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DRINKING WATER, SANITATION AND HEALTH IN KOLKATA METROPOLITAN CITY: CONTRIBUTION TOWARDS URBAN SUSTAINABILITY

ABSTRACT. In an urban area, the water is supplied through centralised municipal tap water system. For the present enquiry, the municipal supply of water for drinking and sanitation purposes has been assessed in terms of its availability and accessibility to the people, possible sources of water contamination and related health issues in Kolkata. The relevant data have been accessed from various secondary sources where the published data from West Bengal Pollution Control Board (WBPCB) and Kolkata Municipal Corporation (KMC) are noteworthy. The data thus obtained have been assessed qualitatively to depict the ground reality on sanitation and health related issues. The analyses of the data reveal that in Kolkata, the availability of good quality drinking water is not sufficient as the supply is low and inadequate. On the other hand, the underground water which is considered as the alternative source to the people is found to be contaminated with heavy metals like arsenic and lead. The non-availability of sufficient water for drinking and sanitation purposes and consumption of contaminated water may result into poor health condition with various water borne diseases. The data on diseases from dispensaries (aided by KMC) in Kolkata has revealed that people with water borne diseases are significant in number where they are found to be affected with diseases like Acute Diarrhoeal Infection and Dysenteries. Some suitable measures have been proposed whereby applying those, the availability and accessibility of water for drinking and proper sanitation could be enhanced and the occurrences of diseases might be avoided.

KEY WORDS: drinking water, sanitation, health, water borne diseases, dispensary, KMC.

INTRODUCTION

The availability and quality of fresh water resources is the most pressing of many environmental challenges in India [Central Pollution Control Board, 2013]. Although 89 per cent of the urban population in India has access to water supply, the average availability is less than four hours a day and in some areas water is supplied only for one hour on alternate day [Asian Development Bank, 1997]. The human body requires minimum approximately 3 litres per capita per day (lpcd) intake of drinking water to sustain life before dehydration occur in tropical climate [White et al., 1972]. When other uses like hygiene (washing and cleaning) get added to it, the requirement increases to 45–55 lpcd [Bhandari

and Gupta, 2010]. Safe drinking water is essential for good health as is sanitation [Bhandari and Gupta, 2010], and lack of these two essential elements result in significant increasein morbidity and mortality conditions [Jalan and Ravallion, 2001; Shreshtha, 2006; World Bank, 2006]. In developing world, majority of children and adults suffer from repeated episodes of infectious diarrheal diseases annually, where water is considered as the major source of exposure to diarrheal pathogen [Sobsey et al., 2003].

Urban India largely depends upon water supply system that either draws from proximate surface or subsurface water bodies [Bhandari and Gupta, 2010]. There has been a constant problem regarding the availability of safe drinking water to the inhabitants in an urban area. In Kolkata, the problem is severe. Despite its location along the east bank of the River Hugli which means availability of abundant water in its vicinity, instead the city faces a grave problem of good quality water supply [Tata Energy and Research Institute, 2013]. The problems are acute to those living in the slum [Kundu, 2003]. On the other hand, in the absence of efficient surface water availability, people depend on underground water sources where its overuse leads to an increase in the arsenic concentration in many wards of the city [Shaban and Sharma, 2007]. Groundwater is generally less susceptible to contamination and pollution as compared to surface water bodies. But its intensive use for irrigation and industrial purposes causes aquifer contamination which resulted into mineralization of water resource [West Bengal Pollution Control Board, 2011].

Poor living conditions and lack of adequate city services such as safe piped water and sewage, lead to serious health and sanitation problems [Douglas, 1983]. It is estimated that throughout the world nearly 1.5 billion people lack safe drinking water and that at least 5 million deaths per year can be attributed to waterborne diseases [Krants and Kifferstein, 1998]. A variety of pathogens infect water supplies in circumstances where poor sanitation allows exerted waste to contaminate drinking water [Anthamatten and Hazen, 2011]. Water borne diseases are caused by viral or bacteriological contamination of water. This is exemplified by the fact that a single gram of faeces can contain 10 million viruses, 1 million bacteria, 1,000 parasite cysts and 100 eggs of worms [Water Supply and Sanitation Collaborative Council, 2002]. Water borne diseases are among the highest cases of morbidity and child mortality in India. India loses about 1.5 million children under 5 years of age annually to diarrhoea, and this might be an under estimate [Planning Commission, 2002].

In order to have a proper understanding of the water related problems and health issues in urban India, the present study is concerned with identification of problems related to municipal supply of drinking water and health issues in Kolkata. The major area has been covered are the sources of water supply, factor affecting the water supply, sources of water pollution and the resulted health outcome due to non-availability of water and consumption of contaminated water. It has also focuses on the sanitation problems where the availability of sufficient water for household purposes, efficient drainage facilities and proper garbage disposal facilities to the city inhabitants were evaluated to assess the health consequences.

STUDY AREA

The present study has conducted by taking case study of Kolkata, the capital city of West Bengal (Fig. 1). Spread roughly north-south along the east bank of the River Hugli, Kolkata sits within the lower Ganga Delta of Eastern India. The city lies about 136.79 kilometres (86 miles) away from the sea and 4.57–6.09 metres (15–20 feet) above the mean sea level [Imperial Gazetteer of India, 1984]. Its latitude and longitude are 22°56′ North and 88°36′ East respectively. According to the Census of India [2011], Kolkata had 4.5 million population with density 24,252 persons per Km^2.The annual mean temperature is 26.8 °C (80°F)

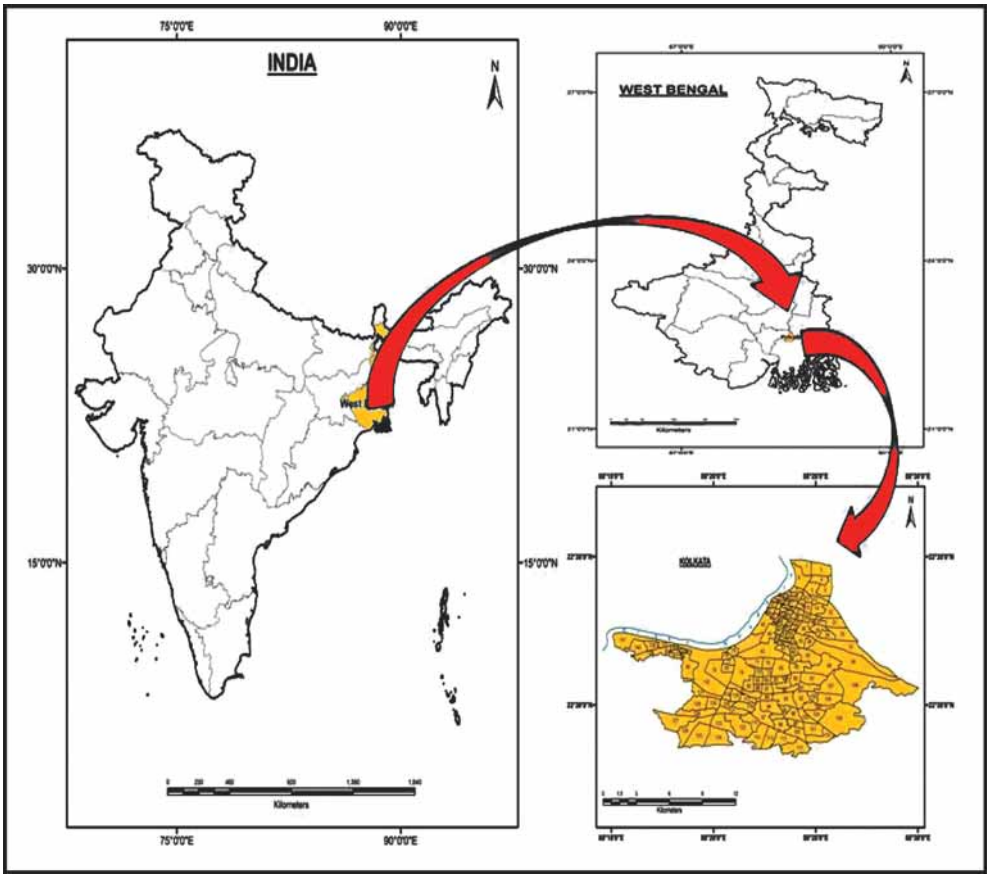

Fig. 1. Location of the study area.

and monthly mean temperatures ranges from 19 °C to 30 °C (67°F to 86°F).Maximum rainfall occurs during the month of August (306 mm) and the average annual total is 1,582 mm [District Census Handbook, 2001]. Kolkata is an unplanned city that has grown gradually to accommodate the influx of people from across the city, state and national borders. As a result, it is characterized by poor drainage and resulted water logging, waste effluent and sewage which create health risks for the city dwellers [Hasan and Khan, 1999].

DATABASE AND METHODOLOGY

The study has been completed based on mainly secondary sources of data along with observation of the researcher that are substantiated with images from the study area to reflect the ground reality of health related problems resulted from non-availability of water for proper sanitation and drinking purposes to the city inhabitant. The relevant data have been gathered from the existing literatures available in the form of research articles, published government reports, books etc. The important sources are West Bengal Pollution Control Board (WBPCB), Kolkata Municipal Corporation (KMC), and District Census Handbook etc. The data thus obtained have been reviewed and assessed qualitatively. The data on groundwater quality have obtained from WBPCB and the assessments were done through comparing the data with the Indian Standards (IS) specification for drinking water along with their desirable and permissible limit and possible health effects (Appendix 1). The data pertaining to diseases have been obtained from the dispensaries run by KMC. Initially, the data were

available in weekly format which later converted into monthly format for interpretation. The monthly data then interpreted by looking at the variation in the total number of patients with water borne diseases.

STATUS OF WATER RESOURCES IN KOLKATA

The city of Kolkata has a centralised filtered water supply which is distributed to the city dwellers via a complex network of pipelines. Two most common allegations against the existing water supply network is the inadequacy of the quantity and deteriorating quality of water [Roy et al., 2004]. The majority of the greater Kolkata's water is treated surface water from the Hugli branch of the River Ganges [Dudley and Stolton, 2003], along with groundwater from various deep and hand tube wells and private pumps [Segane, 2000]. Kolkata Municipal Corporation is claims that 94 per cent of the city's households are connected to piped water and the water is supplies continuously up to 20 hours per day. However, a study by the Asian Development Bank (ADB) in 2007 on the water utilities in India found that only 74 per cent of the households in Kolkata are connected to piped water supply and that the average time of daily uninterrupted water supply is 8.3 hours. The households not connected to the water supply system mainly extract groundwater through private wells and pumps.

A brief overview of the water resource in Kolkata covering the domestic use, its access at the household level, loss due to leakage, treatment of waste water, sources of water supply and associated problems etc. reveal that about 80 per cent of the households have access to the supplied piped water. About 35 per cent of the supplied water gets wasted due to leakage whereas only 52 per cent households are connected with the sewerage services and merely 20 per cent of the waste water is treated before its final dumping. Inefficiency in the use of water resources at the end point is the major problem followed by pollution and flooding (Table 1).

Table 1. Water statistics in Kolkata

Domestic Water Use	130 litre per capita
Households with Water Access	79 per cent
Water Loss due to Leakage in Pipe	35 per cent
Household with Sewerage Services	52 per cent
Wastewater Treated	20 per cent
Main Water Sources	Surface water from the Hugli branch of the Ganges Groundwater from deep and hand tube wells
Main Water Problems	Water use inefficiency Pollution Flooding Ecosystem destruction International dispute

Source: WWF Report, 2011.

The daily water supply needs for Kolkata Municipal Authority (KMA) is 2.75 million cubic metres per day of which KMC accounts for 1.63 million cubic metres. Taking into account the average utilization of the existing capacity, KMA faces a supply deficit of filtered water of about 1.18 million cubic metres per day. This is partially met through pumping of ground water using deep tube wells with average yield of 0.6 million cubic metres per day [World Bank, 2011]. Kolkata and the Ganges delta lie in a geological zone with naturally occurring arsenic in deeper layers of the bedrock and thus the groundwater naturally contains varying levels of arsenic [Segene, 2000].

An analysis of ground water quality in Kolkata revealed that the concentration of mercury in locations near Tangra (3.649 mg/l), Cossipore (1.755 mg/l), Dhapa (0.932 mg/l) and Inside Kolkata Leather Complex (0.719 mg/l) have exceeded the permissible limit (0.001 mg/l). The concentration of Total Dissolve Solid (TDS) has found beyond the desirable limit (500 mg/l) in all the monitoring stations and it was beyond the permissible limit (2000 mg/l) at the location near Cossipore (2080 mg/l) (Table 2).Mercury is a highly toxic liquid metal and consuming water with mercury

Table 2. Ground water quality in Kolkata

Sl. No.	Ground Water Stations	pH	Nitrate	Faecal Coliform MPN/100ml	Total Coliform MPN/100ml	Fluoride	Total Pesticide	Arsenic	BOD	Mercury	TDS
Water Quality Criteria		**6.5–8.5**	**45 mg/l**	**< 2500/100ml**	**< 5000/100ml**	**1.0 mg/l**	**–**	**0.05 mg/l**	**30 mg/l**	**0.001 mg/l**	**500 mg/l**
1	Tangra,Calcatta, West Bengal	7.6	0.09	2	5	0.34	0	NT	0.6	3.649	1888
2	Topsia, Calcatta, West Bengal	7.8	0.1	4	7	0.49	0	NT	1.4	0.588	1370
3	Dhapa, Calcatta, West Bengal	7.9	0.04	8	14	0.37	0	NT	0.4	0.932	1218
4	Garia, Calcatta, West Bengal	8.2	0.04	4	9	0.61	0	NT	1.4	BDL	896
5	Behala, Calcatta, West Bengal	7.8	0.1	_	_	0.41	0	NT	1.1	BDL	826
6	Cossipure- North Kolkata	7.2	0	80	110	0.4	0	NT	0.9	1.755	2080
7	Central Kolkata	7.8	0.04	2	4	0.42	0	NT	0.9	BDL	1292
8	Inside Kolkata Leather Complex	7.8	0.11	2	13	0.37	0	NT	0.5	0.719	1036

Source: WBPCB, Annual Report 2010–11.

contamination over many years could result into kidney damage. Similarly, when TDS levels exceed 1000 mg/l, it is generally considered unfit for human consumption.

SOURCES OF WATER CONTAMINATION IN KOLKATA

The contamination of water takes place when external substances with the possibility to modify the water in negative manner get discharged into it. In general, the sources of municipal waste water are domestic, industrial, storm water and by ground water seepage entering the municipal sewage network [Purkait et al., 2008]. The possible sources of water pollution in Kolkata are as following:

Industrial discharge

In the eastern part of Kolkata near Tangra-Topsia-Tiljala, leather industries are located and the industrial effluents released from the tanneries causes serious environmental hazards through polluting the *bheries* (fishing pond), wetlands and agricultural fields. The manufacturing of leather in these industries produce large quantities of waste which is discharged into the natural water bodies directly or indirectly through open drains, causing pollution and leading to serious health hazards [Ganguly, 2012].

Table 3. Possible sources of metal contaminants in water

Contaminants	Sources of Contaminants in Drinking Water	
	WHO	US EPA
Cadmium (Cd)	Impurity in the zinc of galvanized pipes, water heaters, water coolers and taps	Corrosion of galvanized pipes; erosion of natural deposits; discharge from metal refineries; run off from waste batteries and paints
Chromium (Cr)	Leather tanning industry, the manufacturing of catalysts, paints, fungicides, the ceramic and glass industry, photography, chrome alloy chromium metal production, chrome plating and corrosion control	Discharge from steel and pulp mills; erosion of natural deposits
Lead (Pb)	Production of lead-acid batteries, solder and alloys. Its presence is primarily from plumbing systems containing lead in pipes, solder, fittings or the service connection to homes	Corrosion of household plumbing systems; erosion of natural deposits
Mercury (Hg)	Industrial uses.	Erosion of natural deposits; discharge from refineries and factories; runoff from landfills and croplands

Source: Based on Chacraverti et al., 2011.

Table 4. Number of samples showing detection of metal contaminants

Metals	All samples			River water samples			Drinking water samples		
	No. of samples	No. of detections		No. of samples	No. of detections		No. of samples	No. of detections	
		Dry season	Wet season		Dry season	Wet season		Dry season	Wet season
Cd	56	0	0	8	0	0	48	0	0
Cr	56	3	6	8	3	6	48	0	1
Pb	56	51	56	8	8	8	48	43	48
Hg	56	0	3	8	0	1	48	0	2

Source: Chacraverti et al., 2011.

A study by Chacravarty et al. [2011], traced the source of contaminants in water through testing the level of mercury (Hg), lead (Pb), cadmium (Cd) and chromium (Cr) in samples taken from tube wells, river Hugli and taps at different sites in the KMA during both the dry and wet seasons (Table 3). The detection of lead in river water and drinking water were very much noticeable in almost all the samples in both summer and winter seasons while the presence of chromium has been noticed in river water during wet seasons (Table 4).The drinking water although has been found free from the chromium and cadmium contamination, the presence of mercury during wet season has detected in some places.

Leakage from the landfills

Landfills are huge pile of city garbage. The disposal of garbage is a big problem in India and other developing countries where open dumping at road sides, in open spaces, in front of the riverbanks [Hogland and Marquis, 2007] and any other unorganised places are practised which may pollute the adjacent environment (Fig. 2). When it rains, the landfills get leaked and the leakage pollutes the underground water. One severe problem associated with open dumping is the infiltration of leachate into the surrounding environment and subsequent contamination of the land and water [Walker, 1969; Chain and Dewalle, 1976; Kelley, 1976; Masters, 1998]. In Kolkata, the major disposal site i.e., Dhapa is located at the eastern fringe of the city. The quality of natural leachate sampled from the disposal site (Dhapa) has shown that the concentration of solids, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and chloride were much higher than it is allowed to discharge into inland surface water [Mandal, 2007].

Fig. 2. Disposal of solid waste in Kolkata: (a) Taltala (b) Hatibagan (c) & (d) Park Street.

Leakage from piped water supply

The quality of water at the end use point depends to a great degree on the state of the network of pipelines through which the water flows over vast distances. Nothing is more dangerous to public health than intermittent water supply [Ghosh, 2002]. The intermittent supply of water leads the iron pipelines to be idle for long stretches, augmenting their rusting process, which in turn is largely responsible for the fall in the quality of water. Faecal contamination of drinking water is often associated with untreated water distribution systems through leaking and cracked pipes and causes shallow wells to become contaminated [Roy et al., 2004].

Sewage and waste water disposal

Of the total wastewater generated in metropolitan cities, barely 30 per cent is treated before its final disposal. Untreated water finds its way into water system such as rivers, lakes, ground water and coastal water [Government of India, 2002]. It is estimated that 75 to 80 per cent of the water pollution by volume is caused by domestic sewage [The Energy and Research Institute, 2003].The sewage and waste water generated at the household level is released into the river and fresh water bodies without proper treatment [Bhandari and Gupta, 2010].

Wastewater generated in Kolkata gets discharged into East Kolkata Wetlands (EKW); 12,500 ha. of marshy wetlands connected to the Hugli branch of the Ganges and treating about 2.8 billion litters of sewage from the city [WWF Report, 2011]. The vegetables are grown in Kolkata sewage fed land shows variable toxicity [Gupta et al., 1990],which when mix with water bodies leads to its contamination. On the other hand, recycling of waste water often causes contamination of ground water by mixing of toxic elements like heavy metals and pathogens [Mitra, et al., 1998].

WATER AND HUMAN HEALTH

India though improves it's conditions in terms of water supply and sanitation in last few decades, but still not commensurate with the requirements. Health outcome therefore, continue to be adversely affected and show up as infant mortality, prevalence of communicable diseases and overall morbidity [Bhandari and Gupta, 2010]. It is estimated that about 89 per cent of Indians use drinking water that could be classified as 'safe drinking water' but only about 28 per cent have access to improved sanitation [World Health Organisation, 2009]. India stand far behind when compare to other emerging countries in meeting the water and sanitation needs to its population (Table 5). Safe and good quality drinking water and sanitation is an essential aspect of public health. Vulnerable groups such as children, the elderly and immune compromised patients (e.g., those who are undergoing chemotherapy) are at special risk of diseases caused by water contamination [USEPA, 1999; Tibbettes, 2000].

Table 5. Access to safe drinking water and improved sanitation in emerging economics (per cent)

Country	Drinking water	Sanitation
India	89	28
Brazil	91	77
China	88	65
Mexico	95	81
South Africa	93	59

Source: World Health Organisation, 2009.

Most of the diseases associated with water are communicable and preventable. Although water is the key to sustenance of life; poor water quality due to sewage disposal, dumping of industrial and agricultural effluent can mean increased exposure to carcinogenic compounds, insecticides such as DDT and heavy metals [Brain, 1999]. It may also mean infection with a range of enteric pathogens causing diarrhoeal diseases estimated to be responsible for 4 million child deaths per year in India. Inadequate sanitation implies

reduced levels of personal and domestic hygiene, which lead in particular to the faecal oral transmission of diarrhoea, dysentery, gastroenteritis etc. [Brian, 1999].

In Kolkata, it could be evaluated the ground reality of inadequate sanitation for those living in the congested area (referred to as slum) while looking at them to wash their utensil in dirty water and presence of uncovered drain at their vicinity (Figs. 3, 4). In some places people are also seen having their bath at roadsides. These are some of the issues of grave health concern where the improvement in availability of sufficient water at the household level for sanitation purposes must be given priority for a better well-being and for that the KMC need to play the pivotal role.

Safe water supply is not always available in the less developed regions of the world, where water borne diseases represent a significant public health threat [Friis, 2007]. Even piped water which is available in big cities gets mixed with number of impurities causing jaundice, cholera, typhoid and gastroenteritis etc. [Kudesia, 1980].

Fig. 3. Washing of utensils in dirty water.

Fig. 4. Open drainage in Garden Reach, Kolkata.

Table 6. Water borne diseases in Kolkata

2012	Acute Diarrhoeal Disease (Include acute gastroenteritis)			Total	Bacillary Dysentery			Total
	Narkel-danga Dispensary	Ultadanga Dispensary	Rajabazar Dispensary		Narkel-danga Dispensary	Ultadanga Dispensary	Rajabazar Dispensary	
January	24	13	55	**92**	0	76	0	**76**
February	50	36	76	**162**	0	129	0	**129**
August	103	118	95	**316**	0	172	0	**172**
September	103	26	64	**193**	0	129	0	**129**
Total	**280**	**193**	**290**	**763**	**0**	**506**	**0**	**506**

Source: Kolkata Municipal Corporation, 2012.

According to World Health Organization Report [2004], 88 per cent of diarrhoeal diseases are attributed to poor sanitation and hygiene, lead to 1.8 million deaths per year. Children under five years of age comprise 90 per cent of these deaths. Young children have little time to adapt physiologically to local disease causing pathogens, which make them practically susceptible. According to Shanmuganandan [1999], around 105 million children under 5 years of age die each year due to water borne diseases and India experienced a loss of 200 million man-hours a day every year because of these diseases.

In Kolkata, the data on diseases from dispensaries covering Narkeldanga Dispensary, Ultadanga Dispensary and Rajabazar Dispensary reveal that the patients with *acute diarrhoeal diseases* (include acute gastroenteritis) and *bacillary dysentery* occupying major share among other diseases (Appendix 2). These are water borne diseases resulted due to consumption of contaminated drinking water and non-availability of sufficient water for drinking and sanitation purposes at household level. The dispensaries are the destination for medical check-up mainly follows by those residing in slums and having poor living standards where they get their treatment with free of cost. There are more than 25 major dispensaries and many more minor dispensaries operating throughout Kolkata and these are fully aided by KMC. It has been inferred that the patients with acute diarrhoeal diseases are present in almost all the stated dispensaries while the patients with dysentery are mainly concentrated in Ultadanga dispensary. The concentrations of patients with water borne diseases have found few in number in the month of January (92 with diarrhoeal infection and 76 with dysentery) while it is higher in the month of August (316 with diarrhoeal infection and 172 with dysentery) (Table 6). The more concentration of patients in the month of August may be due to the monsoonal rainfall where the rainwater get mixed with the municipal piped water through broken pipes and leakages and thus contaminate the water at its sources of supply. Therefore, the direct consumption of water supplied through the broken municipal pipes with mixed impurities may result into several water borne diseases.

MEASURES FOR SUSTAINABLE WATER MANAGEMENT

Water is one of the basic resources as it is essential for the very existence of human life. The use of water is manifold i.e. domestic, industrial, recreational and for aesthetic purposes. Among the various facets of uses of water, the availability of good quality water for consumption is of utmost importance for sustenance of human life and for healthy wellbeing. Supplying safe drinking water is therefore an important issue for sustainable development which requires explicit

Fig. 5. Municipal supply of tap water in Kolkata.

emphasis on quality. Following are some of the measures which could be made functional in bringing sustainability for water resources in Kolkata:

Availability and accessibility of safe drinking water

The problem regarding the water in Kolkata is poor availability of drinking water at the household level as the supply of water is low. The ever increasing size of the population and their demand for potable drinking water has always been a big problem for KMC to successfully cope up. Therefore, securing the availability of safe drinking water must be taken as a fundamental issue to bring sustainability in the society.

Connect household with processed municipal tap water

In an urban environment the slum dwellers are seldom connected with the municipal supply of piped water system. In Kolkata, the urban poor are living in a condition where there is less connectivity of piped water within the premises as well as near premises. Therefore, all households especially the slums need to be connected with the piped water so that the requirement of water can be fulfilled at the domestic level and the contaminations of water get controlled (Fig. 5).

Minimize the wastage of water: practice inclusive use of water

In Kolkata, one of the major drawbacks of the water supply is the wastage of water from the direct tap water (Fig. 6). The water supplied through KMC gets wasted without its proper utilization and even reaching to the beneficiaries. This wastage of water must be stopped by taking strict action. Proper utilization of water must be practised at every stage as the wastage of water at one place will create scarcity in another place. So, for the enhancement of sanitation and healthy well-being, an inclusive use of water should be the main focus for the urban planner and municipal supplier of water resources.

Improvement in sewage treatment and disposal

Sewage treatment plant helps in removing the contaminants from wastewater including household sewage and runoff. It produces environmentally safe fluid waste suitable for disposal and reuse. With suitable technology, it is possible to re-use sewage effluent for drinking and sanitation purposes. Therefore, by looking at the utility, the establishment and

Fig. 6. Wastage of water from the tap in Kolkata.

proper functioning of sewage treatment plant is required. It will helps to curb the problem of shortage of water for drinking and sanitation purposes and can bring sustainability through making water available at the household level.

CONCLUSION

Kolkata is blessed with abundant water resources where the River Hugli is the biggest source of surface water for human consumption after it gets filtered. Throughout Kolkata the water is supplied through piped water as a major source of water supply with underground water as a secondary source. The two major problem regarding water supply in Kolkata are the availability of good quality water and its accessibility to the city inhabitants. Among the major sources of contamination of water, the release of industrial effluent to the water bodies without its proper treatment is the prominent one which is followed by domestic sewage and leakages from piped line. The industrial effluents may result into the contamination of underground water where the presence of leather industries in Tangra led to the lead contamination to the nearby underground water. On the other hand, the leakage of pipe may contaminate the underground water and if continue for a long duration may also contaminate the surface water. The solid wastes are disposed without taking proper care and when it rained, theplastic waste get choked with the mouth of the drain and resulted into flooding.

Lack of availability and accessibility of sufficient water for drinking and sanitation purposes at the household level exert a great pressure in sustenance of human life. It has been noticed that due to absence of sufficient water for sanitation purposes at the household level, people are having their bath at roadside. These are very common phenomena for those living in the slums where they also use dirty water for washing the utensil. These are the serious health issues, where there is a need to focus in sufficient supply of water for sanitation purposes. In this regard, the role of KMC is of prime concern as municipalities are the custodian of main supply of water resources to the city inhabitants. On the other hand, the consumption of water with mixed

impurities may result into several water borne diseases where acute diarrhoeal infection is the pressing one. It has been found that the patients with water borne diseases at dispensaries like acute diarrhoeal infection and dysenteries are quite alarming. Water borne diseases are mainly the outcome of consumption of contaminated drinking water and non-availability of sufficient water for proper sanitation. Measures such as; make water available at household level, connect every household with proposed municipal tap water, minimize wastage of water and practice inclusive use of water are of prime significance in enhancing the availability and accessibility of water resources at household level. Once the problem with the availability of water for drinking and sanitation purposes gets controlled, the related health issues will be minimized at greater extent. ■

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Received 29.10.2015 Accepted 06.11.2015

Appendix 1. Indian Standard (IS) Specifications for Drinking Water

Sl. No.	Parameters	Desirable Limit	Permissible Limit	Health Effects
1	Total pesticide (ppb)	Absent	No Relaxation	Affect Central Nervous system.
2	Arsenic (mg/l)	0.05	No Relaxation	Toxic, Carcinogenic, Affect Central Nervous system.
3	BOD (mg/l)	30	100	
4	Mercury (mg/l)	0.001	No Relaxation	Highly Toxic, causes minamata' disease, neurological impairment.
5	TDS (mg/l)	500	2000	Undesirable taste, gastro intestinal irritation.
6	Temperature	5 °C		
7	pH	6.5–8.5		Bitter taste, affects aquatic life.
8	Nitrate (mg/l)	45	No Relaxation	Algal growth, blue baby disease.
9	Faecal Coliform	< 2500MPN/100 ml	–	Gastrointestinal illness.
10	Total Coliform	< 5000 MPN/100 ml	–	Gastrointestinal illness.
11	Fluoride (mg/l)	0.6–1.2	1.5	Dental and skeletal fluorosis.

Source: Indian Standard, 10500–1991.

Appendix 2. Major Diseases at Dispensaries in Kolkata

2012		Acute Diarrhoeal Disease (Include acute gastroenteritis)			Total	Bacillary Dysentery			Total	Acute Respiratory Infection			Total	Malaria			Total	Fever of Unknown Origin (PUO)			Total
		N*	U*	R*		N*	U*	R*		N*	U*	R*		N*	U*	R*		N*	U*	R*	
January	1st week	5	5	23	33	0	22	0	22	55	121	234	410	2	34	28	64	18	0	0	18
	2nd week	8	4	6	18	0	17	0	17	25	97	178	300	2	25	0	27	10	0	11	21
	3rd week	5	2	18	25	0	14	0	14	59	157	226	442	0	30	39	69	9	0	0	9
	4th week	6	2	8	16	0	23	0	23	26	110	109	245	0	15	13	28	17	0	0	17
	Total	**24**	**13**	**55**	**92**	**0**	**76**	**0**	**76**	**165**	**485**	**747**	**1397**	**4**	**104**	**80**	**188**	**54**	**0**	**11**	**65**
February	1st week	3	8	17	28	0	42	0	42	93	152	261	506	2	30	41	73	26	0	0	26
	2nd week	10	15	24	49	0	41	0	41	105	195	263	563	4	1	26	31	28	57	0	85
	3rd week	12	7	16	35	0	21	0	21	94	190	210	494	3	33	28	64	25	0	0	25
	4th week	25	6	19	50	0	25	0	25	59	147	189	395	2	36	45	83	30	0	0	30
	Total	**50**	**36**	**76**	**162**	**0**	**129**	**0**	**129**	**351**	**684**	**923**	**1958**	**11**	**100**	**140**	**251**	**109**	**57**	**0**	**166**
August	1st week	19	50	23	92	0	2	0	2	135	150	221	506	92	0	81	173	0	230	0	230
	2nd week	18	12	27	57	0	33	0	33	111	302	223	636	96	132	77	305	0	0	0	0
	3rd week	16	13	7	36	0	24	0	24	237	401	138	776	121	159	112	392	0	0	0	0
	4th week	21	17	20	58	0	51	0	51	156	402	193	751	210	203	109	522	0	0	0	0
	5th week	29	26	18	73	0	62	0	62	356	370	315	1041	227	365	136	728	0	0	0	0
	Total	**103**	**118**	**95**	**316**	**0**	**172**	**0**	**172**	**995**	**1625**	**1090**	**3710**	**746**	**859**	**515**	**2120**	**0**	**230**	**0**	**230**
September	1st week	23	9	19	51	0	42	0	42	268	542	240	1050	315	423	194	932	0	0	0	0
	2nd week	22	2	19	43	0	41	0	41	234	668	284	1186	322	414	245	981	0	0	0	0
	3rd week	23	8	23	54	0	30	0	30	265	423	240	928	241	300	270	811	0	0	0	0
	4th week	35	7	3	45	0	16	0	16	122	210	290	622	266	275	302	843	0	0	0	0
	Total	**103**	**26**	**64**	**193**	**0**	**129**	**0**	**129**	**889**	**1843**	**1054**	**3786**	**1144**	**1412**	**1011**	**3567**	**0**	**0**	**0**	**0**

Note: N* Narkeldanga Dispensary, U* Ultadanga Dispensary, R* Razabazar Dispensary.
Source: Kolkata Municipal Corporation, 2012.

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