

SUSTAINABLE DRINKING WATER SUPPLY IN PUNE METROPOLITAN REGION: ALTERNATIVE POLICIES

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Abstract

The demand of drinking water is continuously increasing in the Pune Metropolitan Region. Growth of rapid urbanization, population, commercial units, institutions, IT and BT and township planning are the major factors. Supply of drinking water is planned according to the growth of population but the coverage and equitable distribution of water is low. Water loss during transmission and distribution is also higher. Private sector participation is most urgent need to reduce water leakages, improve the coverage and equitable distribution of water in Pune Metropolitan Region. Restructuring tariff will improve the water use and reduce wastage.

Keywords: Metropolitan Region, Equitable distribution, Infrastructure

1. Introduction

The government of Maharashtra has promoted industrialization across Pune region. Due to such policy, automobile, engineering, electronic, information technology and biotechnology industries have grown very fast. Such industries have created huge employment opportunities in the region. Therefore immigration of indigent rural labor and qualified professionals from other states took place. Along with the production and manufacturing, the growth of services sector also concurred. The numbers of corporate offices, business processing units, call centers, banking and insurance services have grown significantly. The abandoned industrial sights are converted into residential locations in the region. Township planning and low cost affordable housing is developed for growing population.

All these factors resulted into increase in pressure on existing civic infrastructure. In the region, drinking water is not supplied on equitable basis and coverage is low. The reasons are topography, faulty and old pipeline, inadequate distribution system, transmission and distribution losses of water etc. The storage capacity of drinking water is also low.

Demand of water in various wards is different. It depends on density of population, industrial and commercial units and institutions. The supply of water is depending on transmission and distribution losses, stock of water, duration and pressure of water etc. If the demand of water is not matching with supply in wards then it results into unequal distribution of drinking water. Some wards get round the

clock water whereas some wards hardly get water in the region. Water tariffs are low and it is not regularly paid by the consumers. Drinking water is used for commercial and construction purposes. Water use laws are weak and they are easily violated.

Water provided by the tankers in far flung areas have lower coverage. Such water cannot be stored by the households because it is provided in a lower quantity and poor households do not have storage facilities. Therefore women and children are carrying drinking water from far places. It affects on the children's schooling performance and often results into lower schooling. Women cannot participate in the productive activities because carrying water from far places reduces the time for household chores, leisure and learning etc. Households can not rely on the ground water because it is highly polluted by the industrial units. Drinking such water causes water borne diseases. Reliable drinking water is becoming a scarce commodity in far flung areas of the region.

Pune city is transmuting from big city to mega city. It has already vanquished its peers such as Ahmadabad, Chandigad and Lucknow in terms of civic infrastructure. Now urban infrastructure is required to sustain the growth of city and water supply cannot be ignored. Therefore drinking water must be provided for 24/7 with adequate and equitable basis.

2. Data and Methodology

The ward wise data for this study is mainly obtained from the census 2001. It gives the total population of each ward, industrial and commercial units etc. We have referred the Pune and Pimpri Chinchwad city development report. Environment status and storm water plan report of Pune city has given the major insight to study the drinking water supply problem. Water supply systems of the metro cities in India such as Mumbai, Delhi and Bangalore are also referred. We have used the ordinary least square method to examine the factors related to demand of drinking water in the Pune Metropolitan Region.

3. Drinking water supply system

Pune metropolitan region consist of the Pune Municipal Corporation, Pune and Khadki Cantonment, Pimpri Chinchawad Municipal Corporation. Pune and Pimpri Chinchwad Municipal Corporation have separate sources of drinking water supply.

In Pune city, drinking water supply system is very old and it exists since 1750. Pune city received first piped drinking water supply from Katraj via Amboli odha, Shaniwarwada. After this scheme of water supply, the Swargate water work came in existence in the year 1873. Such scheme is planned to treat raw water and supply to Pune city. Such water supply scheme is on Mutha right bank channel and it is

picked up at Swargate. Total water supply was inadequate for rising population. When Pune city reached at the status of Municipal Corporation in the year 1950, a project of 45mld is developed on the Mutha right bank canal. Such scheme has provided water to the Pune city and Cantonment.

Other than two major water supply schemes, Pune city gets drinking water from the Holkar water works. It is constructed in 1919 on Mula River. It supplied 22mld water to Pune city and Khadki Cantonment. Warje water work is constructed in 1999 which added 23mld drinking water. Such scheme is build on the Khadakwasla dam. The capacity of Khadakwasla dam is 56 million cubic meters.

Wagholi water work is built on the Pavana dam in 2000. It added 23mld drinking water. Such scheme is planned to provide water to the villages on the boundary of Pune city. Due to the merger of the villages in the Pune municipal area, the villages are obliged to provide the drinking water. Total installed capacity of five water supply schemes in Pune Municipal Corporation is 793mld.

For Pimpri Chinchwad Municipal Corporation (PCMC), Pavana dam is a major source of drinking water. It is constructed in 1972. Intake works are constructed in the river bed 150 meter upstream of the existing Punawale weir near Ravet village. It is six kilometer away from the city. Around 91 percent of the stored water in the dam is utilized for non-irrigation purposes. Drinking water is mainly supplied to the Talegaon, Dehu Road cantonment and Pimpri Chinchwad town ship. Everyday 350mld (51 per cent) raw water is lifted from Pavana dam and supplied to Pimpri Chinchwad Municipal area. Pavana dam has capacity of 241million cubic meters.

3.1. Water demand in Pune Metropolitan Region

Potable water is used by household units for cooking, washing, bath and drinking purposes. The schools, colleges, hospitals are also using the potable water for cleaning and toilet purposes. Commercial units and garages in the city are also using the drinking water for different purposes. We have calculated the water demand of each unit based on the standard norms of drinking water. Total demand of the water is further divided into five administrative regions.

TABLE 1 WATER DEMAND ACCORDING TO ADMINISTRATIVE REGIONS

No.	Administrative regions	Water Demand (MLD)	Percent
1	PMC	531.94	64.87
2	Pune Cantonment	13.30	1.62
3	Khadki Cantonment	12.35	1.51
4	PCMC	239.32	29.19
5	Rest of PMR	23.43	2.86
	Total	820.34	100

The Pune Municipal Corporation has 531.94mld water demand. Such water demand is higher in the metropolitan area because of population, commercial units, hotels, restaurants and institutions. Pune Municipal Corporation also supplies the drinking water to the Pune and Khadaki Cantonment. If we combine the water demand of Kadki, Pune Cantonment and Pune city, then the total water demand is 558mld. In Pimpri Chinchwad Municipal Corporation area, water demand is 239.32mld. In the rest of the Pune Metropolitan Region such as Chandani Chowk, Sutrawada other town and villages, water is supplied. The demand of water from such region is 23.43mld.

3.2. Water demand according to types

Water demand is different by the different units. It also varies according to the time. Municipal Corporation has the responsibility to supply drinking water to all units in the area. It has record of the number of units of different type in the area. Therefore according to the standard norms, water is supplied to the units. We have calculated the water demand for the current year.

TABLE 2 WATER DEMAND AND TYPES

No.	Types	Water demand (MLD)	Percent
1	Domestic demand		
	Population	672.00	81.91
2	Industrial demand		
	Industrial units	41.14	5.01
3	Commercial demand		
	Hotels	21.67	2.64
	Restaurants	38.24	4.66
	Theaters	0.52	0.06
	Shops	1.23	0.15
	Other commercial units	8.71	1.06
4	Garages		
	Cars	2.98	0.36
	Two wheelers	7.95	0.97
5	Institutional demand		
	Health centers	1.71	0.21
	Primary schools	4.31	0.53
	Secondary schools	6.35	0.77
	Higher secondary schools	5.16	0.63
	Colleges	8.46	1.03
6	Total	820.34	100

In Pune Metropolitan Region, demand of drinking water by population is 672mld. It is almost 82 percent of the total demand of drinking water. In Pune city, current population is more than three million and it is expected to cross five million by 2021(PMC, 2006). Similarly in Pimpri Chinchwad, it is estimated to reach 15.07 lakh and 21.05 lakh by 2011 and 2021 respectively (PCMC, 2006). Urbanization in the region has resulted in more demand of water. Industrial demand of water is only 5 percent (41.14mld) in the region. Such demand is lower because most of the industrial units are shifting out side of metropolitan area. The commercial units such as hotels, restaurants are increasing. The water demand by the restaurant is 38.24mld. Demand of water by the hotels is 21.67mld.

In the metropolitan area, water demand by the other commercial units such as mall and other entertainment unit is 8.71mld. In Pune and Pimpri Chinchwad two wheelers, cars are more. Potable water is used for the washing cleaning, repairing of cars and two wheelers in the region. The demand of potable water is almost 11mld. Water demand by the health centers is 1.71mld. In the Pune Metropolitan Region, the numbers of educational institutions have grown significantly over the period of time. The water is used for drinking, cleaning, gardening etc. Water demand by the various colleges is 8.46mld. We have calculated the total 820.34mld water demand in the Pune Metropolitan Region for the current year.

3.3. Drinking water transmission and distribution

Drinking water supply distribution systems are separate in Pune and Pimpri Chinchwad municipal area. In Pune city, water supply operation is divided into seventeen zones. Each zone has its specified area and service. In some part of the city water is pumped and in some part water is distributed through gravity. It is also depend on the zonal reservoirs. Water is distributed through pipes consist of different diameters. The lowest diameter size of pipe is 80mm and highest diameter is 1600mm. Total length of the network of pipeline in the city is 647.18 k.m. Total length of the distribution of drinking water pipeline is 2474 k.m. It also includes the 24k.m transmission line. In Pune city, water supply pipeline is mainly located near the roads. Some roads have more than one pipe line. The reason is that it has been put at different time. Total length of road in Pune city is 1750k.m.

In Pimpri Chinchwad Municipal Corporation, the distribution network covers length of 722 k.m. It is 95 percent of the road length. The water supply system in PCMC covers whole developed area including slums. The newly added areas are catered by the tanker supply. Total water storage capacity is 74ml and it is only 32 percent of installed capacity of the system. Therefore the reservoirs in PCMC are filled up more than two times a day. The water supply is distributed by gravity and pumping zone in the city.

The gravity zone comprises as areas south of the ridge and slopping towards Pawana River. It is served by clear water sumps with total capacity of 20ml. The gravity zone covers west side of Pune Mumbai highway and railway lines like Chinchwad, Gaonthan , Pimpri, Rahatni, Kalewadi, Wakad, Pimple Nilakh , Pimple Gurav, Sanghavi, Thergaon and surrounding areas. There are 24 Elevated Service Reservoirs (ESR's) in the gravity zone.

The Pumping zone comprises areas north of the ridge and slopping towards the Indrayani River. They are subdivided into eight water districts. Each water district is served from the local ESR's. Total ESR's are 15 in pumping zone. It is also depending on the system in that particular ward. The areas covered under pimping zones are Morwadi, Amruteshwar, Masulkar colony, Saint Tukaram Nagar, Kharalwadi, Bhosari, Dighi, Charoli, Wadmukhwadi, Dudhoolgaon, Bokkhel and other areas located on other side of the Pune- Nasik road.

In Pune city, water supply operation and maintenance, pumping of water, treatment and distribution is taken care by the Pune Municipal Corporation staff. Due to wider service area and connections, total 1650 persons including technical staff is employed by the Pune Municipal Corporation. Contractors are also involved in the distribution and maintenance at the boundary of the municipal area. In Pimpri Chinchwad Municipal area, water supply and service area is small. Therefore only 50 persons are employed.

3.4. Water treatment and Quality

In Pune city, quality of drinking water is regularly maintained as per IS 10500, 1991. The laboratory facilities at Parvati and Cantonment water works are well equipped with machinery. The physical, chemical and bacteriological tests of raw water as well as filtered water are carried out in the laboratory on regular basis. Daily 90 samples are collected at different points. It includes overhead and service reservoirs, intermediate connections in distribution network. The major portion is collected from the consumer taps. Water tests are divided as physical, chemical, microbiological examination of water. In daily supply of raw water, there is possibility of the presence of coli form and E coli organism. They may be more than 1800 per 100ml. After treatment of water, they are not present. In the month of August, turbidity in drinking water increases. The efficiency of Parvati water works as turbidity removal is approximately 67 per cent, which is of good quality.

In Pimpri Chinchwad Municipal area, two water treatment plants are located in sector 23, Nigdi. Each one has capacity of 114mld. Total capacity matches to the installed capacity. In Pimpri Chinchwad municipal area, water treatment process is of conventional type. It consist of aeration fountain intake

channels flash mixer, clariflocculator, rapid sand filters, chlorine contact tank, treated water sump and relevant TW, Pumping machinery. At present, PCMC has three water sumps and one BMR for storage of treated water. Treated water is further distributed to different zones in the city.

There is possibility of water contamination through open drainage system. If there is any complaint of water contamination in both Pune and Pimpri Chinchwad Municipal Corporation, then it is solved within 24 hours by engineers and staff.

3.5. Regular water supply in PMR

According to PMC, the gross water supply in Pune city is 260lpcd and net supply is 182lpcd. Drinking water is supplied to 85-88 percent of the city population. The areas such as Kharadi, Kondhwa, Bavdhan and other far flung areas are not covered. The reason is that around 35-40 percent water gets lost due to the leakages, pilferage and wastages through uncontrolled stand posts. Water in the far flung areas and uncovered habitations is provided by tankers.

The storage capacity is only 22 per cent and lowers than the standard (33 per cent) capacity. It mainly affects on the equitable distribution of drinking water. Such lower storage capacity required to fill three times a day. Water in the Pune city is provided twice in a day. The duration of water varies in each ward. In ward 7 and 12 (Hadapsar and Bibwewadi) water is supplied for 8 hours of duration. In other wards it is supplied for less than four hours a day. Nearly 50 per cent of the wards are being over supplied or rather excess consumers whereas the others may have under standard consumption (ESR 2008). The pressure of water is mainly determined by density of population, industrial and commercial units in each ward. In the boundary of municipal area, there is low pressure and remain uncovered of drinking water.

In Pimpri Chinchwad Municipal Corporation, the gross supply of water is claimed as over 154lpcd and net supply is 138lpcd. The net supply is close to the standard supply of drinking water. The water supply pipeline has laid in 1977-78 which are now very old and new branches developed. The PCMC has laid new pipeline in the wards. People are advised to use water of new pipeline. The coverage of drinking water is improving. Lower pressure of drinking water is observed in the areas where water distribution network is old. It is also lower in the areas far from the service ESR's, newly added and distribution system is not completed areas.

Water is provided through tankers in the area where water supply distribution system is yet to complete or not exist. These areas are old and new Sanghvi, Kalewadi, Thergaon, Pimple Nilakh, Bopkhel Charholi, Akurdi, Yamuna nagar, Sudarshan nagar, Vijaynagar, Talera road and Kunal estate. These

areas are served by tankers at an average of about 45 trips per day. The capacity of each tanker is in the range of 9000-12000 liters.

3.6. Water supply connections and tariff

The numbers of water connections in the Pune Metropolitan Region are lower. In PCMC area, new domestic connection deposit is charged at Rs. 1000 to Rs. 12000. The non domestic connection deposit is varies from Rs.3000 to Rs.15000 and it depends on diameter of connection. In Pune Municipal Corporation, for the year of 2005-06, the number of metered connections was 36251. Un-metered connections were 61559 in the city. Some houses had multiple connections in the city. Commercial connections were 19275 in Pune city. Slums had 22000 water supply connections and 500 stand posts.

In the PCMC, total numbers of household connections was 84469. Such connections cover only 41 per cent of total properties in the city. The numbers of domestic metered connections was 298 where as 1550 was commercial/industrial connections. In PCMC, now 60 percent meter installation work has been completed.

Water tariff is difficult to decide because of either lack of meter or illegal connections. In Pune Municipal Corporation area, 1000 liter of water is provided at Rs. 3. In Pune and Khadki Cantonment, it is at Rs.5. For commercial and industrial unit, the rate is Rs.21 per 1000 liter. Household in a slum has to pay Rs365 per annum. Water for stand posts is free of charge.

In PCMC, domestic connections are charged at Rs.3.30 per 1000 liter. Non domestic connections are charged Rs28 per 1000 liter. Un-metered domestic connections are charged a minimum of Rs. 792 per annum. Commercial and industrial un-metered connections are charged of Rs. 652 per annum to Rs. 11358 per annum depending on the diameter of connection.

In PCMC, the water charge for 2004-05 was Rs. 872 per apartment. For 2005-06, it was increased up to Rs.959. For 2006-07, it was further increased up to Rs.1055. For 2007-08, it was Rs.1160 per apartment.

4. Demand and supply projection

In Pune Metropolitan Region, demand of drinking water is increasing fast. We have calculated the demand of drinking water till 2031. It is assumed that domestic, commercial units and institutions will increase in 48 zones of Pune Municipal Corporation, Khadaki and Pune Cantonment and 41 zones of PCMC. The number of theaters, shops, hotels and restaurants are spread across the wards. They will

also increase with increase in the population density. Workers working in various industrial units will also increase with increase in population. The required doctors, nurses and midwives will increase along with population and number of hospitals in the metropolitan region. We have assumed that Pune Metropolitan Region will be slum free because of two reasons. First municipal authority is either improving or rehabilitating the slums. Secondly it is ensured that the economic benefits of growth will trickle down to the masses which will improve their economic condition. After all, drinking water a basic necessity of population.

In order to calculate the water demand, we have taken the standard norms of drinking water and the growth of number of units in the metropolitan area.

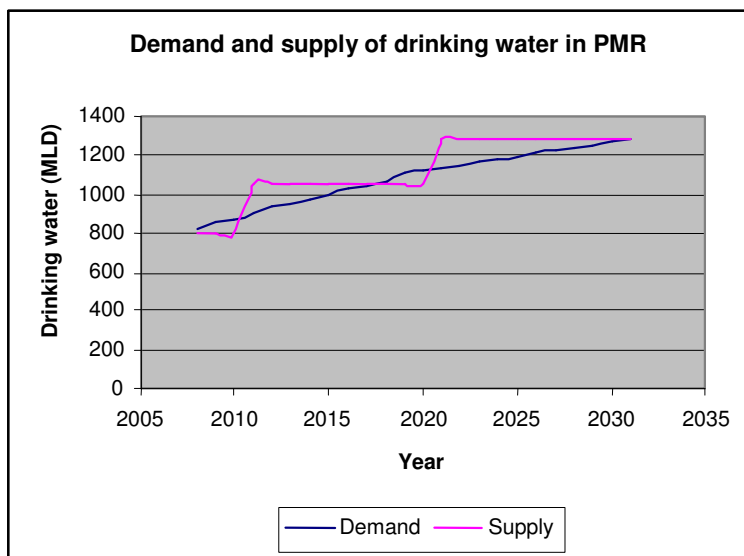


FIGURE 1 WATER DEMAND AND SUPPLY IN PMR

Water demand in the current year is calculated as 820.35mld. After transmission and distribution loss, Pune Metropolitan Region gets 800.1mld drinking water. The water demand for 2031 is calculated as 1286.99mld. The supply of drinking water is also planned by the Pune and Pimpri Chinchwad Municipal Corporation. Pune Municipal Corporation has planned 270mld drinking water supply in the year 2011. Similarly PCMC has planned 100mld water supply to match the growing population. It will be added by developing phase four of Ravet project.

Due to continuous increase in population, Pune Municipal Corporation planned additional 200mld to cater the need in 2031. PCMC also planned beyond 2011-12 and planned 120mld to cater long term need of 2031.

Therefore in Pune Metropolitan Region, demand of drinking water is planned with supply till 2031. There will be no shortage as such of drinking water. But it depends on the future water supply schemes and finance.

5. Regression results

We have used ordinary least square method (Baltagi, 2008) to understand the factors determining the demand of water in the Pune Metropolitan Region. Total demand of water of units in particular year is considered as the dependent variable. It is further regressed on the independent variables. The results are explained as follows.

TABLE 3 REGRESSION RESULTS

Variables	Co efficient	T test
Population	1.00* (0.00)	2143.75
Visitors to theaters	3.17*(0.05)	58.29
Theaters	1.00*(0.00)	210.64
Restaurants	1.52*(0.05)	32.41
Commercial Units	1.32*(0.20)	6.59
Two wheelers	0.99*(0.02)	43.72
Cars	0.98*(0.01)	77.58
Colleges	4.42*(0.04)	94.00
Constant	-0.20(0.26)	-0.79
Rsquare=0.99 Adjust R square =0.99 Root MSE=1.88		

Notes: (a)* Significant at 1 percent.

(b) Figures in parenthesis are standard errors

In the Pune Metropolitan Region, population is continuously increasing. The water is required for the cooking, washing, bath and drinking etc. Such demand is positive and significant. Pune is a highly commercial city in India. The numbers of theaters have increased over the period of time. Water is mainly used for washing, cleaning, cooking etc. Therefore the water demand for the theaters is positive and significant in the city. People visiting to the theaters are also using water for toilet, drinking and other purposes. It means drinking water is used for internal purposes in theaters as well as for visitors. It is positive and significant in the Pune metropolitan area.

In the restaurant, water is used for cooking, washing, drinking, cleaning etc. It also depends on the number of visitors. It is statistically significant and positive. Numbers of commercial units have also increased in the metropolitan area; they have positive demand of water.

In Pune Metropolitan Region, due to lower development of transport facilities, most of the people are using two wheelers and cars. The demand of water is higher for washing and cleaning. It is positive and statistically significant.

In Pune and Pimpri Chinchwad municipal area, numbers of educational institutions have increased significantly over the period of time. Nearly six universities and six hundred educational centers are functional in Pune region. Around five lakh student including one lakh foreign student of 64 countries are taking education in Pune. It is considered as "Oxford of the east". Water is used in such educational institutions for drinking, gardening; cleaning etc. Such demand is positive and significant.

6. Policy Implication

In Pune Metropolitan Region, demand of drinking water is continually increasing due to various factors. Urbanization is a major factor. Water supply distribution is unequal in the metropolitan region. The far flung and newly added areas are not covered under the water distribution system. In some wards, water supply pressure is very low. Unequal distribution of drinking water in terms of quality and quantity leads to water stress. The poor urban population often neglected from the distribution of drinking water and it is a major challenge. (Wipperman 2007) Water tariff structure is lower in the region. Due to illegal and multiple connections, water tariff is not regularly paid. It is main factor behind lower revenue and recovery of the capital cost.

Therefore there is need of drinking water supply management. It will be achieved through the citizen's participation. Municipal Corporation must involve non government organizations, research institutions and academicians in supply management process. There is need of regular revision of tariff structure in the Pune metropolitan area. Water tariff for the commercial units such as five star hotels, malls must be higher than the domestic units. Minimum water supply must be provided at flat rate. If the use of water is increasing then there must be more tariffs. Municipal Corporations must reduce the connection deposit to increase the number of water connections. The funds received by the Pune and Pimpri Chinchwad Municipal Corporation under JNNURM, must utilize for water storage tanks and distribution system in respective area. Building big water tanks and modern distribution system will reduce the lower water pressure in the boundary area. Water supply department must educate people about the proper use of the drinking water. They can do the collaboration with the educational institutions for educating people about different methods of water conservation, preparing small advertisement, water supply situation etc. Municipal Corporation must create more awareness of roof rain water harvesting method and conduct training to architect engineers, plumbers etc.

In the metropolitan area water distribution and transmission loss is high. Municipal Corporation can introduce the private partnership to reduce the leakages and improve distribution system. Private sector participation is not always efficient (Arnold C.A. 2005) but it is useful to tackle with lower coverage, revenue earning, computerization of billing, training and upgrading and maintenance of water distribution system. The private sector companies should not allow fixing the tariff structure. Municipal Corporations must monitor the service of the private companies. Water supply system needs more capital and such capital can be generated through private companies. Such efforts are important for sufficient and sustainable drinking water supply in the region.

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