driving people into a cycle of physical water work and making them more susceptible to health problems.



Figure 3: Kabul City Drinking Water Collection Points
Source: Compiled from reports by UNICEF, Mercy Corps.

9. INSTITUTIONAL AND GOVERNANCE GAPS

Kabul City's urban water issue is mostly caused by a lack of effective administration, lax enforcement of regulations, and institutional fragmentation. Water supply, sanitation, drainage, groundwater management, and environmental protection are all overlapping duties of several organizations; yet, coordination mechanisms are still insufficient and ill-defined. The lack of an integrated framework for urban water management has led to disjointed planning procedures where land-use development, solid waste management, wastewater disposal, and groundwater extraction all function without systematic coordination.

The uncontrolled abstraction rate that exceeds natural recharge rates is made possible because of the absence of regulatory controls over private bore well drilling. The environmental regulations for the disposal of solid wastes and discharge of wastewater are not stringently implemented. This has resulted in severe pollution of groundwater. Decision-making in this scenario is also impeded due to a lack of hydrogeological information, outmoded monitoring technology, insufficient technical expertise, and financial constraints. Rapid urbanization, especially of the unplanned variety outside the framework of official planning regulations, has contributed to sanitation and drainage-related issues. It is also susceptible to long periods of drought as well as heavy rainfall, given that adaptation to climate change has not been entirely integrated into urban water planning. All these issues with governance indicate a problem of institutional capacity that affects urban water management in addition to infrastructure issues. It is not possible to solve issues of continuous hydrological decline in Kabul simply through technological solutions without a stronger regulatory system, interagency cooperation, monitoring capacity, and policy commitment.

10. LIMITATIONS

This research has some limitations despite its comprehensive evaluation of Kabul City's urban water body management. First, the capacity to do long-term quantitative trend analysis is hindered by the lack of current and trustworthy hydrological and groundwater monitoring data. Second, main field studies were limited to specific locations rather than city-wide sampling due to logistical, institutional, and security reasons, which would have limited the findings' geographical generalizability.

Rather than doing comprehensive laboratory testing as part of this research, water quality assessments were mostly based on previously published studies and verified reports. Cross-verification was further complicated by irregularities in official data reporting and the lack of unified environmental databases. Lastly, infrastructure development and governance dynamics may be impacted by Kabul's quickly evolving political and socioeconomic environment, which is outside the purview of this study. These shortcomings highlight the need for better data openness, well-structured systems for monitoring, and future research that includes thorough watershed sampling and longitudinal analysis, even though they do not cast doubt on the main conclusions.

11. POLICY RECOMMENDATIONS FOR SUSTAINABLE WATER MANAGEMENT IN KABUL

An wide and comprehensive policy framework that includes institutional reform, environmental preservation, and infrastructure development is required to handle Kabul City's ongoing water problem. Before solid waste control, stormwater wastewater treatment management, and underground water regulation can be coordinated under a unified framework, an integrated managing urban water resources method must be implemented. The establishment of decentralised wastewater treatment facilities in high-density regions must be given first priority in order to stop untreated sewage from getting into the surface and groundwater supplies. To restore the hydraulic capacity and reduce the flood risk, the riverbanks and natural drainage courses must be legally protected and restored. To combat the falling groundwater level in Kabul City, artificial groundwater recharge strategies such as infiltration zones along the Kabul River and controlled aquifer recharge basins must also be implemented.

In order to reduce the burden on groundwater resources, particularly for non-potable use, rainwater harvesting should be included in building codes. To prevent further contamination of rivers and groundwater resources, there needs to be a better system of managing waste, including recycling and enforcing prohibitions on dumping waste improperly. Risk mapping, groundwater monitoring, and zoning may be assisted by using GIS-based urban planning software. To provide flexible water supply and drainage systems that may withstand climate change impacts, there needs to be consideration of long droughts and heavy rainfall events. Increasing the amount of organizational coordinating mechanisms is necessary to lessen fragmentation among entities that deal with sanitation, water supply, and environmental management. Last but not least, community awareness programs and gender-sensitive WASH initiatives needed to be expanded in order to guarantee

equal access to safe water and sanitation services and to lessen the social cost of water collection. Whatever is considered, these steps provide Kabul City an opportunity to enhance water security, reestablish environmental sustainability, and enhance public health in the long term.

12. CONCLUSION

This study has demonstrated that the urban water issue in Kabul City is the result of a number of causes, including increased urbanization, a lack of infrastructure, overuse of ground water, degradation of the environment, and climate unpredictability. The Kabul River's deterioration, the degree of pollution in groundwater, the lack of centrally managed wastewater treatment, the obstruction of natural channels of drainage, and the careless disposal of solid waste are all signs of an unsustainable and dysfunctional urban water management system. About 85% of Kabul City's population depends on groundwater, which is being overused to the point where it is being depleted more quickly than it is being recharged. In alongside the effects of climate variability, untreated sewage and surface wastes are also compromising the quality of the groundwater. The findings confirm that issues of water management in Kabul are linked to issues of governance, environment, and socioeconomic development, rather than being specific issues of water management. Among the elements that have contributed to the feedback loop of water shortages and environmental degradation are the rapid growth of informal settlements, inadequate monitoring systems, slack legal enforcement, and inadequate institutional coordination. Pollution and subterranean water depletion might cause long-term hydrological disruptions and health risks if prompt action is not taken. To reverse this trend, Kabul requires a new, all-encompassing urban water resources management strategy that includes drainage restoration, wastewater treatment, groundwater control, urban waste management reform, and climate adaptation strategies within a new planned architecture. A sustainable future for Kabul's water systems requires GIS-based surveillance of the environment, artificial aquifer recharge, decentralized management of waste water, protected drainage pathways, and gender-inclusive WASH programs. Ultimately, rebuilding the city's urban water infrastructure requires a persistent commitment to contemporary water in urban areas administration, institutional development, policy consistency, and technological improvement. Proactive, mindful of the environment urban water resource management must take the place of reactive crisis management if Kabul is to have a sustainable water future.

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