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Research Article

PROBLEMS OF URBAN WATER SUPPLY IN HYDERABAD A SPATIAL PERSPECTIVE

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ABSTRACT

The water supply scenario of Hyderabad is confronted with a set of problems. These factors, in isolation or combination have influenced the water supply situation. To evolve meaningful solutions, identifying the problems is first and foremost step. The problems are related to water potability or quality includes basically the quality of water provided by Metro Water Works underground water quality, packaged water quality etc. The water problems associated with urban water supply is not only restricted to inequitable and inadequate supply, but its deteriorating quality. These problems have direct bearing on human health. An attempt is made here to analyze problems associated with various aspects of urban water sector sources of water and suggest some solutions.

Objectives

1. To identify and map the problematic areas
2. To assess the quality of drinking water
3. To analyse the perception of urban residents on water quality and supply
4. To suggest solution and remedial measures

The study necessitated the collection and extraction of information from secondary sources, which would included data obtained from various government institutions. Primary data is collected based on questionnaire method. Random sampling is adopted in this work.

INTRODUCTION

The water supply scenario of Hyderabad is confronted with a set of problems. These factors, in isolation or combination have influenced the water supply situation. To evolve meaningful solutions, identifying the problems is first and foremost step. The problems are related to water potability or quality includes basically the quality of water provided by Metro Water Works underground water quality, packaged water quality etc. The water problems associated with urban water supply is not only restricted to inequitable and inadequate supply, but its deteriorating quality. These problems have direct bearing on human health. An attempt is made here to analyze problems associated with various aspects of urban water sector sources of water and suggest some solutions.

Objectives

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Methodology and Database

The study necessitated the collection and extraction of information from secondary sources, which would included data obtained from Census department, Bureau of Economics and Statistics, Municipal Corporation of Hyderabad, Hyderabad Urban Development Authority, Hyderabad Metro Water Supply and Sewerage Board, Irrigation Department, Ground water department, A.P. Pollution Control Board, Regional Center for Urban and Environmental studies, National Remote Sensing Agency, Vision – 2020 document Government of Andhra Pradesh. The information is supplemented by satellite data. The data collected is processed based on appropriate statistical techniques. Various cartographic methods are used, in the generation of the maps. The analysis and mapping is done applying GIS where ever necessary. The study also necessitated the generation of primary data. Primary data is collected based on questionnaire method. Random sampling is adopted in this work.

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Problems associated with urban water supply are broadly grouped as

1. Water quality/its potability-Surface / Under ground
2. Corrosion of water pipeline and Leakages
3. Unaccounted for Water
4. Duration of Water supply
5. Un metered tap connections
6. Inadequate supply / use of motors/ low pressure
7. Wastage of Water during tanker water supply
8. Depletion of Underground water levels
9. Pollution and loss of water bodies
10. Inequitable supply of water-Demand & Supply
11. Water pressure and bursting of pipelines

While the problem of water scarcity is recurring, the problem of safe drinking water is alarming. There are few factors which has a bearing on the potability of water. Even though the quality control test reports that water is fit for consumption. Old and worn out domestic house connection pipes that are prone to leakage caused contamination. The corrosion of pipeline led to mixing drinking of drinking water with sewage. The gravity of drinking water supply is highlighted by the number of cases related to Jaundice and Hepatitis reported. According to water board officials, worn out domestic water connection pipes are prone to leakage and causing contamination. The pipelines of domestic water consumers which mostly made of galvanized iron have got rusted.

Loss of Water during Transmission and Distribution

Even though the treatment of water is done before distribution, it is seen that the water is getting contaminated due to the problem of leakage, mixing of sewage, storm water etc, making water unfit for drinking purpose. It is also responsible for spreading epidemics. During March 2005, 142 people were admitted at fever hospital (exclusive Government hospital specialized for the treatment of various fevers) for Hepatitis A and E. It indicated that the water meant for drinking purpose is mixed with sewage water and this happened when there is a leakage in the water pipe. As per water boards observation, the pit taps that people in the affected areas had dug, provided environment for the contamination of water. Lack of pressure in taps had forced the people to go for taps at ground level. There were 1200 such pit taps in the epidemic area which proves that there was no water pressure in these areas.

In addition to this, corrosion of pipeline led to the mixing of drinking and sewerage water. Director of Medical Health and Gastroenterologist from Appolo Hospital also believed that a facco-oral i.e. the mixing of drain and drinking water is the most common and reasonable way to explain the spread of hepatitis A and E. It is seen that the contamination sources lies in the distribution system, where leakages and mixing of sewage water is causing epidemics. Besides corrosion of domestic pipeline, collection of water from pit tap is causing the contamination.

Water quality analysis based on House hold survey

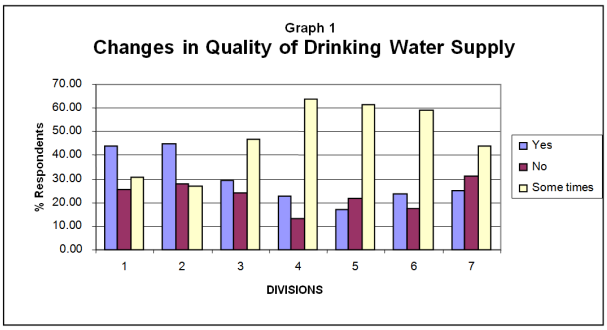
To further corroborate the water problems faced by the inhabitants of Hyderabad, field survey was carried to substantiate and obtain information to read the pulse of people regarding water supply problems. The residents are the ultimate affected party hence, a need is felt to asses the view of the people

Table 1 Changes in Quality of Drinking Water Supply

Divisions/Response	1	2	3	4	5	6	7
Yes	44.00	45.00	29.33	22.67	17.00	23.50	25.00
No	25.33	28.00	24.00	13.33	21.67	17.50	31.00
Some times	30.67	27.00	46.67	64.00	61.33	59.00	44.00

Source: Fieldwork, Note: Figures belong to % respondents

To get an insight into households' response on quality of water the sample respondents where asked to assess their response towards quality of water supplied by water board. As seen from Table 1 majority of the respondents felt that sometimes they observe some changes in the quality of water.

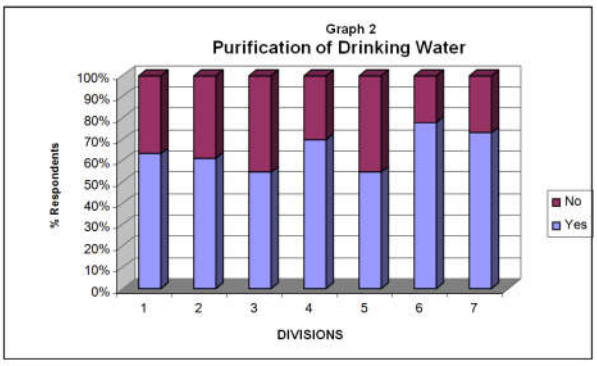


Majority of respondents of division IV (64%) have felt that water supplied by the water board sometimes is not good, where as only 30.67% of respondents in division I perceived that water quality is not good. The sample respondents from division I felt that frequently the quality of water supplied is not good. As seen from the earlier paras epidemics broke in this division and adjacent localities.

Table 2 Purification of Drinking Water

Divisions / Response	1	2	3	4	5	6	7
Yes	63.33	61.33	54.67	70.00	54.67	78.00	73.00
No	36.67	38.67	45.33	30.00	45.33	22.00	27.00

Source: Fieldwork, Note: Figures belong to % respondents



Even though most of the sample respondents from division I&II felt that many a times the water supplied is of bad quality, still about 40% do not use any purification method (Table 2). In general a large section of respondents are using some sort of purification method. It could be either due to general awareness about the quality of water and health or may be due to problems related to quality of water supplied by the water board.

Table 3 Quality of Water Supply

Divisions/ Response	1	2	3	4	5	6	7
Very good	2.67	7.00	14.00	14.00	14.33	10.50	3.00
Good	31.33	47.00	26.67	23.33	15.00	15.50	15.50
Normal	57.33	37.33	34.00	53.33	51.33	62.50	59.00
Bad	8.67	8.67	25.33	9.33	19.33	11.50	22.50

Source: Fieldwork, Note: Figures belong to % respondents

The perception of water quality levels is presented in table 3. The respondents who perceived that the water supplied by water board is very good, constitutes a very low percentage. It varies from 14.33% (division V) to 2.67% (division I). excepting the respondents from division II and III mostly covering old city and old localities to the northwest of Musi river, more than 50% of respondents felt that water quality is normal. The response pattern of perception of water quality is rather mixed. Majority of the sample households to a great extent are satisfied with water quality.

Strategies adopted for Water Quality Management

1. Regular analysis of Raw, Filtered and the Treated water at the Filter beds and the treated water in the distribution system for chemical and bacteriological quality assessment.
2. Ascertaining the quality of chemicals used in the water treatment and fixing-up their optimum dosages.
3. Periodical analysis of filter media of all the filter beds for quality evaluation.
4. Daily sample collection throughout the distribution system and testing for residual chlorine and bacteriological quality.
5. Carrying out the monitoring in collaboration with other agencies viz. Institute of Preventive Medicine(IPM)
6. Assisting the engineering staff in identifying the source of pollution and rectifying the leakages.
7. Re-sampling and analytical confirmation of quality after rectification of pollution.
8. Collection of data on the incidence of water borne diseases recorded in the Institute of Tropical Diseases (Fever Hospital)
9. Intensive monitoring of the piped water quality and the epidemiological studies in localities where patients reside.
10. Conducting Health-Education camps in Schools and Slums for creating awareness on water quality.
11. Whenever there is an increase of water borne diseases, NGOs and welfare organizations are also involved to educate the public in controlling the diseases.

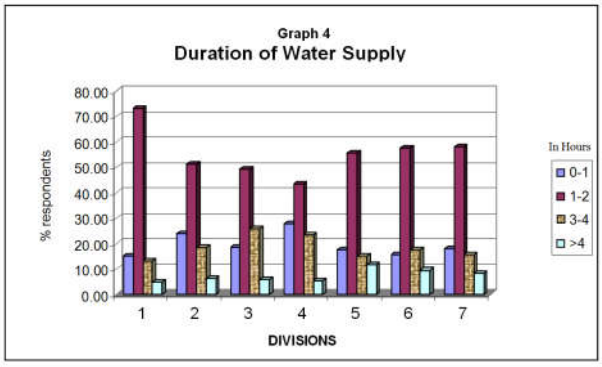
Duration of water supply

Hyderabad city was known for round the clock water, supply. Since one and half decade it is facing the acute problem of supply. The problem of water supply can be gauged by the number of hours during which water is supplied.

Table 4 Duration of Water Supply

Divisions/ Hours	1	2	3	4	5	6	7
0-1	15.33	23.67	18.67	28.00	17.33	15.50	18.00
1-2	73.00	51.33	49.33	43.33	55.67	57.50	58.00
3-4	13.33	18.67	26.00	23.33	15.33	17.50	15.50
>4	5.00	6.33	6.00	5.33	11.67	9.50	8.50

Source: Fieldwork, Note: Figures belong to % respondents

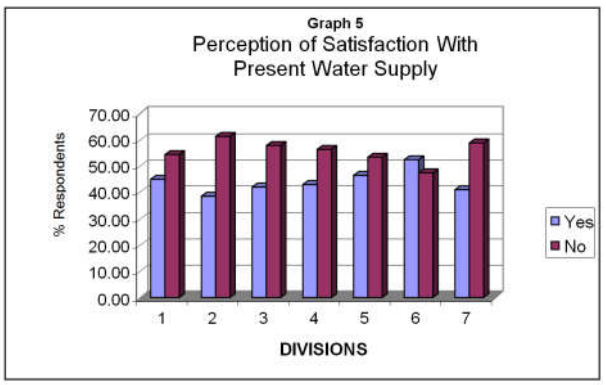


The division where water is supplied from one to less than one hour is maximum in division IV which includes the central part with commercial core of the city. It followed by division II which includes the historic core of the city in Hyderabad south. Almost all divisions receive maximum water supply within 1-2 hours, highest number of sample households (73.00%) in division I which is located in Hyderabad south. Very few sample households receive water supply exceeding four hours (table 4). On one hand the duration of water supply is very less and on the other hand the pressure of water is very low especially for locations situated on relatively higher elevation. As seen earlier, this problem has forced many households to use electronic motors to suck water which is illegal. It also resulted in collecting water from taps located in pits which has possibility of contaminating water. Sometimes, the water pressure is so low that the water collected through taps is just enough for drinking purpose. Yet another problem associated with water supply is that, the duration of water supply is less and the hours during which water is supplied are very odd. Sometimes, the households have to spent sleepless nights to fetch water.

Table 5 Perception of Satisfaction with Present Water Supply

Divisions / Response	1	2	3	4	5	6	7
Yes	45.33	38.67	42.00	43.33	46.67	52.50	41.00
No	54.67	61.33	58.00	56.67	53.33	47.50	59.00

Source: Fieldwork, Note: Figures belong to % respondents



To get the pulse of respondents reaction with the municipal water supply the respondents were asked as to whether they were satisfied with present system of water supply. It is seen from table 5 that more then 50 percent of sample households were not satisfied.

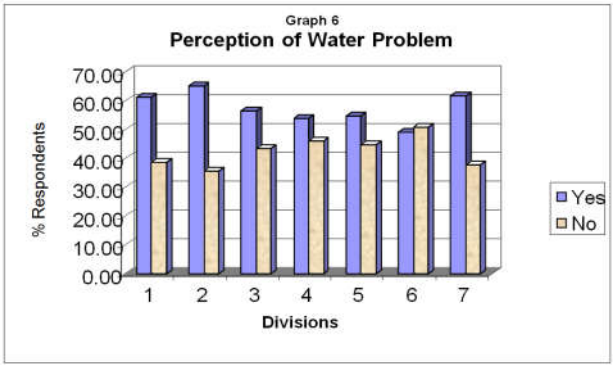
A spatial analysis of perception of satisfaction with present state of water supply revealed that, more than 60 percent respondents of division II of Hyderabad south are not satisfied with it. This area has a large chunk of low income localities. On the other hand less than 50 percent of the households of division VI are dissatisfied with present water supply which houses mostly upper middle and high income households. This observation leads to conclusion that there is no baring in the supply side.

Perception of Water Problem - General View

Table 6 Perception of Water Problem

Divisions / Response	1	2	3	4	5	6	7
Yes	61.23	65.45	56.67	54.00	55.00	49.00	62.00
No	38.77	35.55	43.33	46.00	45.00	51.00	38.00

Source: Fieldwork, Note: Figures belong to % respondents



The state of problem related to water supply is assessed through their perception on water problem. It is seen from table 6 that more than half the respondents have perceived that they are facing the water problem. It is rather interesting to note that both the division in Hyderabad south i.e. I and II, more than 60 percent of the sample respondents expressed their view that they are not satisfied with water supply status. As expected, the sample households in division VI are relatively satisfied with present water supply. This type of response invariably point towards inequitable supply of water.

Problems of Seasonal Water Supply

Another dimension to view the water problem is its seasonality. As seen from table 7 invariably the perception of water problem to be acute during summer season which can be gauged from the fact that nearly 60 percent of respondents felt that during summer season the water problem worsens when the reservoir water levels shown a sharp downward trend.

Table 7 Water Supply Problems- Seasonal Variations

Divisions /Seasons	1	2	3	4	5	6	7
Summer	58.67	68.33	64.00	66.67	63.33	58.50	63.00
Winter	2.67	1.61	2.67	3.33	4.67	5.00	3.50
Rainy	24.66	22.83	30.33	16.67	18.50	21.00	20.50
Always	14.00	7.23	3.00	3.33	13.50	15.50	13.00

Source: Fieldwork, Note: Figures belong to % respondents

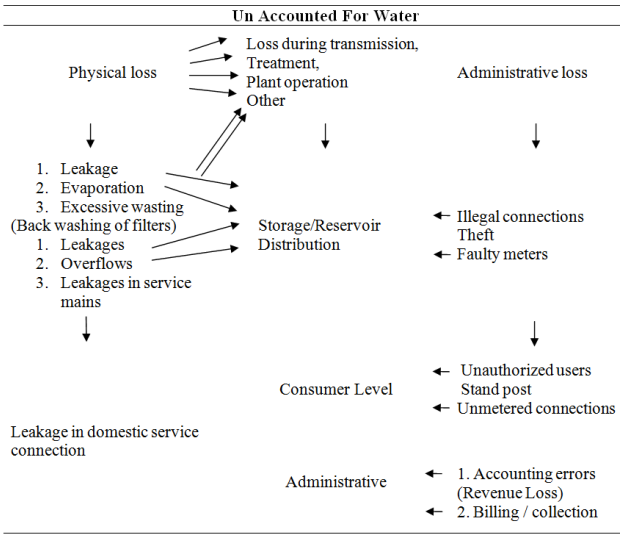
It is observed that during rainy season also the respondents expressed their views that they have faced the water problem. The reason could be inordinate delay in the onset of monsoon leading to low inflow of water in the reservoirs. The crux of water problem can be brought out from the figures in table 7 that a considerably large number of households expressed their view that they have faced the problem throughout the year.

Problems of Water Supply: Leakages - Unaccounted For Water (UFW)

There are number of factors which in isolation or collectively pose problem in water supply leading to decreasing availability of water in urban scenario. The traditional approach to increase water supply in India has been improving the augmenting capacity. It is seen that during treatment, pumping transmission and distribution, bulk of water is lost. This water could have meet the needs of more residents and earned more revenue for this utility. Moreover, water leakages are potential health hazard. As seen earlier, an outbreak of hepatitis in March/April 2005, was attributed to water contamination at a leaking point on the distribution pipeline. In India studies indicate that up to 50 to 60 percent of water treated and pumped is lost.

The other problem faced by the Metro Water Supply is related to loss of water or wastage of water during Distribution or Transmission. A detailed account is presented as here. UFW is defined as the difference between water produced and supplied to the distribution system. In other words, it means water loss. Improved management efficiency in the operation system can reduce water losses, increase financial viability of the utility and improve health of the residents. The reasons for Unaccounted for Water (UFW) or water loss are physical losses, leakages and non-physical or administrative losses are due to unrecorded supply.

A detailed analysis of physical and non-physical losses is presented in the diagram given below



Physical losses can be located at different phases right from treatment stage, storage stage to distribution stage and at individual consumer level. Physical losses are attributed to variety of factors which include

1. Old pipeline and corrosion
2. Leaking joints

3. Reservoir overflows
4. Leakages in service connections
5. Digging for various reasons
6. Vehicular pressure on network of pipeline

Administrative losses is an outcome of following factors

1. Theft of water
2. Illegal connections/Unregistered connections
3. Unrecorded supply
4. Billing/Accounting errors

Table 8 Un Accounted For Treated Water- Hyderabad **(In %)**

Cause	Water Loss
Physical loss	14
Administrative loss	12
Total	36

Compiled from Indo-US, FIRD (D), Project Notes, November 2002.

The percentage of UFW recorded based on some pilot surveys revealed that, it very high in Indian cities i.e. around 50 % .Based on study conducted by TATA consultancy Engineers for Hyderabad Metro Water Supply & Sewage Board related to "water conservation, leakage control and leakage management. The study brought out that 14 percent of water was lost due to physical leakages in transmission system at the rate of 140 liters per connection /hour at 10 mts pressure water.

Daily wastage of water by leakage is estimated as 22mgd. About hundred leakage points were identified. Nearly 11 mgd water is wasted during transmission and distribution and 2 mgd due to illegal connections. Irregular timing of water supply is also resulting in water wastage leakages[2].

According to Sri T.Hanumantharao, Chairman Technical Committee Water Conservation Mission, Andhra Pradesh there is about 35% loss of water in the water supply distribution system of the city. He is of the opinion that this aspect has to be studied in great detail and the zones having heavy losses will have to be identified. Usually the areas having pipelines laid more than 50 years back will have great losses. As per the estimate given by Ex. Managing Director HMWS&SB, 33 percent is lost during transmission due to leakages in the distribution losses. From his viewpoint ideally water loss should be reduced to 15 percent. To quote "We have set a target to reduce the distribution loss to 28 percent in the recent six years. This might be small but it is realistic target". He also gave on estimate that Hyderabad has large amount of illegal users. As many as 43,000 people have never paid the water bills. Two lakh consumers pay occasionally and only one lakh consumers pay regularly. The study revealed that nearly 70 percent of the estimated physical loss in the distribution system was from leakages at tapping points and in service connection points. Non-functional meters were the main administrative cause for Unaccounted for War.

Table 9 Water Auditing

Water Generated (mgd)	Water Allotted (mgd)	Water Accounted for (mgd)	UFW in transmission	Shortfall in generation
248	183.50	149.00	39.94%	-0.15%

Source: HMWS&SB

Based on the statistics provided by Hyderabad Metro Water Supply & Sewage Board it is seen that out of 248 mgd of water generated only 183.50 mgd water was allotted and out of this 183.50 mgd, 149 is accounted for, i.e. received against allocation there by showing the UFW as 39.94% in the Hyderabad Metro Water Works service area which includes surrounding municipalities. About 40 percent of loss of water specially during transmission is considerably high by any standards.

Table 10 Water Received Against Allocation

Division/ Component	I	II	III	IV	V	VI	VII
WRA Allocated	52.63	73.04	89.26	82.14	93.33	70.84	61.82
UFW	47.37	26.96	10.64	16.86	6.67	29.16	38.18

Source: HMWS&SB, WRA: Water Received Against Allocation, UFW: Un Accounted for Water 2004-05

It is seen from the table 10 that the spatial pattern of Un accounted for Water is very uneven. It ranges from as low as 6.67% in division V to a maximum of 47.37% in division I. It is seen that UFW is more for the divisions located in Hyderabad south or old city. Interestingly, it is at a higher side in Secunderabad division (division VII). In fact the UFW for division VI is also very high, which is one of the posh locale of the city with mostly households falling in high income brackets.

Unmetered tap connections

One of the cause for water wastage is unmetered tap connections. There are 4.75 lakh tap connections out of which 1.5 lakh connections are with out meeters amounting to 1/3rd connections. Nearly 50000 meters are not working. This put together 30% of water is unaccounted for. Water wastage is also attributed to blasting of pipeline due to high pressure water flow /pressure as witnessed Kanukunta (BHEL) in which nearly 2 lakh gallons of water is wasted. Similar is the Manjeera pipeline blast near Patancheru in which 100 gallons of water was wasted. Krishna water supply system recorded two pipeline blasts, one near Kondapur in which main pipeline was blasted due to cheaper quality of pipeline material. Nearly 90 mld of water was wasted. Another Krishna pipeline blast took place near Nasarlapally, where main pipeline was blasted in which 15 mgd of treated water was wasted due to high pressure pumping i.e. the pipeline capacity is 90 mgd and water pumped was 94 mgd. The main pipeline at lower tank bund was blasted in which 20-50 mld water was wasted. This pipeline was laid way back in 1920 and has no capacity to take up increased pressure. As per some report irregular timings of water supply lead to water leakage and wastage.

Measures to minimize Unaccounted for Water

The Hyderabad Metro Water Supply & Sewage Board can reduce the share of UFW by adapting following measures

1. Identification of causes for UFW
2. Use of GIS and network analysis by taking inventory of pipes, valves, material condition and age of pipeline
3. The physical losses can be minimized by increasing consumer awareness, detecting and rectifying leakages, proper maintenance of pipeline
4. Controlling water theft

5. Regularizing illegal connections
6. Installing new meters
7. Building consumer database
8. Commercial orientation in the supply of water
9. Private sector participation by which its greater financial and managerial autonomy and accountability will help to achieve greater efficiency. Private sector participation could be in the form of short term service contracts.
10. Achieving greater efficiency and effectiveness in transmission and distribution
11. Operation and Maintenance (O&M) contacts
12. Training staff on leak detecting equipment and surveys
13. Participatory role of consumers by way of awareness programs and educating them on water use and conservation
14. Replacement of all damaged old leaking pipeline and service connections
15. Meter fitting to every tap
16. Checking and monitoring at regular intervals
17. Water tankers supply through unfaulty tankers.
18. Round the clock water supply
19. Use of electronic device to pin point the location of leakages
20. Rectification of leakages on priority basis.

Unaccounted amount of water loss is due to people's ignorance or attitude also consumers collected water in cans at the time of distribution. The water collected is generally more than the required amount. During next distribution, the water unused "thrown and is wasted to fill the can with fresh water" says V.V.Rao. This happen due to mistaken assumption about purity of water. Illegal consumer and unpaid consumers also contribute to this problem. Improper utilization of the existing water pressure has added to water woes. There is a water loss even before its use. Reduction in wastage of water is like generation of water i.e. water supply of a large quantum can be created through saving of water from wastage.

Water Wastage during Tanker Water Supply

Another reason for wastage of water is from tankers. Nearly 500-1000 liters of water is wasted daily by each tanker. Nearly 1000 tankers will make about 1600 trips to supply water. With this rate the wastage of water is alarming. The reasons given are faulty fitting of valves, old tankers in bad condition, lack of lid/cover, negligence on part of tanker operators negligence on the part of water board employees etc.

Since tanker water supply has emerged as a major source of bulk water supply, the wastage of water due to ill maintained tankers is colossal. The problem of wastage of tanker water can be minimized by

1. Replacing the old tankers
2. Proper maintenance of tankers
3. Public-private participation to achieve greater efficiency

Quality of Under Ground Water

Underground water is one of the major source of drinking water supply. Assessment of water quality is essential to the potability of water. A study was conducted by the Ground Water Department based on certain physio-chemical parameters which is presented in table 12. The underground water quality analysis is based on certain chemical constituents of the water samples.

Understanding of water quality is essential to assess its utilization for either domestic or non-domestic uses. The underground water quality analysis is based on the certain chemical constituents of the water samples. The table 11 shows the concentration of various chemical parameters and their standards of drinking water along with minimum and maximum values. Most of the chemical parameters maximum values are well above the acceptable values and limits for rejection, but such cases are very few.

Table 11 Range of Nitrate concentration in ground water samples

S.NO.	Range mg/liters	Percentage of total samples
1	5-45	19.30
2	45-100	49.60
3	100-200	23.20
4	200-400	6.40
5	400-600	1.20
	Total	**100.00**

Source: Ground water department

It is seen from the table.11 that the problem of nitrate concentration is very glaring i.e. about 80 percent of the samples have registered nitrate concentration above tolerance level, (45 mg/liters).

The pollution of underground water is not in all the cases. It is mostly the few sample wells surrounded by industrial areas that show high level of pollution. It is seen from the above table that the problem of nitrate concentration is very glaring i.e. about 80% of the samples have registered nitrate concentration above the tolerance level.

Table 12 Phisio-Chemical Analysis-Under Ground Water

Sl.No.	Constituents	Range		General Range	ISI standards	
		Min.	Max.		Desirable limits	Permissible limit
1	PH	6.5	8.57	6.9-7.7	6.5-8.5	No relaxation
2	EC	200	7500	700-3000	750	3000
3	TH	70	2780	150-1000	300	600
4	Ca	14	720	50-300	75	200
5	Mg	3.6	272	10-120	30	100
6	Cl	3.5	1766	50-600	250	1000
7	SO4	4.8	1392	25-450	200	400
8	NO3	1.2	760	10-300	45	100
9	F	0.17	3.3	0.5-1.7	1.0	1.5

Another study based on shallow bore wells is presented in the following results (Veerana, etal). As per this study the underground water the quality varied widely from place to place. The EC values ranged from 206-7500 limbos/cm while the general range is 750-3000. The areas with EC values beyond permissible limit (>3000) are located around industrial location like Bolarum, Jeedimetla, Sanatnagar, Kukatpally etc. in the periphery of Hyderabad. The nitrate content also is very high.

Table 13 Underground Water Quality Analysis

Water quality	No. of samples	Percentage
Unfit for drinking	9	34.7
Very poor	3	11.5
Poor	5	19.3
Good	6	23.0
Excellent	3	11.5
Total	26	100.00

The study revealed that ground water contamination in the study area was mainly due to the domestic and industrial waste seepage from the drains and open sewage.

The pH values of the groundwater samples collected range between 6.5 and 8.13, i.e. within the desirable limits (6.5-8.5). A maximum alkalinity of 365 mg/l was found in the sample collected near STP plant (Khairatabad). In other places, the Alkalinity was more than the permissible limit imparting a bitter taste to water and making it unpalatable. Fluoride content was more than the agreeable limit in Ameerpet, Punjagutta, S.R.Nagar, Erragadda and Balkampet areas. The high content of fluoride in these areas is mainly due to the seepage of surface water from Kukatpally open drain, which carries industrial effluents domestic sewage. High concentration of fluorides can also be due to the leakage of septic tanks. Increase in chloride content in groundwater in this area is due to the seepage of surface water from the open drains.

TDS was maximum in the sample collected from Khairatabad (1028 mg/l). Samples collected from Chintalbasthi, Ameerpet, Punjagutta, Sanathnagar, Jimkalwada, Balkampet have a TDS of 500 mg/l and above, mainly due to the seepage of surface water from the open drains. TDS in ground water can also be due to natural sources, sewage, urban runoff and industrial wastes (Kurian Joseph, 2001). Groundwater can be contaminated with nitrates by sewage, septic tank effluents and other nitrate-rich wastes. It can also occur naturally through rocks, as nitrate is a major constituent of rocks. Nitrates contamination was mainly due to seepage, septic tank effluents in Jinkalawada and Khairatabad areas. The other water quality parameters, sodium, potassium and sulphates were well with in the permissible limits in the entire study area. The other constituents like sulphate total hardness are also in excess of desirable concentration. In industrial areas trace metals and organic contaminates are reported.

Out of 26 samples of underground water collected in the central part of the city 9 samples revealed that they are not fit for drinking (UFD), 5 samples were of poor quality and 3 of very poor quality. Only 3 were found to be excellent and remaining 6 are classified as good (Asadi, etal 2005).

Problems of water bodies

Insight into the changing status of existing water bodies is very important from environmental perspective and from surface and underground water. The National Remote Sensing Agency has prepared an inventory of water bodies for Hyderabad Urban Development Authority based on satellite data About 222 lakes/tanks were identified.

The consequences of urban spatial growth and urbanization can be witnessed in the encroachment of water bodies. Nearly one fourth of the tanks where partly or completely consumed by the process of urban expansion or settlement activity land filling garbage dumping etc., where as one third of the tank beds remained dry. Dry tank bed is due to the construction activity in the catchment areas of the tanks. There is only an isolated example of a tank whose water spread area has shown an increase.

Some lakes have totally vanished and many others have shrunk in size. The overall impact of such situation is decrease in water-spread area. Nearly 55 Sq.m. area is lost due to encroachment and about 21.7 Sq.km. of tank area remained dry. Decrease in water-spread area has resulted in the reduction of water holding capacity, depletion of ground water table and ultimately the surface and underground water potential of the study area.

Conservation of water bodies

The most important step in the conservation of the lake is to restore the water quality by controlling the pollution. A water body bestows incalculable benefits on its immediate environment in terms of charging the groundwater table, conditioning the climate, providing water for washing, bathing aquaculture, and recreation.

One of the Non-Governmental Organizations active in Hyderabad is Society for Preservation of Environment and Quality of Life (SPEQL). It has taken up the issue of water bodies protection through its 'save the lake campaign'. The role of NGOs assumes further significance as a pressure lobby which would work on two fronts simultaneously i.e., creation of awareness about the issue on the one hand and fighting for implementation of policy by the authority on the other.

Solution for the Lake-conservation

1. Enforcement of suitable legislation for the protection of water bodies.
2. Declaration of water body reserve on the line of forest reserve.
3. Creation of water body cell at administrative level for effective coordination of different government agencies for successful implementation of policy decisions.
4. A clear demarcation of water body boundaries after taking into consideration high and low water.
5. Foreshore Plantations to prevent reclamation and encroachments.
6. Regulation of developmental activities in the catchments.
7. New colonies should be connected to municipal sewer system.
8. Any industrial activity should precede establishment of effluent treatment plant.
9. Regulation of washing, bathing and other detrimental activities associated with water body.
10. Introduction of recreational activities like boating, rowing etc.
11. Regular monitoring of water body ecology.

This program is being implemented by rain water harvesting cell of Hyderabad Metro Water Supply & Sewage Board in association with State Ground Water Department, National Remote Sensing Agency, A.P.State Remote Sensing Application centre, National Geophysical Research Institute, Builders forum and Central Ground Water Board (Southern Region).

Gap in Demand and Supply of Water

Urban water sector is considered as a social good and not as an economically viable endeavor. In the recent times, despite the best effort by the Government, the Metro Water Works is not in a position to provide adequate water supply. Anything which is not freely available commands price and demand. Water being not available in required quantity is slowly getting a status of

economic good. Any economic good can be viewed from supply, demand, consumption, deficit and surplus perspectives. An analysis of supply side from spatial perspective provides an insight into the inequalities of supply. Geographical distribution of water supply to various parts of the city shows a variation in spatial pattern which in turn helps to understand the inherent factors that brings out these variations. There is a wide disparity in terms of water supplied in absolute quantity (MGD). From the study analysis report of water supply to the city division wise, it can be concluded that the water supply is highly variable. It is also seen that there no set standard followed by the water board in the supply of water. Inequitable water supply is one of the lacunae in the distribution of water supply which calls immediate rectification. Equitable supply of drinking water in adequate quantity at required pressure is the major challenge to water works department.

Water conservation

The galloping increase in demand for water on one hand and declining availability and supply on another hand have made it imperative to adopt practical measures for the conservation of water. Water being a scarce commodity particularly in Metros, there is need to conserve water. Conservation, which is less expensive, and more environmentally sound than new investment. Conservation means, higher availability of water. Water is a community resource and conservation involves various stakeholders i.e. Metro Water Works, Pollution Control Board, Hyderabad Urban Development Authority, community and individuals etc. It can be achieved optimally by community participation at large. Some of the water conservation measures that can be adopted are as follows:

***Leakage detection and preventive maintenance*:** It is seen that water losses (UFW) in the water distribution system is to the tune of 24%. The maximum leakage occurs in the house service connections. In addition, losses also occur at the source, in transmission mains, treatment plants.

Metering of Water supply: The metering of water supply is desirable to minimize wastage and to maintain economic pricing of water.

Volumetric Charging: Conservation of water can be achieved by dispensing away with the flat rate of tariff instead, levying water charges on volumetric basis

Enhanced co-operation among agencies: The last, but not least, of the strategies is the enhanced co-operation among various agencies such as SPCB, Industrial Development Corporation, State Financial Corporation, Irrigation Department, Panchayatraj Department, Ground water Department, and some other non Governmental Agencies etc to name a few. In fact, this is also one of the major aspects pointed out by the UNICEF-WWF study.

Reuse and recycling of water: Wastewater reuse implies utilization of water that has been previously used for other purpose. Recycle imply reuse of water more than once for the same purpose.

Rationing: It has relevance specifically during drought years when water demand exceeds water availability. Rationing of water involves limiting the timeing of use and quantity of water use, banning of waste use to gardening etc.

Some of the other water conservation options include the following

1. Education and awareness
2. Charges for excessive use
3. Removal of illegal connections
4. Encouragement and training, recycling
5. Water auditing / effective water governance that is establish a multi shock holder process
6. Metering
7. Multi tapping frame
8. Quality pipeline
9. Replacement of faulty water tankers
10. Fitting valve to public taps
11. Checking and maintenance of pipeline regularly

Role of community in the conservation of water

The community participation in the conservation of water is very vital. Participatory approach in the conservation of precious water can be achieved certain do's and don't's which are as follows:

Do's

1. Reporting leaks in pipelines to HMWSSB
2. Keeping vigilance on water bodies so that they are not encroached and polluted
3. Use of drip irrigation for watering garden
4. Use of washing machine water for flushing toilets and Kitchen garden use
5. Use of mug for brushing and shaving
6. Harvesting rain water

Don'ts

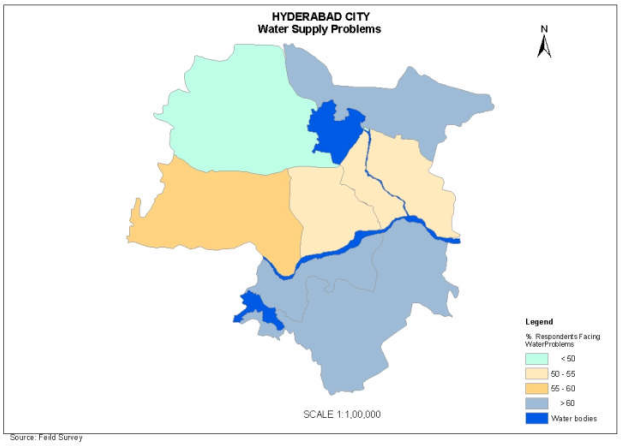
1. Use of hose pipe for washing car etc.
2. Allow the overhead tank / sump to overflow
3. Protest when there is marginal increase in tariff due to inflation.

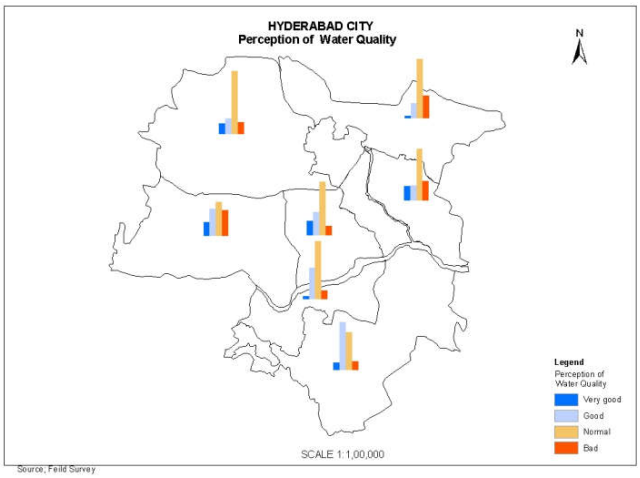
Water is a community resource and needs community participation Right to Water is Right to life

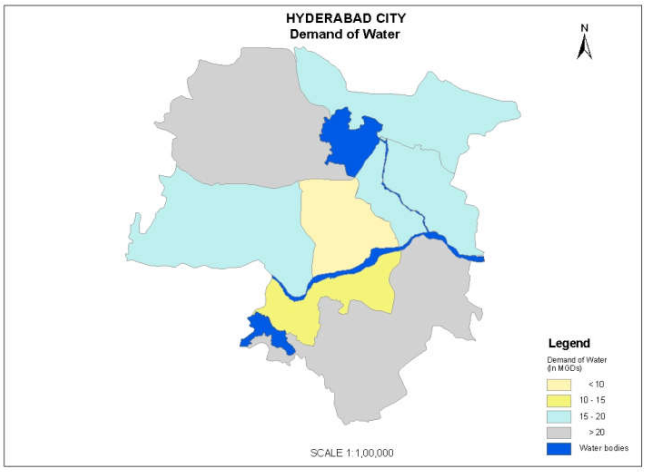
CONCLUSION

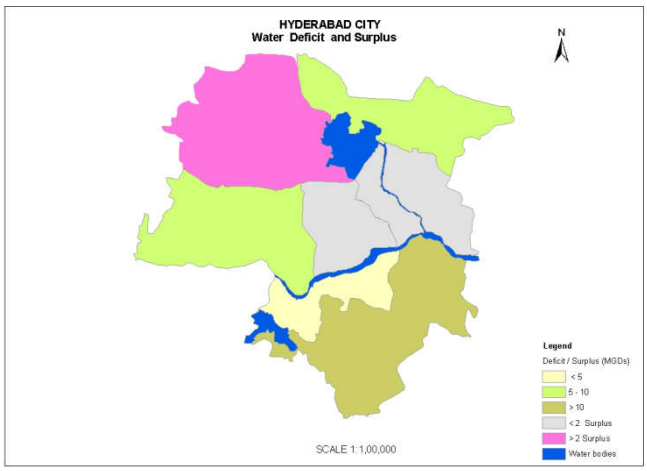
The first and the foremost aspect of drinking water is its quality or potability. This aspect is brought by the physio-chemical analysis of water supplied by various sources to Hyderabad city. The study revealed that a turbidity condition of untreated water is very much higher than the permissible limits in all reservoirs, but it is brought to permissible limits. Even though the water supplied by Metro Water Works is declared as fit for consumption but its potability is doubtful. In certain localities due to a set of factors such as broken pipeline and seepage of polluted water, corrosion of pipeline, worn out domestic pipe connections. Based on the perception of sample households, it is brought out that they did perceive the changes in water quality supplied by the Metro Water Works. The perception of water quality varies. The majority of respondents felt that consequence of unsafe drinking water is use of packaged water. Inadequate water supply is also leading to bottled water supply. The reasons for Unaccounted for Water (UFW) are both physical and administrative. One of the major problems associated with quality of underground water is presence of Nitrates, whose presence is much above the tolerance level. In

certain locations, the water considered as unfit for drinking. Bottled water supply safest of all for the purpose of drinking is also associated with problems like pesticide residues, microbial contamination etc. Rainwater harvesting helped in rising underground water levels, rejuvenation of dry bore wells improvement in bore well yields etc. It can be concluded based on the appraisal of urban water supply that the sources of water supply are varied such as Metro Water Works, Tankers, Underground water, Packaged water etc. The changing paradigm of urban water supply is that its transformation from social good towards economic good.









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