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Issues and Challenges of Water Supply System in Bhopal City, Madhya Pradesh

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ABSTRACT

Water is of fundamental importance for human life and plays an important role in many biological and chemical systems.Only 0.3% of the water resources in the world are usable.Scarcity of water has become widespread all over the world. Current methods for water scarcity assessment are mainly based on water quantity and seldom consider water quality. Population growth and urban development aspect dramatically alter natural watershed ecosystem structure and functions and stress water resources. The demand of time is review water quantity and water quality issues, as well as water supply challenges in an urban environment.So that more than a billion people in the developing world lack safe drinking water. About three billion people live without access to adequate sanitation systems necessary for reducing exposure to water-related diseases.Water is a valuable fundamental asset for life. Availability of sufficient water resource in any region effects socio economic development as well as better quality of life. Lack of water resource is determinant the poor quality of life. This paper based on secondary as well as primary data. This paper highlighted the status of water resource and supply system in the Bhopal city. Paper will also find out the spatial and temporal distribution of water supply system as well as quality and quantity. Paper also analysis the issues and challenges about water resource and satisfaction level of Bhopal city.

KEYWORDS: *Water Resource, Supply, Quality, Quantity, Satisfaction level.*

INTRODUCTION

In the developing world more than a billion people are facing lack safe drinking water. Approxmately three billion people live without access to adequate sanitation necessary for reducing exposure to water-related diseases (Gleick, 1998). Poor water quality continues to major threat to human health. Approximate 4.1 percent of the total global burden of disease due to Diarrhea and is responsible for the 2 million people deaths of every year. Water and water resources are very important for maintaining a productive environment for all living organisms. Due to human populations and economies grow; global water demand has been increasing rapidly. Global population increase and lifestyle changes are growing pressures upon water resources leading to widespread water stress in many countries. As a result there is urgent need to conserve water for future. Actually water influence living standard as well as health status. Water is crucial substance for all living thing not only human beings, so every decision and every step to be taken on water resource is vital (Kılıç, 2020). Water is a valuable fundamental asset for life. Availability of sufficient water resource in any region effects socio economic development as well as better quality of life. Lack of water resource is determinant the poor quality of life. The lack of adequate clean water to meet human drinking water and sanitation needs is in fact a limitation on human health and well being.

Bhopal city is in the phase of transition to becoming a metropolitan city in India due to high level of urbanization and industrialization growth. This rapid growth of industrialization is resulting in the high demands of water resources and enhanced level of environmental stress that further accentuates the scarcity of available resources due to high industrial and agricultural pollution (Dehalwar and Singh, 2016). Bhopal is famous city and also known as the city of Lakes. Bhopal gets this distinction because of a large number of lakes, tanks and ponds in the city.

Water supply to the city is mainly from surface water reservoirs and Municipal Corporation (Singh, 2013). Resources of fresh water are limited. The requirement of water in Bundelkhand region is increasing day by day. Consequently the water requirement was 1.04x10.23m./litre for the year 2005. Availability of water in India is under tremendous stress due to growing population, rapid urbanisation, increase in per-capita consumption and other demands for maintaining system (Singh and Singh, 2010; Singh, 2013).

Similar attempts have been made in different parts of region (Dehalwar and Singh, 2016; Singh and Khare, 2008; Singh and Singh, 2008; Singh and Verma, 2008; Singh and Khare, 2008; Singh, 2011).

OBJECTIVES

These are the objective of present study

- To study the status of water resource in Bhopal city.
- To study the water supply system in the Bhopal city.
- To analyse the quantity and quality of water supply.
- To analyze the issues and challenges about water resource in the city.

STUDY AREA

Bhopal is located in the Madhya Pradesh as well as central part of India and widely known as a "City of Lakes. The study area extends from $23^0$08′-$23^0$20′ N latitude and longitude $77^0$18′-77^0 30′E (Figure 1). According to 2011 census, the total area of Bhopal city is 287.17 sq. km with total population of BMC is 17.96 lakh and is expected to cross 30 lakh by 2041. A large number ofsurface water bodies such as lakes, tanks and ponds present in the Bhopal city.

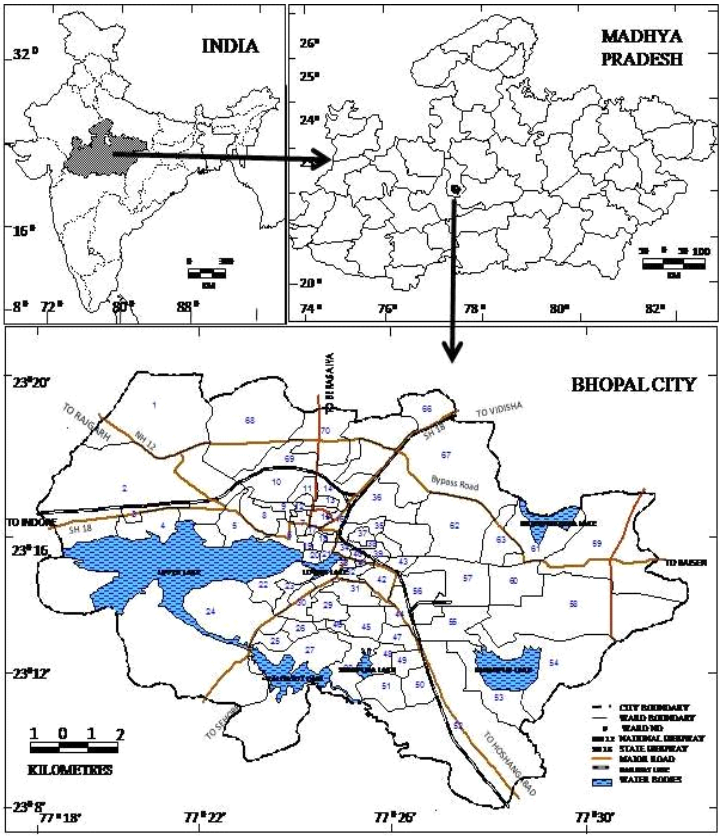

Figure 1: Location map of the study area

DATA BASE AND METHODOLOGY

This study is based on primary as well as secondary data. To assess the Status of existing condition of water supply system in Bhopal city. Area wise survey has been conducted with the help of a structured interview schedule along with purposive random sampling technique used here, from different areas of Bhopal city like slum and non-slum 42 sampling points are selected for primary survey. Sample size was 400, sample distributed in two major parts 144 slum and 256 non slum according to basis of slum and non slum household proportion.

Available Water Resource in Bhopal City:
Bhopal city is also known as the city of lakes because it is embedded 18 water bodies of different sizes located in and around Bhopal. Out of 18 water bodies, the peoples of Bhopal town are more familiar with only 5-6 water bodies because of their proximity of city some irrigation reservoir such as Hataikheda, Kerwa, Laharpur earlier located in the out Skirts of the city have now become in internal part of city due to expansion of city in all the directions (CGWB Ministry of Water Resource, 2011).

Upper Lake: The Upper Lake has a surface area of 36 km^2 and catchment area of 361 km^2. The Upper Lake is a important source of drinking water more than 40 percent of the drinking it fullfill the water demand for an estimated population of 18 lakh in Bhopal City. Upper Lake also called Bada Talab lies on the Western side of the city. It is one of the oldest water resource in the state which was built in the 11th century by Raja Bhoj while the construction of a dam across the Kolans River (Gour , 2015).

Lower Lake: The lower lake has a small catchment area of 9.6km and water spread area of 1.29km. The lower lake receives its inflow partly as seepage from the upper lake and from a number of nallas and perennially spills over a waste water intopatra nalla that leads to Halali River, tributary of Betwa River. The Lower Lake, locally known as Chhota Talab (Small Lake), is situated towards the east end of Upper Lake and is entirely surrounded

by built-up areas. This lake was created in 1794 AD by Nawab Chhote Khan, Minister of Nawab Hayath Mohammad Khan, to add to the beauty of the city (Dehalwar, 2012).

Sahpura Lake: Sahpura Lake situated in the south west part of the city the water of this lake uses in deferent types of work like recreation etc. Shahpura Lake is also famous for fish culture occupation and which is known as the third lake of Bhopal. The various factors are responsible for pollution of Shahpura Lake because of unscientific management system, untreated sewage inflow, siltation, encroachment, washing and bathing activities, deforestation, soil erosion and removal of oxygenated surface water through waste water (Giri, 2017).

Kaliasot Reservoir: The Kaliasot dam was built, as a storage reservoir close to the WALMI campus, Bhopal.The famous name of the Kaliasot got from the name of Kalyan Strote, the one of the minister of Raja Bhoj, who had created spillway of Upper Lake and now known as Kaliasot. Presently, the reservoir serves the purpose of irrigation and water supply (Figure 2).

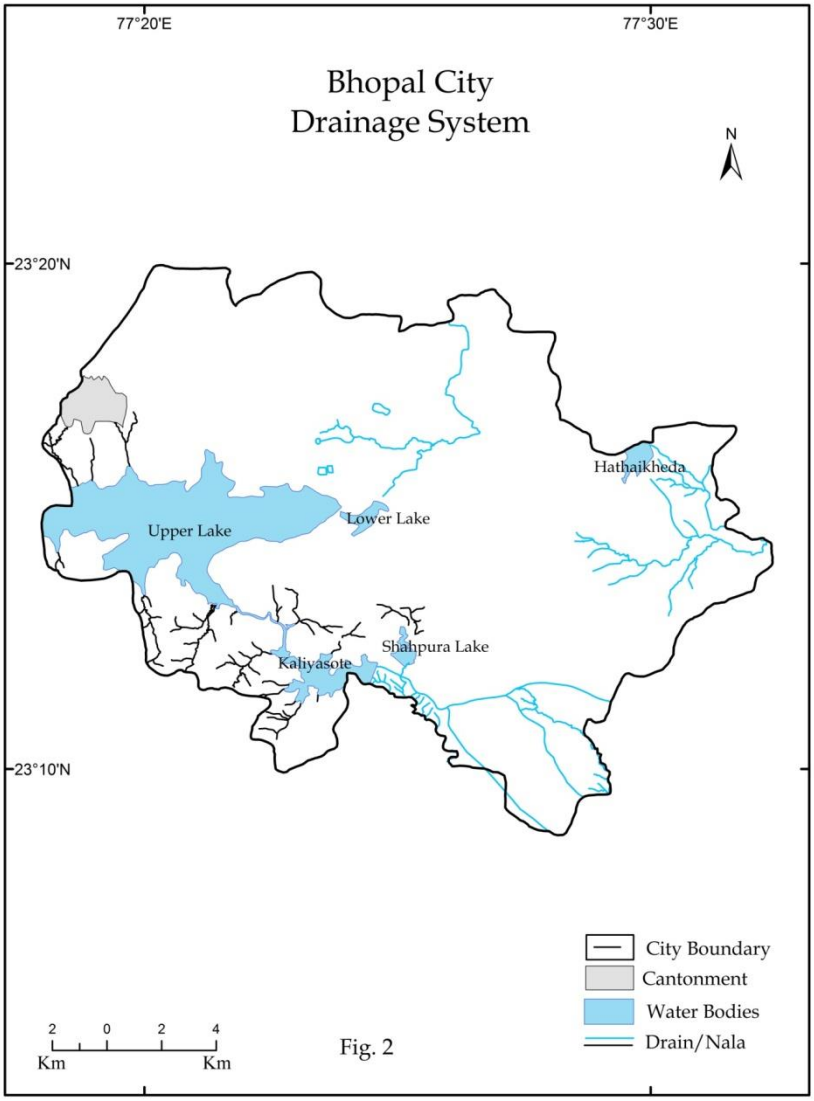

Figure 2: Drainage and reservoir system present in the Bhopal city

Kerwa Reservoir: The water stored in Kerwa dam used for irrigational and other uses. Kerwa dam was constructed in the southwest part of Bhopal city. The Kerwa reservoir supplies irrigation water to the agricultural fields located in its proximity. It is a famous tourist spot of the city and is therefore frequented by a large number of persons especially during the weekends. Malik et al., (2014) study reveals that the water quality of

Kaliasot and Kerwa reservoirs satisfies the norms of potable water source and thus the water could well be used for potable purposes.

Kolar Dam: The capacity of the dam is 265 MCM. The present water supply to city from this treatment plant is 153 MLD (Million litres per day). Raw water supply from Kolar dam to Kolar WTP is 162 MLD. The dam on Kolar River was constructed near Birpur village, which is about 32 km from Bhopal city.

Status of Water Supply & Demand

Water supply in Bhopal city is looked after by PHED and in addition Bhopal Municipal Corporation. In the present scenario, the city depends upon Upper Lake, Kolar reservoir and Narmada River for the supply of potable water. The various sources of treated water given in the table 1.

Table 1: Source of treated water in Bhopal city, 2011

Sl. No.	Source	Distance From City (km)	Abstraction of Raw Water (MLD)	Remark
1	Upper Lake	Within City limit	85.5	Rain Dependent source Generally sustainable
2	Kolar dam	30	135	Rain fed sustainable Source
3	Local Ground water	Within the City limit	22.5	Over extraction –Not sustainable
4	Narmada River	80	-	River

Source: Bhopal Development Plan 2005, BMC 2011

Bhopal the capital city of Madhya Pradesh has dependably been known for its water assets, however the quality and amount of the water assets of this city known for its water accessibility has been debasing with the fast extension and populace blast, a lot of which has occurred in recent decades. A further augmentation of water production by 198 MLD from Kolar dam is implemented by BMC to meet the projected water demand for 2021 at an estimated cost of US$ 22 million. The funding arrangement for this project is being arranged (Bhopal city development Plan, 2005).

Upper lake supply

The raw water from Upper Lake is abstracted for municipal supply at 7 different points around the lake and pumped to 7 independent water treatment plants of total capacity 85.5 MLD capacities. All the treatment plants are conventional rapid sand filters and are commissioned in between 1945 and 1965 and their efficiency has considerably reduced. Although the total installed capacity is 85.5 MLD, the actual production is limited to 81 MLD. The equipment and structures of these water treatment plants require thorough improvement. BHEL, Railways, and M. E.S also extract raw water from the lake (BMC, 2005).

Kolar Dam Supply

The raw water from Kolar dam is pumped to the treatment plant by 2 nos, 36 km long 1450mm dia. Pipes. After treatment in a 154 MLD capacity treatment plant, the water is then pumped to the service reservoirs. The treatment plant was commissioned in 1990 and due to a reduction in efficiency is presently only producing about 135 MLD of treated water. Some of the equipments require improvement. The Water taken from the sluice of both Irrigation and domestic use, this water is good for agriculture, but for domestic use it needs treatment to be taken up to the CPHE manual level. In this process Lots of chemicals such as Potassium Permagnate, Hydrated Lime and Alum are required, increasing the cost of the treatment. This exercise has to be carried out due to the manganese and iron compositions in any man made dam due to anaerobic decomposition. The cost can be reduced with capital investment in constructing a multilevel intake (BMC, 2005).

Ground Water Supply

Ground water is also used currently as a supplementary source and the supply is about 22.5MLD from 42 dug wells, 541 tube wells and 1295 hand pumps. The majority of this supply is from the dug wells as the deep tube wells in the rocky strata are not very

successful. It included 70 municipal wards spread over an area of 296sq.km. (2011) .The population has increased from 185000 in year 1961 to 17.98 lakh in year 2011 indicating a fast increase over a period of 50 years. Urban water supply agencies tend to stress the importance of water quality over water quantity, although both have serious impacts on health and the quality of life (Cross, 1999). Under the JNNURM the vision is to provide safe drinking water for all which will eventually have serious impacts on the health and will ultimately result in better quality of life. To meet the water demand and close the present gaps and different projects have been implemented. Narmada Water Supply Scheme is one of this under, which new sources of water have been created (JNNURM, 2010). In the Bhopal city surface water is used for different purposes (Table 2).

Table 2: Distribution of water bodies in Bhopal city, 2011

Sl. No.	Name of water body	Total Area (in Ha.)	Purpose of
1	Upper lake	3100	Water supply, recreation, and fisheries
2	Lower lake	129	Raw water supply and recreation
3	Shahpura	96	Recreation & fisheries
4	Motia tank	1.89	Washing
5	Siddqehussain tank	1	Abandoned
6	Munshi hussain khan tank	1.2	Fisheries
7	Lendiya talab	1.5	Recreation & fisheries
8	Sarangpani	42	Recreation
9	Lahpura reservoir	350	Irrigation
10	Hathaikheda reservoir	113	Irrigation
11	Halali reservoir	1625	Irrigation
12	Kerwa reservoir	524	Irrigation
13	Kolar reservoir	2850	potable water supply & irrigation
14	Char imli pond	1.2	Recreation
15	Ayodhya Nagar abandon stone quarry pond	6.5	Recreation
16	Damkheda village pond	2.4	potable water recreation

Source: Central Ground Water Board, Ministry of Water Resources, Government of India, 2011

Presently the water of the lake is used by the localities for so many purpose like washing clothes & vehicles, Bathing, Boating, Lotus cultivation, Growth of aquatic weeds, Dumping of solid waste, Recreation, Inflow of sewage/waste, Encroachment & slum development.

Water Treatment plants

There are ten water treatment plants of different capacity supplying the drinking water to the Bhopal city. Out of ten water treatment plants, six representative plants were selected for evaluation. These are Kolar, Laxmi Narayangiri Hills (Birla Mandir), Shyamla Hills (Phase I and Phase II), Phulphukta, Bairagarh, and Idgah water treatment plants (Table 3).

Table 3: Distribution of treatment plants and their capacity, Bhopal city

Sl. No.	Treatment Plants	Source of water	Capacity (MLD	
			Proposed	Current
1	Kolar	Kolar dam	162.0	153.0
2	BHEL	Upper lake	54.0	54.0
3	Laxmi Narayangiri, (Birla Mandir)	Upper lake	23.0	23.0
4	Shyamla Phase-I & Shyamla Phase-II	Upper lake Upper lake	20.0 9.0	20.0 9.0
5	Phulphukta	Upper lake	13.5	13.5
6	Idgah	Upper lake	13.5	13.5
7	Bairagarh	Upper lake	4.5	4.5
8	MES	Upper lake	4.5	4.5
9	Badal Mahal	Upper lake	2.0	2.0
10	Railway	Upper lake	2.0	2.0
Total			**308.0**	**299.0**

Source: Volume II: City Appraisal, 3. Bhopal

The present total water supply from all the water treatment plants in the city is about 299 MLD. This study based on secondary as well as primary data. Secondary data collected by BMC, Bhopal, Ministry of Water Resource and also collected by different publication like report, journal, article, Research paper. Primary data which is used in this paper collected through interview schedule. In present study survey was carried out across the city to identify different zones of the city and to assess the water supply scenario therein. 400 household respondents systematic randomly surveyed from different wards which is located in different 14 zone of Bhopal city. Sample collected from different location and tried to cover maximum area of entire city.

General Problems in city areas:

Bhopal is facing several different problems related to water supply system due to poor maintenance of the water tankers and surfaced pipes that refills the plastic tanks, ruptured underground surfaced pipes at many places causing wastage of water by a heavy outflow in local areas, irregular supply and unproper management.

RESULTS AND DISCUSSION

For human beings, the main source of drinking water is surface water sources Upper Lake and Kolar store. Plus, there are tubewells, handpumps and a couple of huge width dugwells (Figure 3). Bhopal likewise has an unaccounted number of exclusive dugwells and borewells. Water supply in the city covers around 67% of the populace; the rest need to rely upon handpumps and private borewells (Jotwani, 2014).

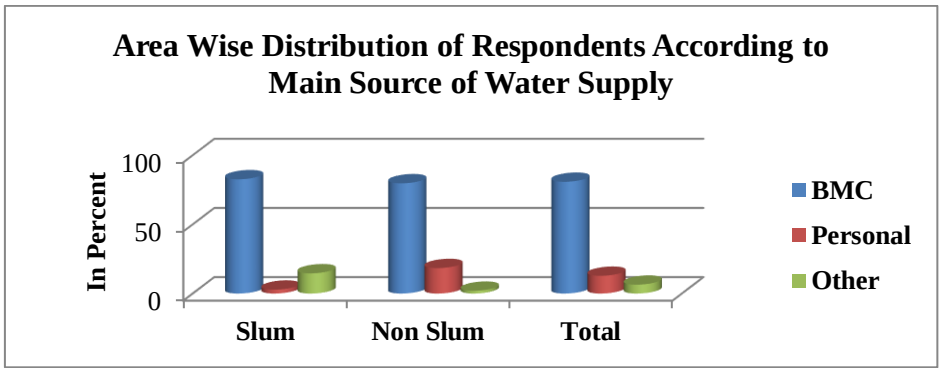

Figure 3: Shows the distribution of respondents on the basis of their water supply.
Source: Primary survey 2016-17

According to the data above 82.6 percent slums and 79.7 percent non slum population has BMC (Bhopal Municipal Corporation) water supply connection, 2.8 percent slum and 12.8 percent non slum population has personal water supply and 14.6 percent slum and 6.4 percent non slum population has other type of water supply (Figure 4). In total 80.8 percent people has BMC water supply, 12.8 percent has personal water source and 6.4 has other source of water supply. It should be noted that BMC represents here regular and public tape water supply although mostly slum respondents dependent on BMC public tape water is due to this reason slum people have 82.6 percent recorded 2.9 percent high compare to non-slum 79.7 percent.

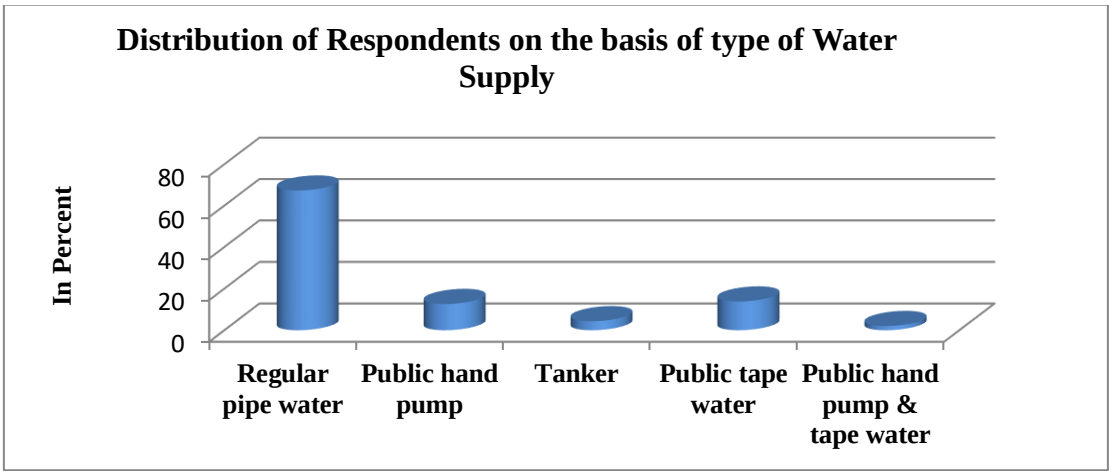

Figure 4: Type of water supply based on the respondents
Source: Primary survey 2016-17

The figure4 shows the distribution of respondents on the basis of type of water supply provided by BMC authority. The figure 4 represents that 67.3 percent respondent has regular tape water supply which needs to be improved, 12.6 percent has public hand pump, 4.3 percent has supply of water tanker, 13.8 percent has public tape water and 2.0 percent has public hand pump & tape water.

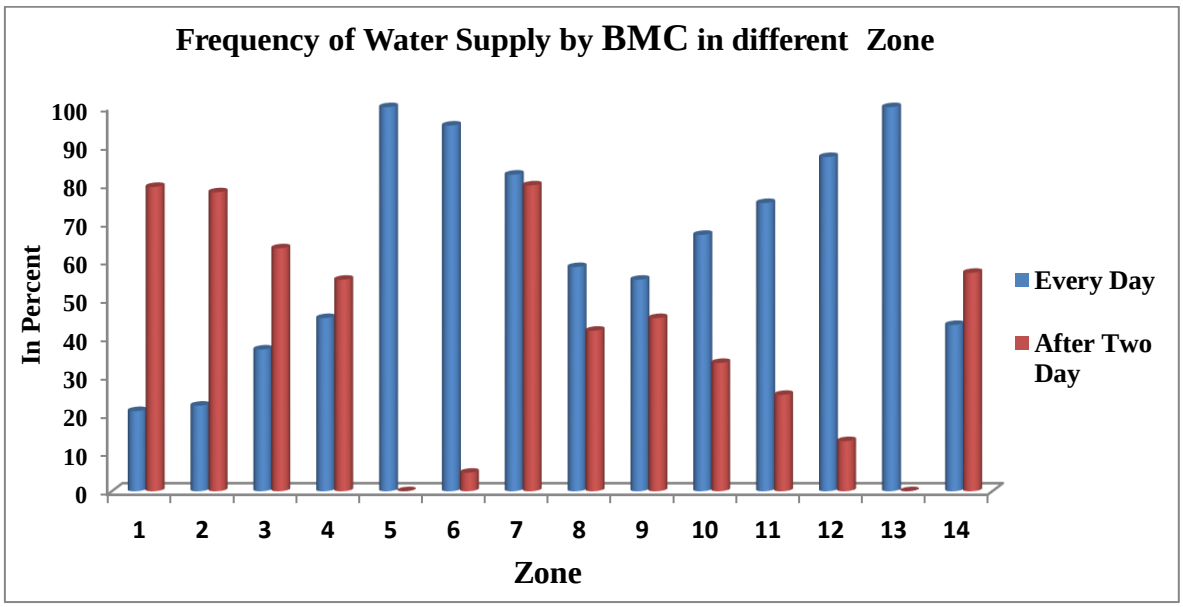

Figure 5: Zone wise distribution of respondents and the Frequency of water supply
Source: Primary survey 2016-17

The figure 5 shows the zone wise distribution of respondents and the Frequency of water supply they receive by BMC in different areas & Zones. The data above determines that zone no. 5 and 13 has 100 percent frequency every day after that zone no. 6 has 95.2 percent frequency, zone no. 12 has 87percent frequency of water supply every day. These four zones are comes under new city and residing people are mostly officers, administrators, high income group residential area and zone 5 is residential area for bureaucrats' similarly part of zone 13 and 12 comes under BHEL area. On the other side zone no. 1 has only 20.8 percent followed by zone no. 2 has 22.2 percent and zone 3 has 36 percent respondents who are receiving everyday frequency of water which is very low percent these zone comes under the old city and periphery area of the city. Poor income group people and slum dwellers have high concentration there.

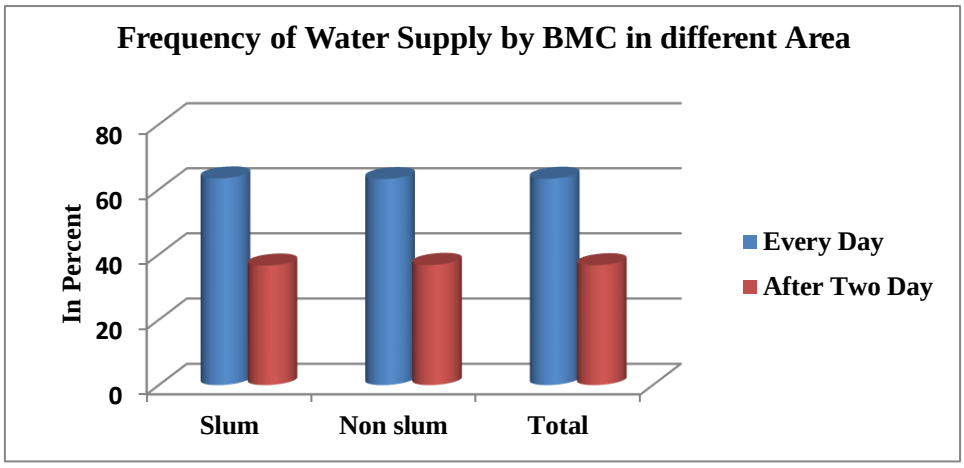

Figure 6: Frequency of water supply in slum and non-slum area
Source: Primary survey

The figure6 shows that total 63.3 percent respondent receiving very day frequency of water supply and 36.7 percent respondent has after two days frequency of water supply. There is no difference in frequency of water supply by BMC in slum and non slum area. The above figure analyses 63.4 percent slum and 63.2 non slum are receiving every day frequency of water supply similarly 36.6 percent slum and 36.8 percent non slum area are receiving frequency of water supply after two days. Very few slum people have regular tape water mostly slum dwellers use public tape water, public hand pump, tanker, because they receive daily supply.

Table 4: Respondents distribution according to the duration and quantity of water supply, 2016

Duration of water supply	**No**	**%**
Half an hour	103	30.7
One hour	60	17.9
Two hour	129	38.6
Three hour	43	12.8
Total	**335**	**100.0**
Daily availability of water (Quantity in lpcd)		
<20	68	20.3
20-60	132	39.4
60-100	104	31.0
Above 100	31	9.3
Total	**335**	**100.0**

Source: Based on field survey, 2015-16.

The table4 shows that distribution of respondents according to the duration of water supply 30.7 percent has half hour duration of water supply, 17.9 percent has one hour and 38.6 percent has two hour and only 12.8 percent respondents has three hour duration of water supply. Above table also shows the distribution of water supply as per the quantity 9.3 percent has 100 LPCD per day, 39.4 percent has 20-60 LPCD per day (Litres per Capita per Day).

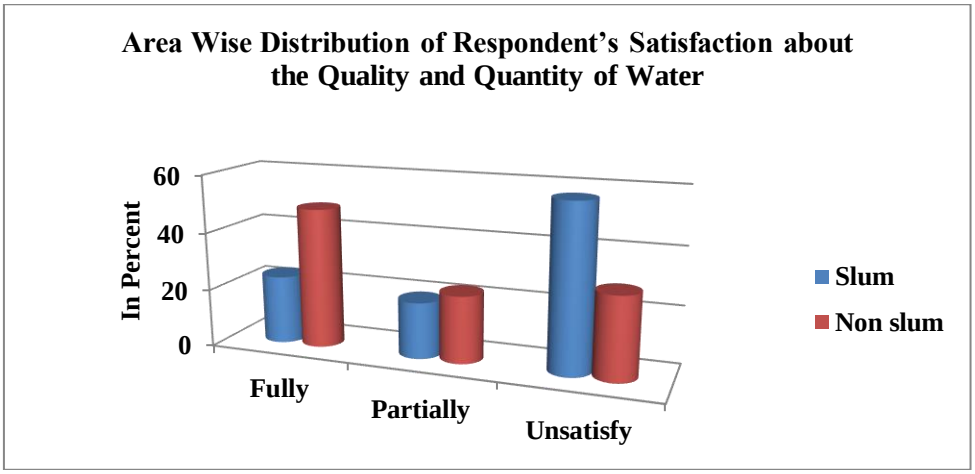

Figure 7: Area wise distribution of respondent's satisfaction
Source: Primary survey 2016-17

The figure 7 shows area wise distribution of respondent's satisfaction about the quality and quantity of water. As per the figure 34 slum respondents (23.6%) and 124 non slum respondents (48.4%) are fully satisfy. Although 82 slum respondents (57.0%) and 73 non slum respondent (28.5%) are unsatisfied. Most of the slum respondents are unsatisfied about the quality and quantity of water. Only 19 slum respondents (19.4%) are partially satisfied (Table 5).

Table 5: Zone- wise distribution of respondents according to level of satisfaction towards quality & quantity of water supplied by BMC, 2016

Zone	Satisfied					
	Yes		No		Total	
	No	%	No	%	No	%
1	14	50.0	14	50.0	28	100.0
2	11	40.7	16	59.3	27	100.0
3	5	22.7	17	77.3	22	100.0
4	16	69.7	7	30.4	23	100.0
5	19	90.5	2	9.5	21	100.0
6	23	76.7	7	23.3	30	100.0
7	8	36.4	14	63.6	22	100.0
8	17	63.0	10	37.0	27	100.0
9	14	51.9	13	48.1	27	100.0
10	16	100.0	0	0.0	16	100.0
11	30	69.8	13	30.2	43	100.0
12	18	64.3	10	35.7	28	100.0
13	39	86.7	6	13.3	45	100.0
14	15	36.6	26	63.4	41	100.0
Total	245	61.3	155	38.7	400	100.0

Source: Based on field survey, 2015-16.

The table5 shows that zone wise distribution of respondent's satisfaction about the quality and quantity of water. Data analyses that Zone no. 10(100.0%) hundred are highest percent of satisfied respondents followed by zone no. 5 (90.5%) and zone no. 13 (86.7%). Zone no. 3 (22.7%) has lowest percentage of satisfied respondents followed by zone no. 14 (36.6%) and zone no.7 (36.4%). In zone wise distribution most of the respondents who are not satisfied about the quality and quantity of water are residing in old city and periphery area of the city (Figure 8). 77.3 percent respondents are unsatisfied from zone no. 3 followed by 63.6 percent of zone no. 7 and 63.4 percent from zone no. 14. The Quality and quantity of water should be improved in old city area and also in periphery. The mostly residing people in these areas are belonging from middle income group and government is not paying any attention towards them.

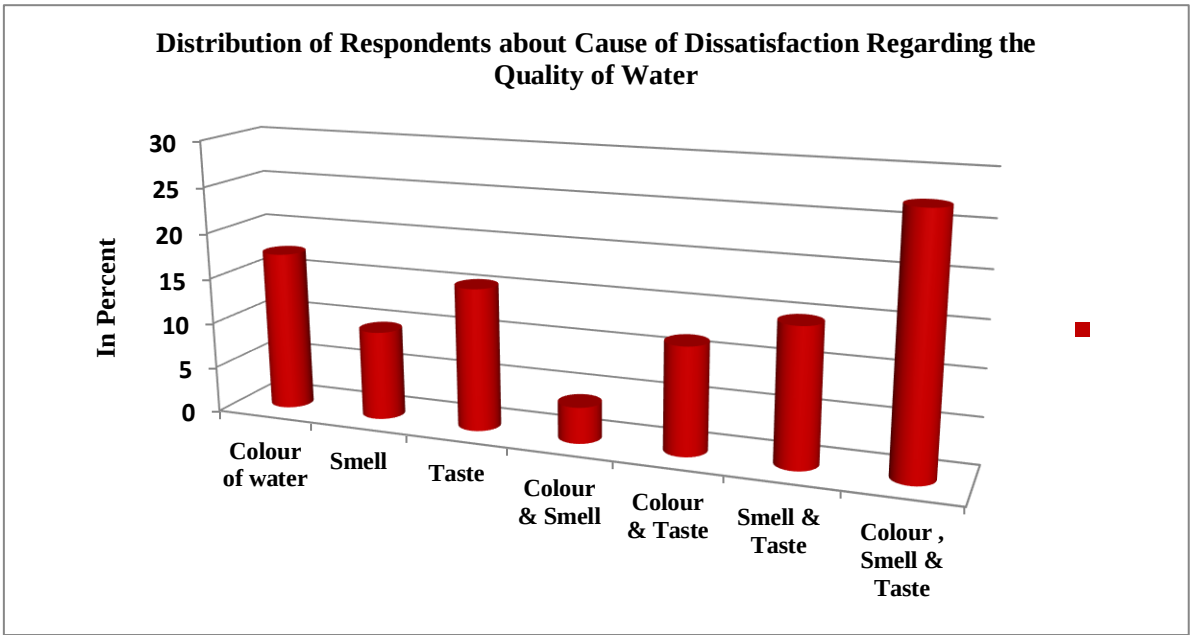

Figure 8: Distribution of respondents regarding the dis-satisfaction of quality of water.
Source: Primary survey 2016-17

The figure 8 shows the distribution of respondents regarding the dis-satisfaction of quality of water**.** Most of the respondents are dissatisfy the quality of water. The people were suffering by different types of water problem like 27.1 percent suffer from problem like colour, smell & taste, 17.4 percent suffer from colour of water, 15.5 percent suffer from different taste, 14.8 percent found foul smell & taste, 11.6 percent found different colour &bad taste, 9.7 percent found foul smell and 3.9 percent found problem in colour & smell in the respective selected zones of city Bhopal. The water from all the three sources Upper Lake, Kolar reservoir and recently commissioned River Narmada water supply subjected to conventional treatment which involves removal of flocculation, physical filtration and disinfection, but during the primary investigation, it was observed that the water reaching the consumers was not satisfying the required standards. One of the most significant threat that potable water faces is the presence of pathogens. Coliform bacteria were found positive in few of the municipal water supply samples including S-4 (New market) and S-11 (Vijay market, Barkheda) which recorded a maximum of 5 org/100 ml and 4 org/100 ml respectively (Jotwani, 2014). As far as current practices relating to water management in Bhopal are concerned, practices such as Effective Rain Water Harvesting, sufficient water supply in the agricultural lands, conservation of Upper and Lower lake are improving the conditions of public life very well as opined by most of the respondents. These measures are not only reducing the water scarcity but also improving

the accessibility of city's population to healthy water in addition to making an overall impact on public health and sanitary conditions of Bhopal (Dehalwar, 2015).

CONCLUSION

The paper elucidates that water bodies are being polluted which needs great concern to its protection. The main problem found in quality of water of colour smell taste and also in the quantity of water. There should be different arrangement of sewage line so that sewage water will not enter in the freshwater body because it affects both aquatic as well as human life. As per the study the slum are suffering to much because the drainage system and water supply system are passing through the same channel in case of leakage in supply line the drainage water gets mixed and makes the water contaminated and prone to diseases. Government authority should keep eye on the status of water body so that in the future we may not made water crises.

SUGGESTION

- Water quality checking framework ought to be begins to resources water quality.
- The sewage system which flow into upper lake and lower lake should be checked and proper arrangement of its passage should be made so that our water recourses will remain long lasting and free from pollution.
- Catchment area of Upper Lake, Lower Lake and Shahpura Lake should be preventing from pollution by the direct or indirect entry of solid wastes.
- Monitoring system of quality water and its assets should be started as soon as possible.
- Public should be aware about environmental problem because public participation are essential for protect and conservation of water resource from pollution.
- There should be special police patrolling party who will keep eye on those who were throwing garbage into water body.

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