



Assessing the right to water of the urban poor in Dhaka city

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Abstract Dhaka, the capital metropolis of Bangladesh, is burdened with huge population and unplanned urbanization. It is facing huge challenge to provide city-wide water connection due to the declination of groundwater resources, pollution of surface water sources, and poor governance. The low-income communities (LICs) in the city suffer the most due to the absence of formal water supply. This study assesses the right to water of the urban poor in three select slums of the city. It dissects the issue from four broad perspectives: economic burden of water, sociopolitical constraints to attain the right to water, climate change led potential aggravation to the right, and prevailing policy environment to protect the right. It also assesses the implications of the non-fulfilment of right to water on the water security of the urban poor. The study collects primary

data using a mixed-method approach, and secondary data from government organizations and dynamic downscaling of regional climate model. The findings indicate that dealing with high water price with low income creates extra financial burden for the poor families resulting in high gender inequality. This inequality varies with hydroclimatic extremity and probability of eviction of the slums. The right to water of the urban poor, especially the slum women, would be greatly impacted by the potential climate change. The existing water and climate change policies in Bangladesh fail to address the right to water issues of the urban poor due mainly to the absence of implementation protocol. The findings would be useful in formulating policies to improve water supply to LICs in Bangladesh and elsewhere.

Keywords Urban poor · Right to water · Affordability · Water security index · Gender · Government policy · Climate change

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Introduction

Water is a basic need for human life. In fact, it is the second most important resource, after air, for human survival. Therefore, access to sufficient, safe, acceptable, physically accessible, and affordable water for personal and domestic uses is considered a human right (United Nations, 2002). This notion has become prominent since the establishment of basic water

requirements (United Nations, 1977). The key aspects of the right to water have also been identified to create the ground for common understanding, as the perception on the right to water can vary across the nations and stakeholders. These key features include entitlement, sufficiency and continuity of supply, safe and acceptable water quality, accessibility, and affordability for all (United Nations, 2010). The obligations for meeting such requirements are clarified by the Human Rights Council (COHRE et al., 2008). Several countries, namely the Democratic Republic of the Congo, South Africa, Bolivia, Uganda, Ecuador, and Uruguay, have directly protected such right through their national constitutions. Some other countries, such as Maldives, Algeria, and Sri Lanka, have formulated policies and legislations to outline the responsibilities of the State in ensuring the access to water and sanitation for all the citizens.

To ensure the right to water in a city, the establishment for the right to the city itself has also been advocated. The citizens' rights to tenure, own property and recognition of their basic needs are suggested to be included in the city fabric. In a recent follow-up, the New Urban Agenda has been adopted incorporating the sustainable development goals (SDGs) and keeping the right to city at its heart (United Nations, 2016). The right to water as a component of the right to city and citizenship is clearly outlined in the 5th and 6th thematic areas of the agenda, titled respectively "Urban Ecology and Environment" and "Urban Housing and Basic Services".

The right to water not only means access to water, but also includes the technology and infrastructure needed for transporting water, deciding the location of water points, and establishing the right to water as a resource (Boelens & Zwarteveen, 2005). The "World Charter on the Right to the City" addresses the right to water for all urban inhabitants, regardless of their income, power, gender, ethnicity, and religious orientation (World Urban Forum, 2004). Also, in the New Urban Agenda, emphasis is put on the just distribution of water resources among all citizens regardless of gender, social status, ethnicity, religion, and other aspects of diversity (United Nations, 2016). Thus, the development models must be pro-poor to ensure their right to water in terms of technology, income, and power (World Urban Forum, 2004). Moreover, equal participation of men and women in water management, collection, and decisions related

to the installation and maintenance of water points is needed to promote gender equality and social justice.

In the context of Bangladesh, the national constitution does not directly declare the right to water as a basic human right. However, the National Water Policy advocates for the right to water for all, and defines the State's responsibilities to ensure such right (Ministry of Water Resources, 1999). The rights declared in the policy are protected in the Water Act (Government of Bangladesh, 2013). The complexities in the operationalization of the right to water required further specifications in legislation, and therefore, the Water Rules (Government of Bangladesh, 2018) was adopted. The Dhaka Water Supply and Sewerage Authority (DWASA) has adopted a long-term water master plan, which is also committed to ensure water for all and is inclusive of the urban poor (DWASA, 2014). There are some other national policies, plans and regulations linked to the right to water for the people regardless of their socio-economic status and gender.

It thus appears that there are a good number of international and national policies and legislations to support the right to water. However, it is not known how far such right has been achieved, particularly by the low-income communities (LICs) living in cities of the developing countries. Moreover, it is not known how the economic and social disparities as well as the governance regimes in the LICs interplay with the right to water of the urban poor. The social and economic constraints could lead to the violations of the right to water for the urban poor and play a significant role in deteriorating their water security. However, such water security of the LICs have not been investigated, though it could be assessed using the water security index (WSI), which encompasses the social, economic and environmental dimensions of water, and covers the water availability, accessibility, affordability, quality and sanitation issues. Moreover, the potential implications of climate change on water demand and the right to water of the impoverished urban population are also not well documented.

Dhaka, the capital of Bangladesh, is the 11th largest (United Nations, 2018) and 4th least livable (EIU, 2021) city in the world. Rapid urbanization and population growth, along with gradual declination of groundwater and pollution of surface water sources, have made the city vulnerable to insecure water supply (Moshfika et al., 2022). About 50% of

its population live in slums and squatter settlements compounded with poverty (Akhter & Ahmad, 2021). The total number of slums in the city is more than 5000 (World Bank, 2017). Water and sanitation services are generally poor and expensive in the slums (Kashem & Mondal, 2022; Rahaman & Ahmed, 2016). The slums are often left out from the legal water supply. It is also not known how such poor services and high prices of water impact women differently than men.

Climate change is likely to further threaten these urban LICs, especially women, as it would increase the water requirement, and adversely affect the water resources at local and global levels (UN Water, 2010). Despite strong commitments for mitigation and adaptation efforts to climate change in the Paris Agreement (United Nations, 2015), the water-related sufferings of the poor would increase till the ongoing temperature rise is arrested. Though there are many studies on changes in climatic variables over Bangladesh using measured and model-projected climate data (CCC, 2009; CDMP, 2013; IWFM, 2022; Mondal et al., 2020), the studies focusing on climate change impacts on LICs are few (Jaren & Mondal, 2021; Mehzabin & Mondal, 2021). Climatic trend and variability, particularly in temperature, could affect water requirement, quality, distribution and price, leading to disproportionate economic and health impacts for the urban poor. The notion of right to water as a basic life and livelihood need may be jeopardized further due to climate change. However, these issues have not been investigated so far, particularly in the context of Bangladesh.

Literature review

Water has been characterized in a variety of ways over time and space, including as a public resource, a common pool resource, a flux or flow resource, a non-replaceable resource, and an economic good (Brown et al., 2016). The right to water guarantees public ownership as well as ensures equal access, non-discrimination, fair prices based on affordability, prevention of abuse by the private sector, equity in legal changes, and accountability (Prieto, 2021). Though the right to water is now widely acknowledged at the international level as well as the national level in many countries, there are frequently ongoing

practical challenges in providing this right to all residents (Miroso & Harris, 2012). Consequently, this fundamental right is not always ensured for the low-income slum residents. However, there are about one billion people who live in urban informal settlements. The world is also currently not on track to achieve the United Nations' Sustainable Development Goal number six, which seeks to ensure availability and sustainable management of water and sanitation for all by 2030 (Adams et al., 2022).

India has the largest slum population in the world. Out of 4041 statutory towns of the country, 2613 have slums, and the total slum population is over 65 million. Mukherjee et al. (2020) studied water security in the slums of Kolkata. Almost one-third of the urban population of Kolkata live in slums, and majority of them collect domestic water from standposts. About one-fifth of the slum households lack bathing facilities and two-fifths lack latrine facilities. In consequence, they experience deprivations and risks associated with water insecurity. The water insecurity in this study was assessed only from domestic water, sanitation and hygiene perspectives. Adams et al. (2022) studied the women's daily struggles for water in informal settlements in the Blantyre city of Malawi. Women were found to experience a high level of water insecurity, and water fetching was a significant time burden for them. Moreover, they were exposed to many risks related to physical terrain, social conflicts, and built environment. The study was based on qualitative data from walking interviews and audio–video records of 25 women participants. In Kibera, one of the largest slums in Africa, the female slum dwellers faced a myriad of challenges to access the water and sanitation services (Odeny, 2020). Gender inequalities among the families were blamed for the limited access to water and sanitation for the women. Gender-responsive policies and laws in relation to water and sanitation were suggested to be framed for a positive effect on the female slum dwellers.

Wagle (2022) studied the institutional appropriation of the right to water for the unprotected slum dwellers in Mumbai, India by the High Court at Bombay as well as by the Municipal Corporation of Mumbai. The study found that, due to narrow and selective interpretations and executions of the right to water by these two organizations, securing water justice for the two million poor was adversely affected.

Establishment of separate mechanisms to monitor and enforce the court directives by the executing agency was proposed to improve the situation on the ground.

In a study on water vending in an informal settlement of Nairobi, Kenya, Sarkar (2020) found that the poorer slum dwellers were more disadvantaged regarding water access and paid much more to get water. In addition, the dwellers did not receive much help from the vendors in terms of timing of water delivery, choice of payments, or frequency of payments. Thus, there was a major procedural injustice in water vending in the largest slum in Nairobi that Sarkar studied. In another study on 23 squatter settlements of Cochabamba, Bolivia (Wutich et al., 2016), it was found that grave injustices persist in unregulated informal water markets. The study underscored the need for community-based innovations in water delivery through community-vendor contracts, oversight boards, and community-owned water trucks and storages.

About 50% of the population of Dhaka city live in poor urban settlements. Haque et al. (2020) examined the quality of and access to water and sanitation services in the slums of Dhaka city. The water and sanitation services were reported to be provided mostly by the non-regulated providers, and the local landlords or middlemen played a large role in the installation and management of the facilities. In another study on a large slum of Dhaka city, Rahaman et al. (2021) assessed the drinking water, sanitation and hygiene service access levels. Only 33% of the population had access to safely managed drinking water services, and only 1.2% had access to safely managed sanitation services. About 20% of the population in Khulna city is slum dwellers. The slum residents in the city faced substantial water scarcity, inadequate drainage system, and a lack of toilets, tubewells and bathing facilities (Khan, 2022). These created a major concern, particularly for women. In another study (Akther & Ahmad, 2022), livelihoods of two slum communities in Dhaka city were found to be vulnerable in normal situation and the vulnerability increased further in stressed situation, such as urban flooding. Different livelihood assets were found to be interconnected, and hence, the negative impact of a hydro-climatic event on one asset, such as health, adversely affected other assets, such as financial capital.

From the review of above literature, it appears that some challenges in accessing, affording, and

managing safe water resources in different cities in South Asia, Africa and South America as well as some statistics on access to water and sanitation have been presented. However, an in-depth assessment of the right to water for the low-income people and its socioeconomic implications has not been conducted yet. Since one-eighth of the global population still lives in slums and squatters, there is an absolute necessity to investigate their right to water situation and suggest the potential policy and institutional measures to improve that.

Materials and methods

Study areas

The study was conducted on three select slums of the Dhaka city, the capital metropolis of Bangladesh. With the massive growth of urbanization, the Dhaka city is facing an enormous increase in the poor migrant population (Biswas et al., 2019; Hasan, 2019; Iqbal et al., 2017; Soheli et al., 2017). These migrants settle in vulnerable locations, such as slums, of the city. The life and livelihoods of these impoverished people are burdened with a lack of access to basic utility facilities and services. To better understand the right to water situations of these urban poor, we selected three slums, namely the Korail, Baganbari and Tejgaon slums, for detailed investigations. These three slums were selected after reconnaissance visits to eight slums further including the West Vasantek LIC, Paris Road slum, Boubazar slum, Kolabagan slum and Baroikhali slum. The last three slums are located in the Dhaka South City Corporation (DSCC) and others in the Dhaka North City Corporation (DNCC). The prevailing water supply system (legal or illegal), presence of environmental hazards (urban flooding or poor water quality) and demographic diversity were taken into consideration while selecting the slums. Figure 1 presents the locations of the study slums in the Dhaka city. It is to be noted that the Dhaka city was divided into two corporations for administrative conveniences a few years back. The characteristics of a slum in the city do not depend on whether it is in the north or south. For example, the Baroikhali slum in the DSCC has a legal water supply like the Korail and Baganbari slums in the DNCC. Moreover, the water supply and sanitation services in

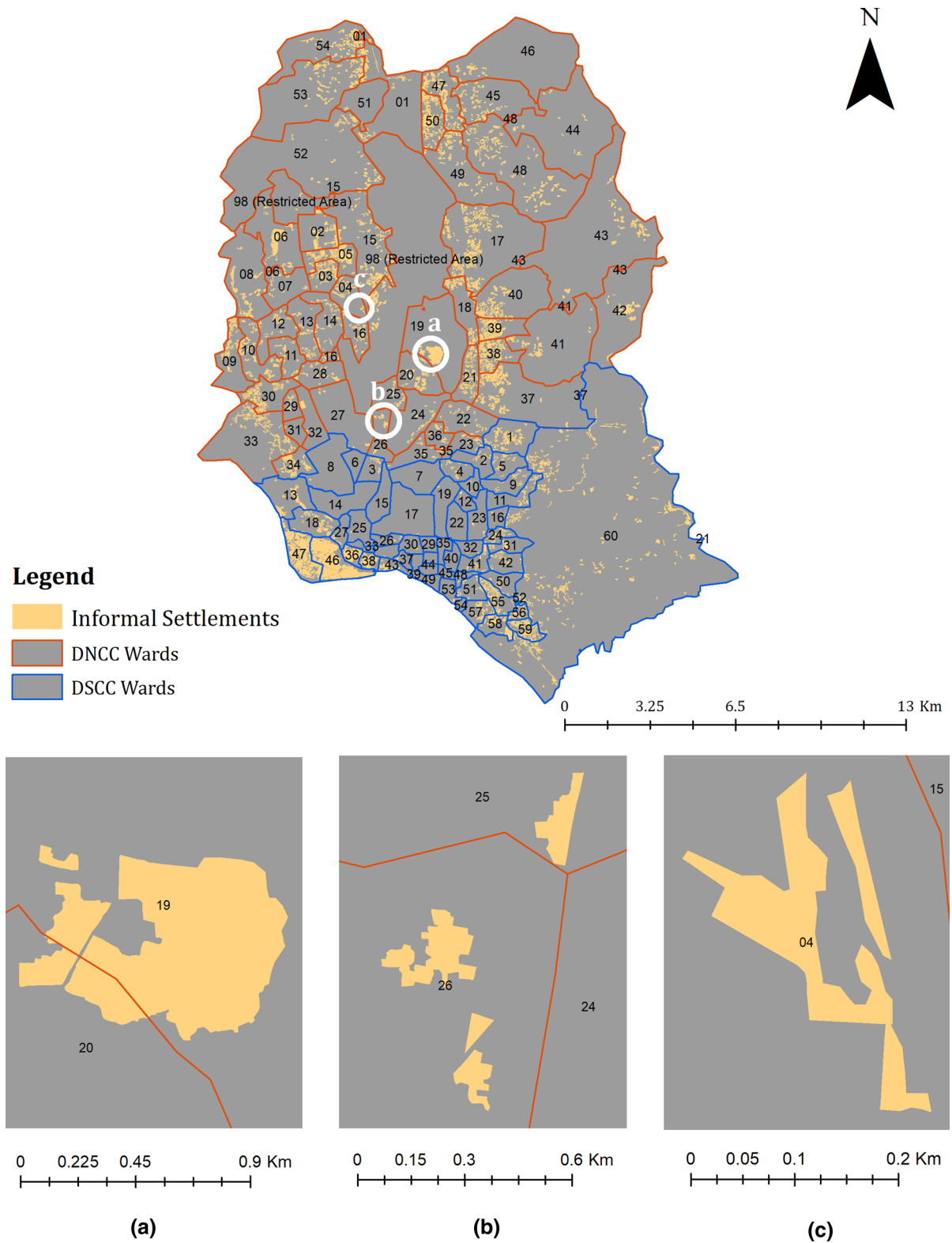


Fig. 1 Locations of the study slums in the Dhaka city: **a** Korail, **b** Baganbari, and **c** Tejgaon (Adapted from World Bank, 2017)

both the corporations are provided by a single entity (DWASA).

Of the select three slums, the Korail slum is much larger than the Baganbari and Tejgaon slums in terms of area, number of households and population coverage (Table 1). The Korail and Baganbari slums also represent the legal water connection from DWASA, while the Tejgaon slum represents the illegal water connection. In addition, the Baganbari slum has an urban flooding problem, and the Korail and Baganbari slums have water quality issues.

Methods and data

The right to water of the urban poor is linked with a number of economic, social, environmental and governance factors. A conflicting situation arises within the poor communities when water scarcity becomes severe. The changing climate increases the scarcity of water for the urban poor as the water demand increases. In addition, it becomes tough to afford the cost of utilities for the poor people with their low income in most cases, as attaining a decent job is difficult. Furthermore, the forced eviction upholds the tenure insecurity in the slums. This is one of the key sociopolitical factors that prevent from legalizing water services, leaving loopholes that the water mafias (local goons, who work as middlemen or private vendors) exploit to increase the price of water (Haque et al., 2020; Rahaman & Ahmed, 2016; Sultana, 2020). Being the water manager of every house, women become the worst victim of these water issues (Ahlers & Zwartveen, 2009; Figueiredo & Perkins, 2013). Therefore, this study is built on the interrelationships of the right to water with its economic, social, environmental and governance dimensions. A conceptual framework depicting such relationships among different factors is given in Fig. 2.

As shown in the figure, the study builds on the economic, sociopolitical, hydroclimatic and policy-governance constraints that impede to attain the right to water, and also addresses the level of water insecurity in the slums due to such constraints. Under each category of constraints, one or two representative indicators are chosen to evaluate the constraints (Table 2). The core domestic water uses, such as drinking, cooking and bathing, are considered to be lifeline uses and should be priced within the affordability range of the families. Also, it is socially unjust and unethical if an LIC is charged a higher rate than an affluent community in the formal settlement. Thus, for the economic constraint, the selected indicators are the affordability of the slum dwellers and the gap in water price in the slums with the formal water supply. If scarcity of water arises in a community, it impacts the gender relation. The forced eviction is a key barrier to offer a formal water supply in the slums. Therefore, for the sociopolitical constraint, the existing gender inequality in the slums and the chances of eviction of the slums are considered. The rise in temperature directly or indirectly increases the domestic water need. Hence, as hydroclimatic constraints, the potential rise in temperature and the increase in water demand are considered. National policies, strategies, plans and acts provide an enabling environment in which different organizations and institutes work. Therefore, the potential gaps in the current policies and plans in Bangladesh were identified and were considered as lack of enabling environment in attaining the right to water. Thus, a total of seven indicators were selected to evaluate the constraints towards gaining the right to water in the three slums.

This study follows a mixed-method approach to analyze the status of the right to water of the urban poor in the present as well as future contexts. It combines a conventional household survey with a number

Table 1 Basic characteristics of the three select slums of the Dhaka city. *Source of data:* BBS (2015)

Characteristics	Korail	Baganbari	Tejgaon
Location	Ward nos. 19 and 20 of DNCC	Ward no. 4 of DNCC	Ward no. 25 of DNCC
Area	40.46 ha	1.01 ha	1.98 ha
No. of households	18,000	350	455
Population	59,516	1734	1820
Type of water connection	Legal	Legal	Illegal

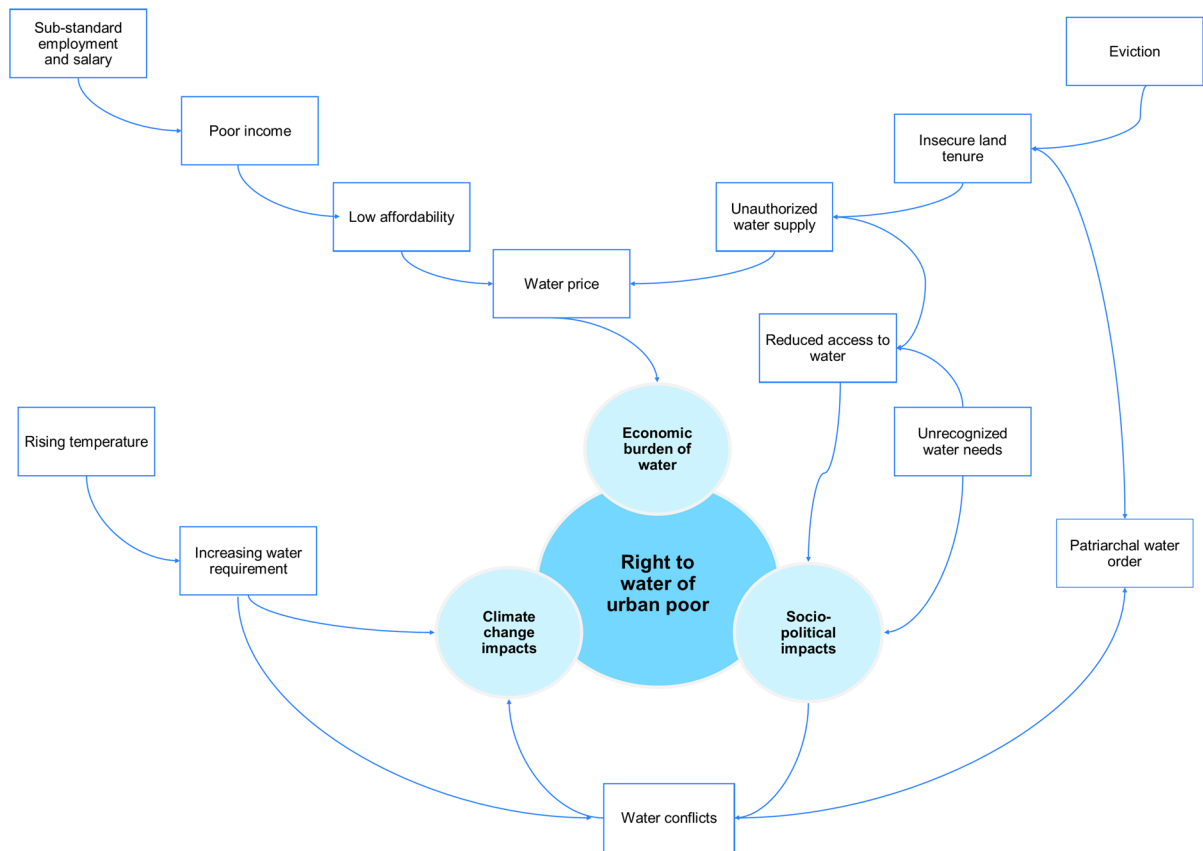


Fig. 2 Conceptual framework of the study depicting the relationships of the right to water with different pertinent variables

Table 2 Indicators selected for evaluation of constraints in attaining the right to water for the urban poor

Constraints	Evaluation indicators
Economic	Affordability of the slum dwellers Price gap with formal water supply
Sociopolitical	Gender inequality Chance of eviction
Hydroclimatic	Change in temperature Increase in water demand
Policy-governance	Gaps in policies and governance

of participatory tools to collect the necessary primary data and information. A set of questionnaires were prepared before conducting the household survey to collect data on income, expenditure, water use, unit price of water, expenditure on water, impacts of current price on water use, health and sanitation, etc. (see Supplementary Information). The questionnaires

were pre-tested in the slums before finalization and administration. A stratified random sampling technique was followed by segmenting each slum into a few smaller strata by location. Then from each stratum, the households were selected randomly from a household list. A statistical calculation with 90% confidence level, 10% margin of error, 75% standard deviation (population proportion) and finite population correction indicated a sample size of 51, 44 and 46 for the Korail, Baganbari and Tejgaon slums, respectively (Sufian, 2009). A total sample size of 150 with 50 respondents from each slum was ultimately selected. Thus, the sampling ratios were 0.3%, 14.3% and 11.0% for the Korail, Baganbari and Tejgaon slums, respectively. The survey respondents were both males and females aged mostly between 20 and 40 years. The education level of the respondents was low (secondary or below).

The household survey was supplemented by a qualitative analysis of narratives and quotations and

data from in-depth interviews (IDIs), focus group discussions (FGDs) and key informant interviews (KIIs) to better understand the right to water conditions and the underlying reasons for such conditions in the select slums. The study employed 9 FGDs (3 from each slum), 12 IDIs (4 from each slum), 3 KIIs, and 3 pair-wise rankings of water problems (one from each slum). The numbers of FGDs and IDIs were decided based on sequential sampling, i.e., targeting saturation of gathered information (Neuman, 2014). The diversity of the tools used and the number of samples gathered indicate a good representation of the select slum dwellers if compared with sample sizes of similar studies. For example, Khan (2022) collected data from the climate migrants of slums in five wards of the Khulna City Corporation in Bangladesh with only 4 KIIs and 9 FGDs. Several visits to the slums in the years of 2020 and 2021 were made to gather the data.

The study started with the identification of the problems and knowledge gaps regarding access, affordability, eviction, gender, temperature rise, water demand and water pricing mechanism in the slums by reviewing relevant literature. Then it gathered information on the prevailing water problems in the slums using transect walks. Pair-wise rankings of the problems were made to identify the dominant problems in each slum. Based on the identified problems and contextual findings in each slum, a semi-structured checklist was prepared. After that, FGDs with the target groups were carried out to understand the slum-specific water distribution systems and gather more information on the prevailing water issues. The FGDs also helped understand the economic burden of the water utilities, and the sociopolitical constraints in attaining the right to water. Then IDIs with the slum dwellers were conducted to obtain further insights on their struggles for water. The IDIs were conducted with both men and women (two males and two females from each slum) to identify the differences in their opinions and to understand the gender inequality better. To understand the social and political aspects further, the study also employed three KIIs with an official of the LIC Unit of DWASA, an official of a non-governmental organization (NGO), and a member of a community-based organization (CBO). Quotations were used to contextualize the findings on the right to water.

To understand the adverse effects of climate change on the right to water in the present and future,

analyses were done for the years of 1953–2020 with the observed data, and projections were made for the years 2021–2100 with the modeled data for the core city area. The analyses were done mainly for temperature as it is directly linked with the right to water at the household level. The observed daily data were collected from the Bangladesh Meteorological Department, and the projected future data for the Representative Concentration Pathway (RCP) 4.5 (moderate climate change) and RCP 8.5 (extreme climate change) were collected from the Coordinated Regional Climate Downscaling Experiment. The latter data were downloaded from the online portal of the World Climate Research Program. The data from the Rossby Center regional atmospheric model (RCA4) was used in this study as this model data has recently been used in the Bangladesh Forest Master Plan 2017–2036 (Bangladesh Forest Department, 2016). However, the downloaded data per se could not suffice for the local scale needed. Hence, bias correction on the data was done using the following variance scaling equation (Fang et al., 2015; Mendez et al., 2020):

$$T_{cor,m,d} = \frac{T_{cor,m,d} - \mu(T_{raw,m})}{\sigma(T_{raw,m})} \sigma(T_{obs,m}) + \mu(T_{obs,m}) \quad (1)$$

where $T_{cor,m,d}$ is the corrected temperature on the d th day of m th month, $T_{raw,m,d}$ is the raw temperature on the d th day of m th month. $\mu(\cdot)$ and $\sigma(\cdot)$ represent the expectation and standard deviation operators, respectively. The subscripts ‘obs’ and ‘raw’ refer to the observed and raw data values, respectively.

The adequacy of the bias correction was checked with the Coefficient of Determination (R^2), Percentage Bias (PBias), Nash–Sutcliffe Efficiency (NSE), Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE). The CMhyd software (Rathjens et al., 2016) was used for the bias correction of the climate data, and the ClimPACT2 package in R (Alexander & Herold, 2016) was used for the calculation of the climate factor “Daily Maximum Temperature Beyond 32 °C”.

To see the implications of right to water on the water security of the slum dwellers, we also assessed the water security in different slums. Several studies have assessed water security using diverse frameworks, which mainly focus on certain mutual factors, such as

availability, accessibility, affordability, quality, safety, management and governance (Ahmed et al., 2018; Babel et al., 2020; Gain et al., 2016; Jensen & Wu, 2018; Li et al., 2019; Ray & Shaw, 2019). This study uses a WSI based approach that encompasses three main water security dimensions: social, economic, and environmental. Having no significant overlap, each dimension captures a distinctive aspect of water security. The dimensions are characterized by two or more contextual indicators, such as water use (per capita) gap with the World Health Organization (WHO) standard, average time spent to avail service per use, no. of people served per toilet, no. of people served per water point (social); percentage of income spent for water, ratio of slum water price and formal residential water price (economic); average annual GW depletion (m), percentage of slum area getting flooded, and dissatisfaction with water quality (environmental). Both primary (stated above) and secondary data were needed to assess the WSI. The required secondary data such as groundwater level was collected from the Bangladesh Water Development Board (BWDB) for the time period of 1996–2020. To calculate the percentage of flooded area, Sentinel-1 image was acquired for the week of flooding (July 15–21, 2020). Upon inspection, calibration, conversion to decibels and terrain adjustments, the flood map was prepared in the Sentinel Application Platform (SNAP) and the flooded area was calculated in the Quantum Geographic Information System (QGIS).

The WSI of each slum was estimated using a multi-criteria assessment called principal component analysis (PCA). For an unbiased scoring of the water insecurity indicators, the values of the indicators were standardized using a standardized scoring technique (Min–Max) and the weights of the indicators were determined using PCA. There were both positive and negative indicators in the study. To address the differences, two separate formulas were used for standardization of the indicator values as below:

$$x_i^* = \frac{x_i - \frac{x_{min}}{1.05}}{(x_{max} * 1.05) - \frac{x_{min}}{1.05}} \text{ (for } x_i \text{ being a positive indicator)} \quad (2)$$

$$x_i^* = \frac{(x_{max} * 1.05) - x_i}{(x_{max} * 1.05) - \frac{x_{min}}{1.05}} \text{ (for } x_i \text{ being a negative indicator)} \quad (3)$$

where x_i^* is the standardized value of an indicator for location i . The terms x_i , x_{min} , and x_{max} are the original value for location i , and the lowest and highest values considered, respectively (Tang & Feng, 2016).

Using the PCA method for weight determination has an advantage of dimension reduction without the resultant principal components (PCs) being correlated. The maximum number of PCs possible is equal to the number of variables. Each PC is associated with an eigenvector that provides the weight to the indicator. To determine the weight, PCs that obtain an eigenvalue (λ) of greater than 0.7 are used. As more than one PC was selected, more than one weight was available for each indicator. Therefore, an aggregation method of the PCs was needed to calculate the weight of the indicators. First, the loadings (product of eigenvector and square root of eigen value) for the indicators were determined. Then, for the selected PCs, the sum of square roots of eigen values was determined (Senna et al., 2019) as below:

$$w_i = \sum_{k=1}^n \left(v_{k,i} \frac{\sqrt{\lambda_k}}{\sum_{j=1}^n \sqrt{\lambda_j}} \right) \quad (4)$$

where w_i is the final weight for the indicator i , k is the number of principal components, $v_{k,i}$ are the eigen vectors that vary from 1 to k (PCs) and from 1 to i (indicators), λ_k are the eigen values of k number of PCs, and $\sum_{j=1}^n \sqrt{\lambda_j}$ is the sum of the j -adopted eigen values after the selection of PCs based on the criteria application. The higher the variance proportion is expressed by the loadings, the higher the weight will be to compose a final weight of an indicator. All the calculations were done in python programming. The overall score was determined as below:

$$WSI = \frac{\sum_i^n w_i * x_i^*}{\sum_i^n w_i} \quad (5)$$

where n is the number of cases for different scenarios and years, and i is the indicator. The maximum and minimum scores possible are 1, and 0, respectively (Tang & Feng, 2016).

Results and discussion

Economic burden of water

Every year a large number of low-income people move to Dhaka due to the capital centric development and income opportunities. The migration has become more frequent with the progression of industrialization, i.e., garment factory which has generated huge demand for the urban labor (Al Amin & Kalam, 2017; Ishtiaque & Ullah, 2013). Hope for a better living with employment outnumbers all the other reasons for relocating to this metropolis (Al Amin & Kalam, 2017; Biswas et al., 2019). The migrants engage themselves in a variety of works in the informal sectors as garment workers, vendors, day laborers, street hawkers, industrial workers and rickshaw pullers (Alamgir et al., 2009; BBS, 2015; Haque & Islam, 2012) and add a significant economic contribution to the city (Biswas et al., 2019; Haggblade et al., 2010). Although the urban sector is undergoing a significant growth (60%) in gross domestic product (GDP) (Ishtiaque & Ullah, 2013), the income inequality has increased by 10% (Ahmed, 2014). Being a labor-abundant developing country, the work is offered at a very cheap rate regardless of the significance of that work in the country's economy. As a result, the struggle for a better living for the unemployed or migrated poor people continues, despite getting several work opportunities in this city. They have less access to the standard salaried income on one hand, they are also underpaid on the other. An example can be drawn from the garment workers in this regard. Garments, the largest exporting industries in Bangladesh, contribute about 16% to the total GDP by conveying 81% of the foreign exchange (Rahman et al., 2017), but nearly all the workers are poorly paid here (Hossain et al., 2018).

The under-wage scenario is clearly identified in the study findings. From our primary data, we find that a female garment worker is paid only US \$25–\$60 a month (1 US\$ = BDT 84.74 as per 2021 conversion rate) depending on her responsibilities. A poor family head of other occupations gets only \$53–\$118 a month to maintain all the basic needs for the family. More than half of these families are also in the lowest income category. The average incomes are estimated to be \$89, \$66 and \$76 per month for the Korail, Baganbari and Tejgaon slum

residents, respectively. Thus, their income is comparatively lower than the other city residents having an average monthly income of \$650 (PPRC, 2016) which indicates their low affordability. However, their level of affordability does not matter in accessing the basic water. This is evident from the statement of a slum dweller in the Tejgaon slum, 'Our low income does not matter at all for getting water. There is no water for us when we do not have money to pay for it'. Thus, although the impoverished people come with a hope of better living, their low affordability often creates obstacles in the way of this hope.

The slum dwellers have to spend a significant portion of their little income for accessing basic utilities. The people living in the Korail and Baganbari slums spend about 1.3–2.0% of their income just on water utilities. These circumstances even get worse in the case of not having an authorized water supply system. Water accessibility of the city, however, is close to meeting the SDGs, but the right to basic water for the LICs is yet to be achieved because of the several prevailing issues regarding water quality, pricing, reliability and liability. At many levels of service delivery, the involvement of middlemen (local mafias or private vendors) is witnessed. Particularly where there is no legal water connection, water is supplied at a high price by the private vendors. For example, in the Tejgaon slum, the people are paying \$2.95 for buying 1000 L of water, whereas it is only \$0.17 for the legalized connection holders. Nearly 90% of the slum respondents criticized the existing water price for not falling under their affordability ranges. The combination of high water price with low income forces the slum dwellers to spend more than 8% of their monthly income on the water on an average in the Tejgaon slum. Even in some cases, the expenditure exceeds 14% of their monthly incomes.

The economic burden of water is more clearly understood through a comparative breakdown of the existing water issues in the study slums (Table 3). Despite their low income, the dwellers of the Korail and Baganbari slums use 38–46 L of water per capita per day (lpcd) on an average. This quantity of water use is greater than the basic access standard (20 lpcd) (Howard et al., 2020). However, the water use of the Tejgaon slum (17–18 lpcd) does not even meet the basic standard because of its higher price. The current water-use practice is further instigating other

Table 3 Comparative scenarios of existing water issues in the select slums of the Dhaka city

Existing water issues	Korail	Baganbari	Tejgaon
Average income per month	BDT 7542	BDT 5593	BDT 6440
Type of water supply	Legalized connection from DWASA	Legalized connection from DWASA	Illegal connection from private vendors
Water price (per 1000 L)	BDT 14.40	BDT 14.40	BDT 249.97
Income spent on water	0.5–1.3%	1.3–2.0%	8.0%
Average water consumption	42–46 lpcd	38–40 lpcd	17–18 lpcd
Sanitation cost (per use)	No separate cost	No separate cost	BDT 5.00
Bathing cost (per time)	No separate cost	No separate cost	BDT 10.00
Open defecation rate	8%	0%	80%

BDT is the Bangladesh currency (1 US\$=BDT 84.74 as per 2021 conversion rate)

survival complications, such as low consumption of drinking water, maintaining poor sanitation hygiene and raising gender inequalities. About 64% of the respondents in the Tejgaon slum claimed to drink less water because of the high price while the ratio is quite lower in the other two slums.

As shown in Table 3, the vendors of the Tejgaon slum price separately of \$0.06 for toileting and \$0.12 for bathing for only one time which pushes the low-income people into an unhygienic sanitation practice. In addition, a family of four has to pay an additional \$14 per month for taking bath every day despite paying their monthly water charges. The exorbitant expenses make bathing a luxury for the slum dwellers. About 82% of the respondents complained that they had to take baths at two- or three-day interval. A completely different scenario is found for the other two slums. The majority of dwellers (76%) in the Korail slum use the DWASA water for drinking purpose, while it is 100% in the Baganbari slum. For getting water at an affordable price, their complaints about economic burden shifted to the fuel cost for water boiling rather than the water price itself. This

indicates that, when the price of the basic water required for meeting the daily needs is comparatively low and affordable, the slum people can pay attention to other water issues. Table 4 presents a comparative result of pair-wise ranking regarding the dominant water issues in the three slums. The results reveal that the high price of water outweighs the other issues in the Tejgaon slum. In the cases of other two slums, as water is within the affordability range, they can think about other water issues, such as quality, improper sanitation facilities, water-related hazards and water contamination. For example, when the Korail slum dwellers were asked about their main water issues, a 10-year boy replied, *What is the point of having a latrine if we do not get it to use in an emergency like diarrhea? There are so many people for one toilet, you do not know how long the queue becomes in the morning.*

To sum up, the lack of the right to water adds an economic burden to the low-income urban people. It can also be argued in an opposite way that the low affordability works as an obstacle in the way of attaining their right to water. The combined effect of

Table 4 Ranking of water-related problems in the select slums of the Dhaka city

Ranking of Problems	Korail slum	Baganbari slum	Tejgaon slum
1	Poor water quality	Urban flooding	High water price
2	Unhygienic and insufficient latrines	Poor water quality	Long-distance of water source from house
3	Waterborne diseases	Waste disposal into waterbody	Extra burden from separate sanitation cost

low affordability and high water price often pushes their life to a miserable state. They cannot maintain the basic domestic and sanitation hygiene properly on one hand, it fuels several social issues on the other. The good thing is that DWASA has provided water-connection to the four largest low-income settlements of the city, namely the Korail, Bhasantek, Paris Road and Sattola slums. The agency is also working for supplying water to the Kalapani, Beguntola, Kurmitola Camp, Balurmath, Rajur Bosti, Muktijodha Complex, Thirtynas Camp, MCC Camp, Rahamat Camp, Rabeda Camp, Ersadnagar, Vanga Dewal, Godown Bosti, Beder Bosti, etc., slums, by the help of some local NGOs (DWASA, 2018). However, there are around 3399 slums in the Dhaka city and the number of slum dwellers is around 643,735 (BBS, 2015). Thus, there are still a considerable number of LIC dwellers with no or minimal access to the legalized water connection from DWASA. They have no alternative but to depend on illegal connections for meeting their daily water needs (Nurul & Mohammod, 2014; Uddin & Baten, 2011). Such dependency is burdening them with an excessive price for basic water.

Social constraints and their implications on the right to water

Water as a human right requires access to water for all people in quantity and quality according to their basic needs. But the implementation of water as a human right faces many challenges at family, community and national levels. Social and political dynamics that shape the governance and management of water in an area may become the significant constraints. For example, political factors, such as privatization or corporatization of water, create a hindrance in the social justice of ensuring water accessible to all (Fantini, 2020). On the other hand, hierarchy in the social system, injustice and disparities result from racism, classism, sexism and other forms of discrimination, which turn water into a susceptible resource both for drinking and sanitation purposes (Tisdell, 2003). For these reasons, the right to water is dependent on the regime that ensures and enforces the fundamental human rights and social justice, more precisely, the water justice. In this study, these sociopolitical dynamics were assessed in terms of eviction and gender disparities prevailing in the studied slums.

Forced eviction is a sociopolitical constraint that violates the human right to access a utility or service including food, water, housing, health and education. It is defined as the permanent or temporary removal of individuals or communities against their will from the lands that they occupy. These individuals or communities are not provided any legal protection or access to any human right (UN-Habitat, 2011). There are many driving factors behind the forced eviction, such as poverty, political manipulation, illegal identity, urbanization and industrialization. Almost 57.8% of the people in Bangladesh live in multidimensional poverty and 21.2% are vulnerable to multiple types of deprivation (UNDP, 2013). Though the people from both urban and rural areas in Bangladesh face evictions, the low-income people living in the slums of the Dhaka city frequently confront with the forced eviction (Islam & wa Mungai, 2016). Insecure tenure and illegal settlement on public or private lands cause sudden eviction of the people in the slums and squatters in Dhaka, violating their human rights. Among the other human rights, the right to water of the impoverished slum people is significantly jeopardized due to the eviction because the legalized connection of water depends on a stable living place. As an example, DWASA provides the water supply services to the people who have land titles (individuals having land ownership) and approved building plans. Although an NGO, Dustha Shasthya Kendra (DSK), helps the slum dwellers to get a community-based water supply and sanitation system, the risk of eviction creates a hindrance for both the slum dwellers and DSK to implement any water supply project. The slum dwellers living in the frequently evicted slums do not invest in the community-based water projects due to the fear of eviction. Among the three study slums, the last eviction incidents that happened in the Baganbari and Korail slums are dated in 2011 and 2012, respectively. Both the slums have not been evicted since then, and the DWASA-based water supply and sanitation systems are available in the slums. On the other hand, the Tejgaon slum is frequently evicted, and the last eviction happened in 2020 which in turn obstructed getting a legal water supply from DWASA inside the slum.

The absence of legal water supply results in great suffering for the slum dwellers, such as collecting water from distant sources, paying a higher price for water, and compromising minimum water needs and

sanitation hygiene. Moreover, the insecure water supply is also playing a vital role in boosting up gender inequalities. As both the Baganbari and Korail slums have legal water supply inside the slums, both men and women have access to water and control over the water points to some extent. About 3–4 families jointly share a water point in both the slums and divide the payment of the water bill from DWASA among themselves. Each family in the Baganbari slum pays between \$2.4 and \$3.5 for water depending on the family size. But the scenario is different for the Tejgaon slum. Due to its location alongside a railway track, the dwellers in the Tejgaon slum do not have ownership to the land they live in and therefore they are deprived of getting legal water supply. They are highly dependent on the private vendors for getting the minimum amount of water at almost 17 times higher price than the other two slums. This finding is also supported by Rahaman and Ahmed (2016) who found that the water providers charge the slum dwellers as much as 14 times the other residents.

Due to the patriarchal social norms, the economic burden of water in the Tejgaon slum is putting huge pressure on the women for compromising their health and hygiene. In 80% of the households, at least one woman completes her defecation and urination at home and dumps the garbage beside the railway track, while the children defecate on and beside the railway track. According to a woman respondent, *Toileting is too expensive here, it is better for us to do it at home*. Moreover, nearly 60% of the female respondents claimed that they had stopped their menstruation cycles through a uterus removal surgery called hysterectomy to give relief to their husbands because it saves the additional cost for maintaining the menstruation hygiene. Besides, the water management responsibility of women forces them to travel outside the slum to carry heavy buckets of water twice or thrice a day. Regarding the sharing of water-fetching workload with men, the women felt insecure and were afraid of conflicts in the family life, even if they are employed. This was echoed in the voice of a woman who said, *If we do not collect water, will they [husbands] provide us food? Will they not abandon [divorce] us?* Therefore, the patriarchal social norms are rendering the women to suffer from several illnesses, such as itching, urinal infection, constipation, diarrhea, and gastrointestinal disorders, due to water shortages and to face some chronic physical stresses,

such as back pain and spinal pain, for carrying water regularly.

In contrast to the Tejgaon slum, the economic burden of water is not working as a catalyst for gender inequalities in the Baganbari and Korail slums. The Baganbari slum is situated beside a natural drainage system, Baunia Khal, and is frequently flooded whenever a high-intensity rainfall occurs. The tube-well platforms are inundated during the flooding which creates difficulties for the women in accessing water for drinking and sanitation purposes as well as affects their ease of movement. Children and older people are dependent on women for fetching water from the water points, taking care of them, cooking, and doing other household chores during the urban flooding. Every year during the flooding, their sufferings and burdens increase which further hampers their productive roles. These are evident from the modest queries placed before the research team by the women of the Baganbari slum, *'Apa [sister], how can we go for work during flood? Who will take care of our children? What will happen if they fall into the flood water?'* Another woman added from behind, *'Men can somehow walk and go for work, even when there is a waist-high flood, but we cannot go outside with our wet saris [clothes]. It is inappropriate and shame for a woman! What will people say?'* The women who have menstruation during the flooding also face problems in getting proper water supply and sanitation facilities. Thus, during the urban flooding, the access to and control over water resources significantly decrease for the women in the Baganbari slum.

In the Korail slum, the female respondents have claimed that their full contribution in ensuring water for all the family members is completely undervalued. Being the largest slum in the Dhaka city, many water projects are being executed in the Korail slum, but the women have no access to the decision-making process of water utility provision. The locations of the toilets and water points are still selected by the male members of the slum although they are the persons who bring and manage water for the families.

Although the underpinning factors behind gender inequalities vary from slum to slum, the main point is that the role of a woman is much broader than a mere water provider or caretaker in the studied slums. They have to utilize many soft skills, such as scheduling water collection, assigning human resources, deciding the size and number of water buckets, bargaining, and

fixing budget, and ensuring proper execution within the minimum amount of money as well as dealing with the hydroclimatic extremities. However, this enormous contribution of women is still undervalued not just because of their unpaid reproductive role, but also because of the lack of decision-making power. Though women are deemed as the water managers and held responsible to ensure water at the household level, they often have no participation in the decision-making mechanisms and control over the relevant resources. Therefore, the needs of the urban poor women regarding safe water and sanitation are often compromised despite playing a key role in executing water management-related tasks.

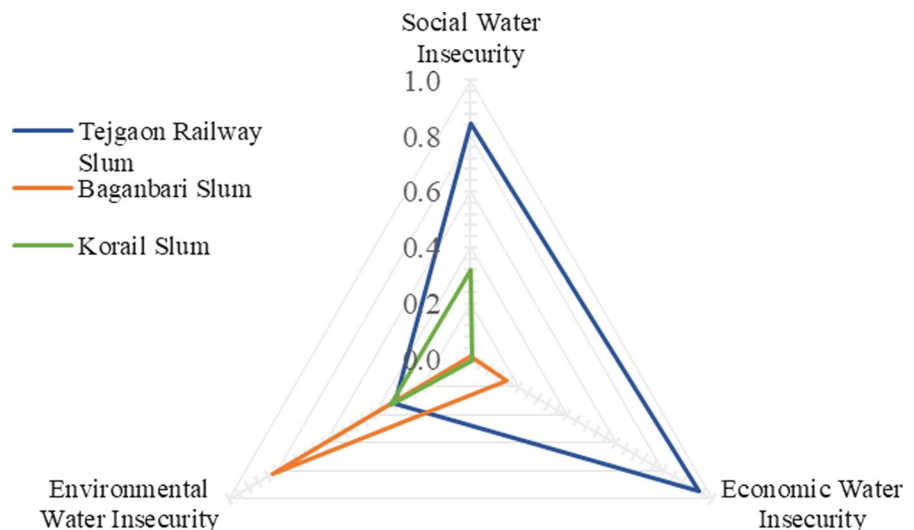
Implications on water security

The WSIs are found to be 6.2, 2.8 and 3.4 in the Tejgaon, Baganbari and Korail slums, respectively. Thus, the Tejgaon slum is found to be the most water insecure and the insecurity level is almost 3 and 2 times of the Baganbari and Korail slums, respectively, due to its informal water supply and high cost of water. A comparison of different dimensions of WSIs in the three slums is given in Fig. 3. In comparison to the other two slums, the Tejgaon slum is socially less secure. The dwellers of this slum use about half of the water used in the other two slums and fail to meet even the WHO minimum water standard (20 lpcd). The number of toilets and water points are also very few in the Tejgaon slum. About 150 people share one

toilet and waterpoint in this slum compared to about 40 people in the Baganbari slum. The presence of DWASA as well as NGOs (DSK and BRAC) in the Baganbari slum helps improve the situation. In the Korail slum, although the number of toilets is large (> 1100), there are still about 500 hanging latrines indicating the prevalence of an unhygienic sanitation practice. The Tejgaon slum dwellers have to wait for about 30 min for collecting water, whereas the Baganbari and Korail dwellers have to wait about 10–15 min.

From the economic perspective, the Tejgaon slum dwellers are more insecure than the Baganbari slum dwellers in terms of affordability and price burden. The prevailing water supply system is the major driving factor behind the inter-slum differences. As already stated, the residents of the Tejgaon slum pay 17% higher water rate than the other two slums due to the lack of legalized water supply system. This price burden has a significant impact on income-expenditure on water. The people of Korail and Baganbari slums can avail this utility service by spending only 0.5–2.0% of their income, whereas the Tejgaon slum dwellers have to spend 8.0% of their income. The three slums also show noticeable distinctions in the environment dimension. Despite being the primary source of water, the groundwater depletion rates are different in the three slums. Tejgaon exhibits the greatest depletion, while Korail exhibits the least. In terms of flooding, Baganbari exhibits the most vulnerable situation with the highest extent of flooding

Fig. 3 Water security indices of the select slums in the Dhaka city



(30%). Flooding is also prevalent in Korail (21%), but almost absent in Tejgaon due to its higher elevation. Additionally, poor water quality is a great problem for Baganbari and a portion of the Korail slum due to the odor and color of the water. Even though the Tejgaon slum has an illegal water supply, the residents do not complain about its water quality. To sum up, the level of water insecurity varies from slum to slum. In the three studied slums, Tejgaon is more socially and economically insecure. Although both the Baganbari and Korail slums are getting the utility services legally, the dwellers of Baganbari are in comparatively better position than Korail due to its smaller size and low population. However, the insecurity from an environmental perspective is higher in Baganbari than the other two slums due to the severe disruption to normal life from urban flooding.

Climatic change and water needs

Dhaka is one of the most vulnerable megacities to climate change (Babel et al., 2021). Climate change could exacerbate the existing struggles of the city with further water shortages. However, the impacts would not be distributed equally among the city's residents. Lack of social, economic and political capitals has already adversely affected more than three million people living in the slums of Dhaka (Baten et al., 2021). When it comes to the right to water, the rights of the poor are compromised first. Therefore, climate change will create more pressure for the urban poor to secure enough water for their basic needs (Amjad, 2019).

The observed data from BMD shows that the mean daily temperature of the city is rising rapidly, with already more than 2 °C above the local average (Fig. 4). Such an increase is alarming from a right to water perspective, as temperature rise is linked with increasing water needs of people for drinking and other daily purposes. According to the WHO, daily temperatures reaching beyond 32 °C can increase the daily drinking water requirement alone by 1.8 L for one adult (Howard & Bartram, 2003). In recent years, the number of days with temperatures beyond this threshold has been frequent and is increasing.

On the downloaded climate model data, bias correction was made with the observed BMD data at the Dhaka station. Then a comparison of the bias corrected climate data was made with the observed BMD data. The mean annual maximum and minimum temperatures were 31.04 °C and 22.38 °C, respectively, from the BMD data. Such temperatures for an overlapping period of 2006–2017 were 30.72 °C and 22.66 °C for the RCP 4.5, and 31.06 °C and 23.08 °C for the RCP 8.5 scenario. Thus, there was a small negative bias in the maximum temperature for the RCP 4.5 scenario. There was a small positive bias in the minimum temperature for both the RCP 4.5 and RCP 8.5 scenarios. The adequacy-check statistics of the bias correction are given in Table 5. As seen from the table, the PBIAS, MAE and RMSE are low and NSE is high for both maximum and minimum temperatures in both RCP 4.5 and RCP 8.5 scenarios. Based on the PBIAS and NSE values, the bias correction results can be considered to be very good (Moriasi et al., 2007).

Fig. 4 Annual temperature anomaly in Dhaka (1953–2017)

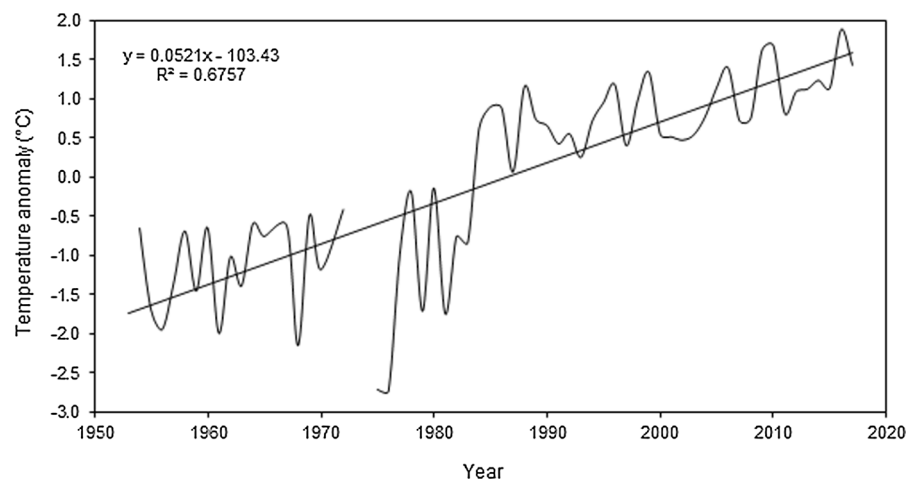


Table 5 Adequacy-check statistics of bias correction on climate model data for Dhaka

Temperature	RCP	PBIAS	NSE	MAE (°C)	RMSE (°C)
Maximum	4.5	−1.06	0.78	2.4	3.1
Minimum	4.5	1.25	0.89	2.1	2.8
Maximum	8.5	0.04	0.79	2.2	3.6
Minimum	8.5	3.12	0.88	2.2	2.9

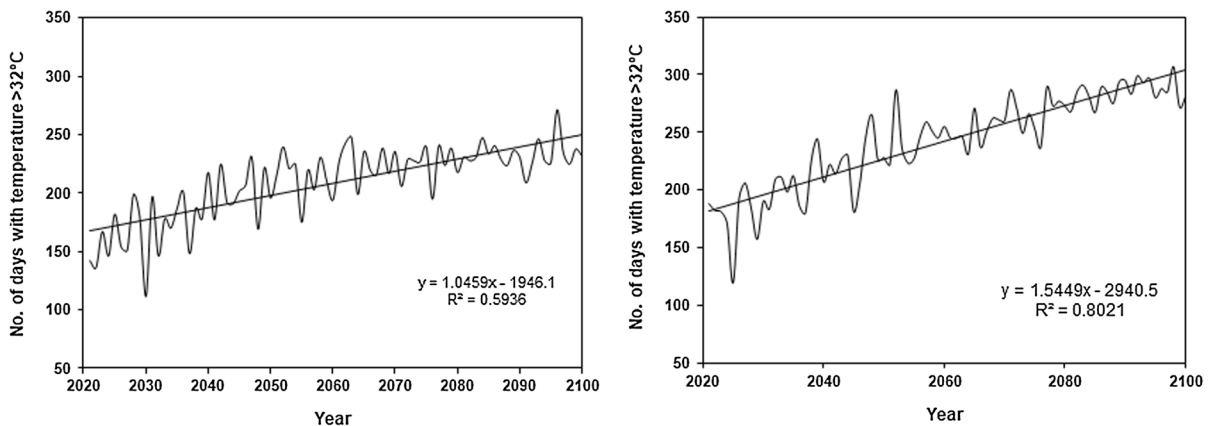
Future projections for temperature at both moderate (RCP 4.5) and extreme (RCP 8.5) emission scenarios (Fig. 5) indicate that more than two-thirds of a year by 2100 would have daily maximum temperature beyond 32 °C at which the drinking water need could exceed almost 2 lpcd. Although WHO did not provide any estimate of how water uses in other spectrums, such as bathing, washing and cleaning, would be affected by such thermal increase, it confirms that regardless of socio-economic status, the need in other uses will also increase with rising temperature. The high temperatures would also be detrimental for the human body, as thermal regulation of the body needs additional support, like energy intensive cooling facility. Increasing temperature can cause serious loss of productivity of the people, especially for the urban poor, as they can neither afford housing with proper insulation, nor jobs that are less demanding of physical labor. In such cases, securing basic drinking water will become more expensive for the urban poor.

The low-income settlers who do not have a continuous water supply will struggle the most as their

required number of trips to collect water, time spent on water collection and conflicts in water use will increase. The urban poor communities who do not have access to a subsidized water supply will be further worse off as the water price will likely exceed their economic capacity due to the skewed demand–supply situation of water in the Dhaka city. As it is observed that the society is mostly patriarchal and the women are held responsible for water management at the household level, their water needs would be at the threat of becoming secondary in dire crisis scenarios. Such a situation would expose the women to different health risks like urinary tract infection and poor menstrual hygiene. In our research, the Tejgaon slum was a place where the urban poor did not have the DWASA water supply and paid 17 times higher water price than the other places. The drinking water needs were not fulfilled as well, especially for the women in the Tejgaon slum. Because the water points are distant and the services for water and sanitation are not continuous, the women often did not feel safe to avail the services as well. This scenario depicts how extreme threat is posed to the right to water when an authorized water supply to the urban poor is not ensured.

Policies to safeguard the right to water

For the urban poor in the Dhaka city, the equation of right to water is not simple. The success of water and sanitation projects heavily depend on both the effectiveness of policy implementation and the state

**Fig. 5** Number of days per annum with projected maximum temperature > 32 °C in Dhaka during 2021–2100 for RCP 4.5 (left) and RCP 8.5 (right) scenarios

of the settlement. To this day in 2022, most of the urban poor reside in slums, which are prone to evictions. This unstable housing scenario is one of the main reasons for many organizations to retract their projects (DSK, 2019). The rapid growth of slums and squatters in the cities are mentioned in the National Housing Policy (Ministry of Housing & Public Works, 2016). The measures to be undertaken for the upgradation of slums and squatters to ensure the basic needs of the urban poor and improve their living standard are also described in this policy. As outlined in the policy, the shifting of a slum or squatter is to be considered only if an inevitable situation arises and a proper resettlement and rehabilitation plan is prepared. A forced eviction of slums and squatters is illegal according to the policy, only resettlements with proper strategy are suggested. Nevertheless, the National Housing Policy does not mention about land ownership or tenure rights of the slum and squatter dwellers. As housing is a basic right according to the Constitution of Bangladesh, the provision of secured tenure or land ownership would help the urban poor to ensure their basic human rights, including the right to water. DWASA in its water master plan (DWASA, 2014) envisioned for a full coverage including slums of water supply services and proposed a mechanism for ensuring water supply to the slums. But it still needs a long time to provide the full water coverage in the LICs of this city.

Regarding the women's right to water, the National Water Policy (NWP) (Ministry of Water Resources, 1999) has conscripted participation of women in local community water management organizations and creation of enabling environment for women. NWP states that women's involvement in water management needs to be ensured to reduce the gender inequality, empower women in decision making and establish their right to water by themselves. Besides, it is also stated that the interests of the water users from LICs, especially women, are required to be protected. Additionally, access to safe water and sanitation, and stakeholder participation are also mentioned in the NWP. Later, the Bangladesh Water Act was enacted to integrate the development, management, protection and use of water resources. The water act emphasizes water rights, optimum use of water resources and conservation of nature (Gain et al., 2017). The act states that all rights over surface water, groundwater, sea water and atmospheric water within the

country territory are vested upon the State on behalf of its people. In the act, the highest priority is given to the right to potable water, hygiene and sanitation, although the gender issues are not directly mentioned (Government of Bangladesh, 2013). Besides, the gender budget report of Bangladesh for 2019–2020 describes strategic objectives, targeted for women's rights and advancement in sustainable management of water resources (Ministry of Finance, 2019). The report mentions that the participation of women in water resource management will be ensured, and women will constitute 33% of the total members in the organizations related to water management.

Another challenge in the pathway towards ensuring the right to water is the affordability of the people. The first policy addressing the pro-poor strategies in water sector (LGD, 2005) highlighted the need for providing a safety net for the poor people. Following that, the National Strategy for Water Supply and Sanitation in Bangladesh (LGD, 2014) also highly emphasized the need for establishment of the right and ownership of the marginalized and vulnerable groups. The policy proposes a progressive tariff for the piped water supply and sewerage systems with an inclusion of a lifeline tariff for the poor for basic level services (LGD, 2012, 2014). However, the proposed pricing framework in the policy has not yet been implemented (Qureshi et al., 2015).

Regarding climate change adaptation, there are many policies for national and local levels, such as the National Adaptation Program of Action (MoEF, 2009) and Bangladesh Climate Change Strategy and Action Plan (Government of Bangladesh, 2009). Bangladesh has prepared a separate gender action plan to ensure gender equality in climate related policies, strategies and interventions (MoEF, 2013). However, specific guidelines to ensure water-resilience for the urban poor are absent in the policies. Although the Bangladesh Delta Plan 2100 (GED, 2018) addresses the need to promote the resilience of the urban poor, the urban poor women are still overlooked in the plan. The DWASA master plan also did not consider the potential increase in water demands due to climate change. The national water policy did not address the climate change issues, and therefore needs updating. Moreover, climate change adaptation practices need to internalize the gender issues, as only a small share of the current adaptation

practices specifically consider those (Mondal et al., 2019).

To sum up, the people's right to water is well documented in the Bangladesh policies. Many of the water and climate change policies in the country acknowledge the gender and affordability challenges of the LICs but fail to provide any roadmap for their implementation. Hence, the implementation of the right to water policies occurs on a rare basis. The issues of gender, equity and social good generally get weakened as we move from policies to institutions to projects (Gain et al., 2017). Lack of good governance norms and practices while implementing different organizational and institutional policies results in low implementation of the policies (Mondal et al., 2014). Moreover, the implementation of the policies often leaves behind the marginal groups (Baten et al., 2021). Moreover, despite women being considered providers and managers of water, their decision-making power and voice in policies and plans are neglected (Lane & Jarman, 1998). Water is distributed in "patriarchal water order" where water is treated as a commodity, not as a resource, and the right to water refers to the right to capital or political power (Shiva, 1998). The patriarchal order devalues and damages water as a resource that women need for their survival and puts market value that can only be controlled by men (Panda, 2007). Because of the discriminatory system, the needs and voices of women are often not well understood, and hence neglected in necessary interventions. Providing legal water connection to LICs—either directly by DWASA or through NGOs, implementing a lifeline water pricing through a per capita based block tariff system, incorporation of the gender and climate change issues while updating the policies, and reducing the gap between policy and practice through capacity building of implementing agencies are some of the initiatives that can be undertaken to promote the right to water for the urban poor.

Conclusions

The slums and squatter settlements in the Dhaka city have unique social, economic, environmental and governance characteristics. These characteristics act as potential barriers in attaining the right to water for the urban poor. Disparities in accessibility and affordability of water create havoc to the life of

the slum dwellers, particularly for women. Despite water being a fundamental human right, the dwellers of the three select slums are denied from their right to water, though the degree of denial is different in different slums. The Baganbari and Korail slums have legal water connection, but the poor quality of water along with the poor sanitation system due to environmental degradation and encroachment to nearby surface waterbodies hampers to attain safe and hygienic water. Contrary to this, the Tejgaon slum does not have a legal water connection, and hence its dwellers have to pay a high price for accessing basic water. Paying higher price for water by the low-income dwellers of this slum creates additional constraints to their other family expenditures. The patriarchal societal norms combined with the financial burden create obstacles in the life of women in the slums, especially in maintaining basic water and sanitation needs and personal health, as their needs are seen as secondary and are often blocked from positions of decision-making regarding water and sanitation. Equity in water distribution and price regulation are necessary to reduce the social injustice and economic burden in the low-income informal urban settlements. Security of land tenure for the urban poor and penalties for forced evictions without consensual rehabilitation are to be clearly stated in the housing policy of Bangladesh. Moreover, existing policies do not include climate-resilient strategies for the urban poor, though alarming rise of temperature and heat waves is evident to create more pressure on such socially excluded groups with extra economic burden in future. Strategies and essential actions should be taken to reduce the climate change impacts by revisioning the current development plans of relevant authorities, such as DWASA, City Corporation and Capital Development Authority (RAJUK). Providing water at affordable price through legal connections and stopping forced evictions are necessary to secure the right to water for the urban poor. The inter-slum differences reveal that the water security in slums is highly contextual. Hence, policies not only require addressing the general right to water of the people living in slums, but also demand specific guidelines to generate evidence-based contextual solution and address the gender needs.

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Data availability The data used in the study can be made available upon request to the corresponding author.

Declarations

Conflict of interest The authors have no relevant financial or non-financial conflict of interest associated with this manuscript.

Informed consent Participation in the study was voluntary.

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