Chapter 13
Coping with Urban Water Insecurity in the Colonial City of Kolkata and Implications on Sustainable Development Goals

Bhaswati Ray and Rajib Shaw

Abstract The Sustainable Development Goals adopted in September 2015 aim at ensuring clean water and sanitation to all, building resilience in infrastructure through innovations, and making cities inclusive, resilient and sustainable, at a time when global water systems are challenges by variability in climatic conditions, rapid growth of population, and environmental degradation. Moving from a tank-based surface water supply system, the colonial capital since 1773 had its first pumping station in 1820 to distribute water from River Hugli to the main city by gravity. Though having sufficient supply of freshwater, the current water supply system in the megacity of Kolkata is crippled with intermittent supply, old worn-out zonal mains, high leakage loss, inadequate coverage, dependence on groundwater, poor water quality, and low-cost recovery. In this paper, an attempt has been made to study the existing water supply system and its implications on the Sustainable Development Goals 2015 and to also explore coping strategies for a resilient and sustainable water future. It is evident that the formal water supply system is far from adequate and communities are seeking resilience in an informal parallel water supply system.

Keywords Water systems · Communities · Sustainable

13.1 Introduction

Providing clean water to all is the greatest challenge facing urban water systems in the twenty-first century, under the impacts of exponential growth of population, rapid and mass urbanization, higher levels of consumption, changes in land use pattern, and climate change. Over one billion people worldwide lack access to clean and safe

B. Ray (✉)
Sivanath Sastri College, University of Calcutta, Kolkata, India
e-mail: bhaswati173@gmail.com

R. Shaw
Graduate School of Media and Governance, Keio University, Fujisawa, Japan

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water, and 2.4 billion people live without adequate sanitation (Vo 2007; Cain and Gleick 2005; Cosgrove and Rjisberman 2000; Gleick 1999, 2003). The importance of water in the global sustainable development agenda beyond 2015 is evident from the fact that water has been recognized as a key to a sustainable future at the 2012 United Nations Conference on Sustainable Development. The key global challenges of poverty, hunger, illiteracy, inadequate health services, gender inequality, degraded ecosystems, climate change, and disasters as also their impacts are governed by the availability of safe drinking water. The Sustainable Development Goals adopted in September 2015 thus aim at ensuring clean water and sanitation to all, building resilience in infrastructure through innovations, and making cities resilient and hence sustainable.

Sustainable management of water resources and capacity building are essential components for a resilient and sustainable water supply system in most urban areas across the globe. The Indian cities are no exception. Most Indian cities are faced with water insecurity issues under the twin impacts of mass urbanization and climate variability. The urban population of India is 377 million and accounts for 31% of the country's total population (Census of India 2011). The average annual increase of urban population is estimated at eight million (Census of India 2011). The decadal urban growth is recorded at 3.4% between 2001 and 2011, an increase from 2.1% between 1991 and 2001. Nearly, 43% of this urban population resides in the metropolitan or million-plus cities. The urban population is also projected to increase rapidly from 377 million in 2011 to 600 million by 2030, an increase of more than 200 million in 20 years (Planning Commission 2012). The increase is likely to be concentrated in the large cities. The massive size of the mega cities of India is well documented in the ranking of world cities by the United Nations based on population size. Mumbai and Delhi are placed among the top 10 cities, while Kolkata is ranked among the top 15 (United Nations Human Settlements Programme 2011).

The Indian cities, particularly the million-plus cities, are affected by severe water insecurity, evident from the inadequate availability of safe drinking water as well as from the frequent urban floods during monsoon months. In a study by Mathur et al. (2000), it was seen that only 2.7% of the municipalities under study supplied more than 100 l of water per capita per day. The 100 l benchmark is in accordance with the norm for urban water supply by the National Institute of Urban Affairs (NIUA), fixed at 95–125 l per capita per day, though it is higher for the medium-sized towns at 150 l per capita per day (National Institute of Urban Affairs 1997). It may be noted that the minimum desirable supply of drinking water per person per day is higher for the Class I towns and is 220 l according to the National Commission of Integrated Water Resource Management (NCIWRD) (1999). The hours of supply are also limited in all urban centers, except for Thiruvananthapuram and Kota, where the supply of water is for 24 h. The average supply of water to the urban centers is for 4.3 h only, and 30% of the water is lost during transmission (Asian Development Bank 2007). The National Water Policy 2002 encourages private participation and recommends private involvement in building, owning and operating, water resources facilities for increased resilience and capacity building (Ministry of Water Resources 2002).

Like most Indian cities, the megacity of Kolkata also faces severe water stress under the impacts of rapid urbanization and expanding city size. The water supply system, one of the oldest in the country built during colonial period, has failed to keep pace with the rapid urban growth. The study focuses on the water insecurity issues in the megacity of Kolkata and its implications on Sustainable Development Goals. The scope of the paper is defined by the appraisal of drinking water insecurity in the colonial capital of Kolkata and the associated unsustainable withdrawal of groundwater, community participation for improved water supply and wastewater management. It thus addresses some of the targets specified in SDGs particularly those in goals 6, 9, 11, and 15. Goal 6 on water supply and sanitation aim at ensuring availability of water and sanitation for all, sustainable management of water resources, and capacity building through innovations and community participation. Goal 9 emphasizes innovations for improved infrastructure, Goal 11 on building inclusive and resilient cities, and goal 15 recommends ecosystem management.

13.2 The Colonial City of Kolkata

Kolkata, referred to as Calcutta till 2001, is one of the biggest cities of eastern India sprawling over an area of 187.33 km^2 and with a population 4.5 million according to the Census of India, 2011. With the addition of Joka I and Joka II Gram panchayats on September 1, 2012, the total area under the jurisdiction of Kolkata Municipal Corporation now stands at 200.71 km^2. Kolkata is the third largest megacity in India. The population of the urban agglomeration was 14.1 million in 2011 (Census of India 2011). The city, evolved from the merging of three rural hamlets of Kolkata, Sutanuti, and Gobindapur, was the hub of commercial and business activities for the British since 1690 and was nominated to the capital of India in 1773. Located in the Ganga Delta region only 100 km from the Bay of Bengal, it is at an elevation of only 1.5–9.0 m. Much of the city was a vast marshy wetland, remnants of which still remain as the East Calcutta wetlands and occupies the eastern peripheral parts of the city, reclaimed over the decades to accommodate the city's increasing population. To protect the wetlands from being reclaimed and converted into urban use to accommodate the expansion of Kolkata, the East Calcutta wetlands are designated as Ramsar site with restrictions on alternate use under the Ramsar Convention held on August 19, 2002.

Flanked by the River Hugli on the west and the River Kulti to the east, the city is hydrologically endowed with enough freshwater. Kolkata also has rich reserves of groundwater available at a depth of only 3 m from the surface. Yet the city is water insecure.

13.3 Evolution of the Urban Water System in the Colonial City of Kolkata

The water supply system of Kolkata built by the British during colonial period is one of the oldest in the country. In the early days, the drinking water supply in Kolkata was from River Hugli, though the banks and the river were prone to polluting activities like bathing, washing, and idol immersion. Water pollution was thus a major concern for the European residents in this trade capital of the British East India Company. Having revulsion for the polluted water of River Hugli, the Europeans living in Kolkata preferred to use stored rainwater, even for the purpose of drinking. Improved and extensive storage facilities were needed as the city grew in terms of population and importance, particularly since 1773 when the city was nominated to become the capital city of British India. Kolkata continued to serve as the capital of India till 1912. It was during this period that more tanks were dug to conserve rainwater to enhance drinking water supply in the city. The oldest of them popularly known as Lal Dighi at Dalhousie Square, the heritage hub of the city, was deepened further in 1709 to ensure improved water supply to the garrison city at Fort William, around which the colonial capital of Kolkata later expanded. Between 1805 and 1836, large water tanks were excavated at College Square, Wellington Square, and Wellesley Square that ensured increased water supply in the city.

Later, in 1820, a small pumping station and a system of open masonry aqueducts were constructed (Ray and Shaw 2016; Dasgupta 1991). The completion of a pumping station at Chandpal Ghat in 1822 allowed the lifting of water from River Hugli into masonry aqueduct for distribution by gravity to a population of 200,000 residing in parts of present-day central Kolkata. Apart from the supply of drinking water, the distribution system also provided water for the washing of streets and for fire hydrants. Pumping stations operated for seven hours daily, between 6 a.m. and 10.00 a.m. in the morning and between 4 p.m. and 7 p.m. in the evening. By 1870, Kolkata had piped water supply in all major streets through stand posts that were 500 in number according to the Kolkata Metropolitan Water and Sanitation Authority. There was no purification except for the sand and charcoal filters in individual houses.

The first water treatment plant (WTP) was constructed at Palta in 1870. The total capacity of the treatment plant was six million gallons per day (MGD). A pumping station and a reservoir of capacity one million gallon were also in use. A second pumping station was also constructed at Wellington Square. The site of the treatment plant being 30 km upstream at Palta helped reduce the risk of contamination and diminished the presence of tidal seawater. The residents thus had access to filtered water through the distribution network at a per capita availability of 60 l per day. In 1888, three underground reservoirs constructed at Wellington Square, Halliday Street (Md. Ali Park), and Auckland Park (Bhowanipur) helped augment supply. The supply of filtered water, however, did not exceed seven million gallons daily and continued to be intermittent. Hence, as a measure of economy, unfiltered water supply was extended for street watering and fire fighting. Gradually, an additional engine was installed at Tallah, the pumping plant at Chandpal Ghat was strengthened, and unfiltered water supply was further extended. The Chandpal Ghat Pumping Station was transferred to the Port Commissioners following an extension of the unfiltered water pipes in 1871. This pumping station supplied all the unfiltered water required for the town area. In 1897, another pumping station for unfiltered water supply was constructed at Watgunge. The supply of unfiltered water grew from a little over a million gallons (4.546 million l) per day at Chandpal Ghat to 33 million gallons (150 million l) per day from Mallick Ghat and Watgunge Pumping Station in 1921.

It soon became evident that the works should be enlarged. The capacity of the water treatment plant at Palta was increased in 1914, and an elevated reservoir was also constructed at Tallah to ensure an increased supply of water to the city. After independence, production capacity of the water treatment plant at Palta, renamed as the Indira Gandhi Water Treatment Plant in 2002, was increased to 120 MGD in 1952 and further to 160 MGD in the year 1968. For a total population of 2.70 million, the supply of water was 130 l per person per day. For more efficient distribution of filtered water further into the expanding city, the existing underground reservoirs at Wellington Square, Halliday Street, and Auckland Square were converted into booster pumping stations. Continuous supply could not, however, be maintained due to wastage in the water supply system (Ray and Shaw 2016) which amounted to 3% in the Palta network (Calcutta Environmental Management Strategy and Action Plan 1995). The supply was further declined toward South Kolkata, the outer limits of area served by the Palta waterworks, because of leakages in the zonal mains and in the distribution lines. Hence, the supply was being supplemented by groundwater sources.

According to the Kolkata Municipal Corporation, the city is now served by five water treatment plants. River Hugli remains the predominant source of the water supplied in Kolkata, after being treated at the three water treatment plants currently located at Palta, Garden Reach, and Dhapa. The 260 MGD capacity Indira Gandhi Water Treatment Plant at Palta is the oldest treatment plant in city. Water from Palta is distributed in the city through four zonal mains and a distribution network of 3,800 km, after getting lifted at the pumping station at Tallah. The other important water treatment plants are at Garden Reach and Dhapa, with respective capacities of 135 and 120 MGD. The Dhapa Water Treatment Plant, however, runs at a capacity of 30 MGD and supplies water in the eastern peripheral wards. Water supply to these wards is hence insufficient, and many parts continue to remain outside the supply network. Municipal supply is supplemented by groundwater in eastern fringe areas, known to be affected by arsenic above permissible limit. There are two other water treatment plants though with smaller capacities of 8 and 5 MGD at Jorabagan and Watgunge, respectively (Fig. 13.1).

The combined capacity of the five water treatment plants is 438 MGD though supply to the city is only 315 MGD (Table 13.1). Groundwater supplies another 30 MGD in the peripheral wards inadequately served by the municipal supply from treatment plants, lifted with the help of power-driven tube wells. The average per capita availability of water is 130 l per day, against an NIUA recommended 95–125 l per capita per day.

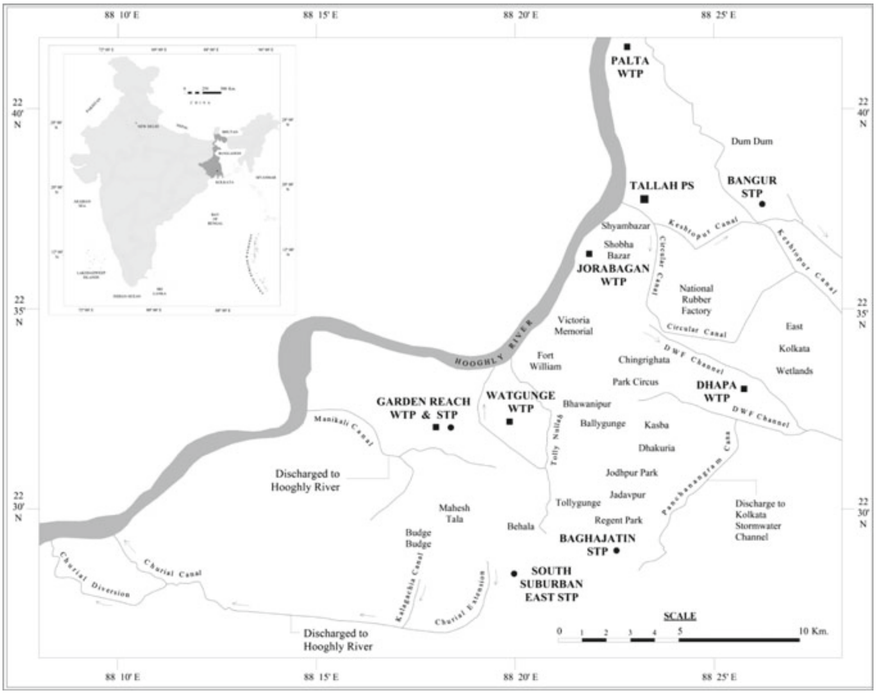

Fig. 13.1 Water and sewage treatment plants in Kolkata

13.4 Urban Water Insecurity in Kolkata and Its Spatial Dimension

In spite of being equipped with enough freshwater, Kolkata suffers from water insecurity. Even in the best water supply wards in the city, nearly 35% of the total population continues to remain uncovered by municipal supply. Another 20–25% is covered by single tap connections within their premises. 8000 stand posts provide water to more than half of the slum and squatter population who do not have access to piped water supply. The population living in slums or squatter colonies account for 32.4% of the total urban population of Kolkata. Because of the uncontrolled continuous flow during hours of supply, 60% of the water from the stand posts is never utilized, leading to immense wastage of supply. Backflow from the stand posts during hours of no supply also adds to the wastage. The duration of municipal water supply is also far from adequate and varies markedly in different parts of the city (Table 13.2). According to the Kolkata Municipal Corporation, daily hours of municipal water supply in different parts of the city vary between 9 h in the main city or central Kolkata to 6 h in the peripheral wards (Table 13.2). The supplied water is also not safe always, as the intermittent supply and the low pressure in supply mains increase the risk of contamination. It may be mentioned that pressure in the supply lines is

Table 13.1 Water supply in the city of Kolkata

Water treatment plants	Capacity in MGD	Supply in MGD	Area covered	Remark
Indira Gandhi Water Treatment Plant	260	200	Central or main city	Treated surface water
Garden Reach Water Treatment Plant	140	135	Southern peripheral	
Jorabagan Water Treatment Plant	8	5	Central city	
Watgunge Water Treatment Plant	5	3	Western peripheral	
Dhapa Water Treatment Plant	30	10	Eastern peripheral	
Total	438	315	315	
Groundwater	30	30	30	Untreated
Total	468	345	345	

Source By authors (based on data provided by Kolkata Municipal Corporation)

kept low in an attempt to reduce the high transmission and distribution loss to the tune of 30% because of the old dilapidated networks. The municipal water supply in the city also suffers from microbiological contamination as is evident from the 3000 water samples analyzed by the Federation of Consumers Association West Bengal and Better Business Bureau. Eighty percentage of samples were found to contain fecal bacteria or *Escherichia coli*, typhoid-causing *Salmonella,* dysentery-causing *Shigella,* and *Vibrio* that causes cholera. Though chlorinating the water kills these microbes, not the slightest trace of chlorine was found in even a single sample (The Telegraph, April 14, 2003).

The residents particularly those in the peripheral wards have their own groundwater sources to supplement municipal supply, making the population vulnerable to arsenic contamination and salinity. The water supply system of the city, one of the oldest in India, is crippled with inadequate and intermittent supply, low per capita availability, inadequate coverage, low-cost recovery, and excessive dependence on groundwater, often arsenic contaminated. Major deficiencies in the water delivery system include intermittent and irregular supply, low pressure, high leakage loss, and over-exploitation of groundwater (Majumdar and Gupta 2007). The city also suffers from inadequate zonal mains and old supply networks in an advanced state of dilapidation (Ray and Shaw 2016; Sivaramakrishnan 1993). Kolkata Municipal Corporation's recovery of operational costs, which is merely 15%, is one of the lowest among all Indian cities (McKenzie and Ray 2009). The policy of not pricing the water used for domestic consumption has earned the authorities criticism for promoting wastage (ADB 2007; McKenzie and Ray 2009) and lack of capital for network improvement. Only central Kolkata, served by the Indira Gandhi Water Treatment

Table 13.2 Urban service delivery status in Kolkata and its spatial dimensions

Area	Population %	Coverage %	Liters/capita/day	Hours of supply	Metered connections %
National average		81	123	4	25
All KMC area		92	134	8	0.1
Central	69	100	146	9	None
Eastern periphery	6	76	109	6	None
Western periphery	7	45	120	6	None
Southern periphery	18	83	120	6	None

Source Kolkata Municipal Corporation, 2012

Plant, is above the national average in terms of all parameters of water supply including coverage in terms of population and area as well as duration of supply per day. The percentage of population covered by municipal supply is particularly poor in the peripheral areas, especially the eastern and western peripheries.

13.5 Community Response to Urban Water Insecurity in Kolkata

It is evident that municipal supply of drinking water is insufficient in the city of Kolkata. The inability to ascertain the provision of universal and equitable access to treated and safe drinking water may be attributed more to delivery inefficiencies, bureaucratic inertia, lack of investment, poor cost recovery, as well as institutional and governance issues, rather than actual limitations on production capacity. To cope with the insecurities in the formal water supply system, urban communities are seeking resilience in an informal parallel supply system. The study thus aims to assess the sustainability and resilience in the urban water system in the city, based on questionnaire survey conducted in 300 households in the city of Kolkata. For the selection of households, stratified random sampling was used to ensure participation of households from the central or main city as well as from the peripheral wards located toward the outer limits of the city proper. Supply in central Kolkata is above the national average and mostly from Indira Gandhi Water Treatment Plant located at Palta. The southern and eastern peripheral wards are served by the water treatment plants located at Garden Reach and Dhapa, respectively (Fig. 13.2). Here the supply is poor in terms of per capita availability, coverage, and also on water quality issues. Survey was also conducted in the low-income slum pockets with perpetual scarcity

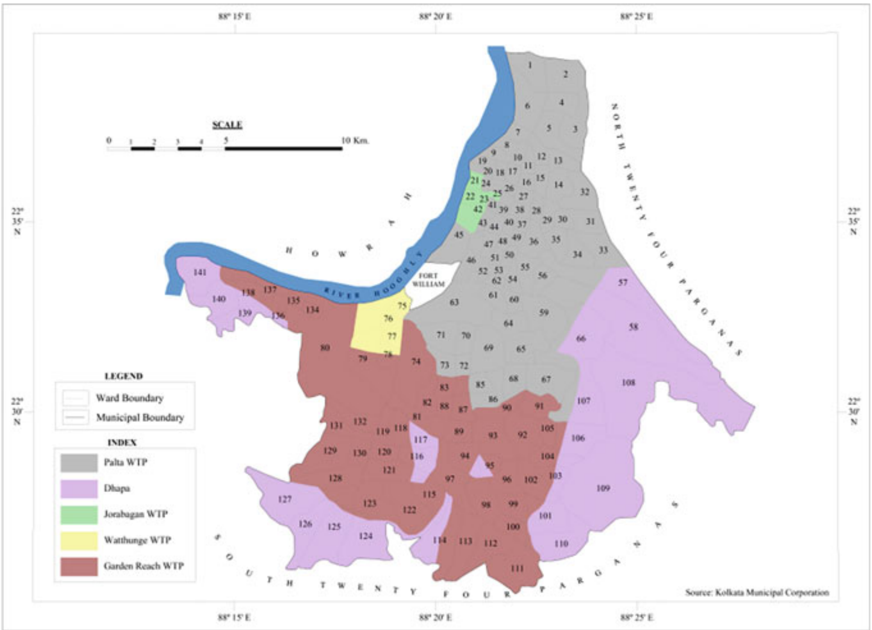

Fig. 13.2 Wards served by the water treatment plants in Kolkata

of drinking water and inadequate sanitation facilities. The aim was to assess the availability of water in terms of hours of supply and the adverse impacts of reduced pressure in the supply mains. Coping strategies adopted by the urban communities were also evaluated for an inclusive, resilient, and sustainable urban water system. The survey thus addressed the goals 6, 9, and 11 of the SDGs. The wastewater management system in the East Kolkata Wetlands was also explored.

With respect to the hours of supply, major parts of the city had fewer hours of supply than claimed by the civic authorities. While in the main city, the hours of municipal water supply ranges between 6 and 8 h; majority of the surveyed population complained that the duration of municipal supply was much less (Fig. 13.3).

Central Kolkata gets water supply three times a day, in the morning from 6.00 a.m. to 9.00 a.m., from 11.30 a.m. to 12.30 p.m. in the afternoon, and from 4.30 p.m. to 6.00 p.m. in the evening. In the peripheral wards, supply is only twice a day, once from 6.00 a.m. to 9.00 a.m., and again from 4.30 p.m. to 6.00 p.m. The coverage percentage is also quite low as is evident from Table 13.2, except for the core city where 100% of the area is covered by municipal supply. The supply is for 6–8 h for majority of the households even in the core area. However, the respondents highlighted that earlier pressure in the supply lines was adequate to enable lifting of water to personal overhead tanks during hours of supply so that tap water was available for 24 h. In an attempt to reduce leakage loss, pressure in the supply lines is now kept low, making it difficult to lift water to the overhead tanks during municipal supply. The peripheral

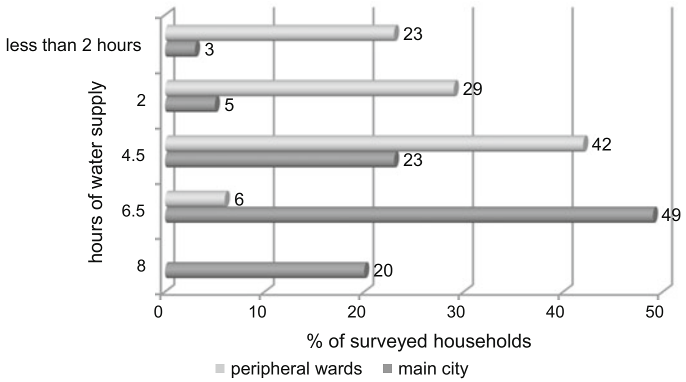

Fig. 13.3 Duration of water supply in main city and peripheral areas

wards, on the other hand, have fewer hours of water supply. For 42% of the surveyed households, the municipal supply is for 4.5 h while for another 29% the supply is for 2 h only. Hence, the residents are compelled to supplement municipal supply with informal sources like the unregistered watermen.

Urban communities have thus evolved their own water management strategy to supplement the inadequate municipal supply. Many of the households, particularly in the peripheral wards, have their own groundwater sources. The percentage of surveyed households dependent only on municipal supply is 89% in the main city or central Kolkata while it is only 4% in the peripheral wards. Even the Municipal Corporation supplies groundwater to households in the peripheral wards through a network of tube wells, reservoirs, and pipelines. It is, however, already noted that groundwater in parts of Kolkata has arsenic above the permissible limit. Hence, dependence on groundwater exposes the urban population to various health hazards. It was revealed during primary survey that 92% of the respondent households have never tested the quality of the groundwater they use for drinking. Many of the households are also compelled to buy water from the waterman who often sells the same municipal water, available at community taps and stand posts, at a price though municipal supply within the city is not priced (Fig. 13.4). In fact, 37% of the surveyed households supplement the municipal water supply with water bought from the waterman in the peripheral wards while it is only 5% in the main city. Hence, the civic authorities could explore the possibilities of water metering for resource mobilization. Forty-one percentage of the surveyed households in the peripheral wards supplement the municipal water supply with groundwater sources while another 18% of the households depend only on groundwater sources, in the absence of municipal supply (Fig. 13.4).

Community participation in water management is also evident among the slum population without household connection or without any access to piped water supply. The stand posts are an integral part of the urban water system in Kolkata and provide drinking water for the poor households and the slum population. Apart from

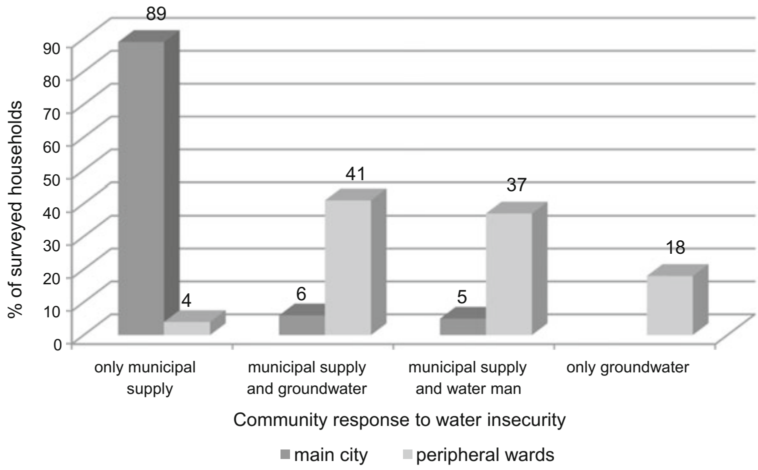

Fig. 13.4 Sources of municipal water supply in central and peripheral areas of Kolkata

supplying drinking water to the poor households in the city, they are also a source of economic sustenance for the poor slum population. Shelters near the stand posts double as vending spaces during the daytime. Tea stalls and street kitchens cluster around the stand posts and supply food to the daily commuters. Hence, these stand posts provide income opportunities to the poor households in the city. In spite of the high underutilization of the available water, immense wastage, and contamination of water due to backflow during hours of no supply, the stand posts are an indispensable component in the urban water system of Kolkata. Water is also often supplied to the poor slum households by the municipal corporation through mobile water tanks during hours of acute crisis.

It is thus evident that urban water supply is inadequate in the city of Kolkata and needs to be supplemented from alternate sources including groundwater sources and the waterman, particularly in areas not covered or inadequately covered by the municipal supply. The dual water system, with the municipal supply supplemented by groundwater or the waterman, also raises doubts about the quality of drinking water particularly in areas not covered or inadequately covered by municipal supply. No treatment facilities are available except for domestic filters, used by only 63% of the surveyed households. The old dilapidated network results in leakage loss, and the low pressure in the supply mains exposes the drinking water to contamination, including fecal contamination, during hours of no supply. Stand posts that are an integral part of the water supply system in Kolkata result in wastage as does the unmetered domestic supply. The absence of water meters and the consequent financial burden on the municipal corporation prevent innovative adaptations for a resilient urban water system.

13.6 Kolkata's Wastewater Management

Building on the experience of the MDGs, the Sustainable Development Goals 2015 emphasize improving the quality of water with reduced pollution, eliminating the dumping, and release of hazardous chemicals into natural water systems, reducing the proportion of untreated wastewater by 50% and promoting safe reuse and recycling. In spite of such efforts and global initiatives, the extent of wastewater treatment is extremely poor in low-income and lower-middle-income countries, suggesting an urgent need for implementing affordable solutions and promoting safe water reuse (United Nations Economic and Social Council 2016). Ecosystems are also effective in providing economical wastewater treatment services, at least as long as these ecosystems are healthy and the ecosystem's pollution carrying capacity is not exceeded by pollutant load. There are natural limits to the assimilative capacity of ecosystems, beyond which they are threatened, and they fail to perform a purifying role (United Nations Economic and Social Council 2016). Treated and partially treated wastewater when used for ecosystem management enables improved resource efficiency and benefits the environment through nutrient recycling, reduced water pollution, development of fisheries, reduced freshwater abstraction, and aquifer recharge (United Nations Economic and Social Council 2016).

Kolkata is fortunate in having a twin river system, with the River Hugli to bring in freshwater and the River Kulti to flush out its wastewater. The wastewater drains into River Kulti through a system of channels constructed in 1934 to carry dry weather and stormwater flow as well as sewage into the river. These channels continue to drain nearly 75% of the city's rainwater and sewage. The system was developed in the wetlands of East Kolkata. These wetlands continue to function as the city's wastewater treatment plant, treating almost one-third of its sewage. The East Kolkata Wetlands can receive and effectively treat 810 MLD of city sewage every day that act as nutrient for the fish and the farmlands. They also purify the water through oxidation and natural aeration in *bheris* or fish ponds and in the channels, nearly 2,000 km in length. The city thus got its wastewater treatment plant in the pisciculture system in local *bheris* that use wastewater of the city brought in by the network of channels. It is estimated that these *bheris* produce 8,000 t of fish annually. The naturally treated wastewater then flows into River Kulti, 28 km to the east of the city. To stop the filling up of the wetlands under the impact of rapid urbanization, the East Kolkata Wetlands were declared a Ramsar Site in 2002. The area is since designated as a no development zone.

The city's sewage system was first engineered by the colonial rulers in the late 1800s for a small city to discharge its waste into a tidal creek east of the city. The system now stands choked with sewage and garbage and hence is unable to handle very high-intensity rainfall exceeding 6 mm per h. Four small capacity sewage treatment plants (STP), namely Bangur STP (45 MLD), Garden Reach STP (45 MLD), Bagha Jatin STP (2 MLD), and South Suburban East STP (45 MLD), carry treated water into River Hugli but continue to be largely unconnected to the city sewage it has to treat.

The city thus has its unique natural system of wastewater treatment in the East Kolkata Wetlands. It is already proven that the planned use of wastewater can be beneficial to ecosystem functioning and benefits the wetlands as fisheries and aquatic ecosystems thrive better. The wetlands also help in recharging the fast depleting aquifers.

The wetlands in Kolkata have, however, been built upon, and silting continues to be a major problem in many wastewater conduits such as stormwater drains, sewers, and canals. The channels are choked with increased amount of garbage, and the sewer lines built during colonial period are in a state of decay. The Bagjola canal along Kolkata's northeast and the Krishnapur canal in the north are already choked. The blockage is up to 50–70%, while Tolly's Nallah in south Kolkata shows a blockage up to 40% (Biswas 1999). Besides, the gully pits are blocked because of poor solid waste management system resulting in a time lag for water to reach the pumping stations. The closing of the *bheris* under urban expansion and the destruction of the natural system of recycling of the sewage in them caused a chocking of the city with wastewater particularly in the monsoon season. Hence, both the channels and sewer lines need to be repaired and upgraded if necessary to carry the increasing amount of sewage as the city grows. The wetlands need to be preserved to ensure a sustainable wastewater management system for the colonial city of Kolkata.

13.7 Urban Water Management and Implications on Sustainable Development Goals

The city of Kolkata suffers from inequitable and inadequate supply of drinking water. Only 69% of the population in central Kolkata has access to municipal supply. In other parts of the city, the percentage is much lower. For the peripheral wards, it is below 20%, the lowest being 6% in the eastern peripheral wards. The hours of supply vary mostly between 4.5 and 6 h, while in many pockets, the daily supply is for 2 h only. The urban water system suffers from old dilapidated network, high leakage loss, risk of contamination during hours of no supply, and poor cost recovery. The peripheral wards continue to depend on groundwater with arsenic above the permissible limit. The slum population accounting for 32.4% of the city's total population is without access to individual connections and depends mostly on the stand posts. The supply in the stand posts along with unmetered supply in the city adds to wastage in the already limited municipal supply. Under the impacts of inadequate maintenance of the canals, lack of preparedness of the civic authorities and the high-intensity rainfall in short spells, the low-lying parts of Kolkata are under constant threat of waterlogging in the monsoon season.

From the above analysis, it is quite evident that water supply needs to be improved throughout the city of Kolkata to facilitate universal and equitable access to safe drinking water by 2030 in accordance with the SDGs. In an attempt to ensure availability and uniform access to water for all, the Kolkata Municipal Corporation is already working on increasing the number of booster pumping stations to improve supply.

It is also indicated in the SDGs that community participation needs to be supported and strengthened for improved water management and capacity building. The urban communities in Kolkata have already developed their own system of drinking water supply to supplement the inadequate municipal supply. These measures may be strengthened through certain adaptations involving the local communities. One such measure could be to incorporate the waterman in the formal water supply system and ensure that the supply by them is from the municipal stand posts and not from other sources. This could help in revenue generation through the introduction of proper licensing policies. It would, at the same time, ensure that the quality of water is not compromised with. Gradual phasing out of the individual or institutional groundwater sources may also be thought of to ensure sustainable withdrawals, in keeping with the targets specified in the SDGs. Such measures along with network improvement to reduce wastage and water metering for resource mobilization would ensure sustainable and resilient urban water management.

Protection of ecosystems and wastewater treatment, other major SGDs targets, are well taken care of by the unique natural system of wastewater treatment in the East Kolkata Wetlands. However, the sewer lines that carry the wastewater are in a state of decay and need to be repaired and upgraded to carry the increasing amount of sewage as the city grows and make the wastewater management system sustainable. Flow in the channels also needs to be restored. Pisciculture in the bheris of the East Kolkata Wetlands is a source of sustenance for the urban poor, particularly those residing next to the canals or bheris, thereby contributing to enhanced economic viability of the wetlands. Thus, the colonial city of Kolkata is naturally equipped with a wastewater treatment plant that not only takes care of the refuse from the city but also engages in economic upliftment of the urban poor through pisciculture.

For wastewater management, the Kolkata Municipal Corporation has upgraded its sewerage and stormwater drainage system by building new brick sewer systems, installing mechanical sewer machines, constructing new pumping stations, cleaning and dredging of canals, and protecting the wetlands. Garbage collection at household level would also help reduce the dumping of garbage at gully pits. Plastics are often responsible for the choking of the gully pits and sewer lines. The controlled use of plastic would help keep the gully pits clean.

13.8 Conclusion

The existing urban water system in the city of Kolkata is far from adequate. It is thus important to channelize efforts to strengthen and improve the existing water system to make it sustainable and resilient. Community participation is already evident in improving the availability of drinking water, particularly in the peripheral wards where a parallel informal water supply network exists. The informal supply network if included within the formal water supply system could help in removing the gaps in municipal supply, both spatial as well as across different socioeconomic groups and ensure equitable access. Since the parallel water supply system comes with a cost, water meters may also be introduced at household level. Charges could be made proportional to the quantity of water consumed above a minimum of 100 l. It would not only help in resource mobilization for the civic authorities and better maintenance of the dilapidated supply network, but would also help in reducing wastage substantially. Replacement of old worn-out pipelines is highly recommended to reduce leakage in the supply system. Demand management options also need to be explored. The stand posts may be fitted with a knob to regulate the supply of water and minimize the wastage of water. The ownership right on the stand posts may be bestowed upon the local communities against a nominal charge so as to ensure proper functioning of the regulators. While the phasing out of individual groundwater sources is recommended, the existing system of municipal supply using groundwater may be maintained for emergency use. To improve resilience in the urban water system, rainwater harvesting and recharging of groundwater are recommended. Such measures may be made mandatory, at least at the institutional level. Innovations in urban water system would also involve wastewater treatment and reuse, use of gray water, rainwater harvesting, and community participation. The possibility of public–private partnership in the water sector also needs to be explored in accordance with the National Water Policy, 2002. Dredging and desilting the wastewater channels as well as the protection of the East Kolkata Wetlands would, on the other hand, improve efficiency in the system of wastewater treatment in the city. The system of treating sewage through the older fish farming techniques also needs to be enhanced. Coordination between the various departments responsible for urban water management needs to be strengthened for better implementation of project initiatives.

The city administration (Kolkata Municipal Corporation) has already adopted many of the suggested interventions to cope with water security in the megacity of Kolkata. Seven newly constructed booster pumping stations, when fully operational, are expected to augment supply and coverage. Two others are proposed. In the strategic plan for 2025, Kolkata Municipal Corporation envisages to phase out the use of groundwater for consumption and provide surface water supply for the entire city by 2025. For better resource mobilization, the possibility of introducing water meters is also under consideration.

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