WASTEWATER TREATMENT AND REUSE: AN INSTITUTIONAL ANALYSIS FOR HYDERABAD, INDIA

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Abstract

The current paper presents an institutional analysis of wastewater (non) treatment and reuse scenario using the case study of Hyderabad, India. The objective of the institutional analysis in the current study is to determine the extent and the character of an observed gap between declared rules (formal) and rules-in-use (informal practices) in the context of wastewater disposal, use and its adverse impact on environment and people of Hyderabad. The analysis shows that there is a wide gap between the declared rules and rules-in-use due to: insufficient organizational capacity to implement and monitor the rules, lack of awareness among people, poor water and sewerage pricing system, insufficient attention and budget towards environmental issues of water pollution and the fact that the rules have not kept pace with the changing socio-economic realities of the society. This gap has been used as an indicator to suggest that a change in the existing institutional framework of wastewater treatment and reuse scenario is essential. The suggested changes include: increase awareness among people on the need to protect our rivers and other fresh water sources; need to increase the general efficiency of the water boards; increased allocations of budgets for wastewater treatment and to improve the quality of our rivers; need to change the pricing strategy for the water supply and increase the sewerage cess; make efforts to increase the trust of people on the water boards; ensure solid waste management of the city; ensure treatment of industrial wastes before they are released into the river.

1. INTRODUCTION

"Institutions are the humanly devised constraints that shape human action (North. 1990)". They set the ground rules for resource use and establish the incentives, information, and compulsions that guide economic outcomes. Institutions evolve with changes in the society and its priorities. From an economist's viewpoint, institutions affect the performance of an individual, group, organization, a country or its economy, through the effect they have on the costs of exchange and production. Together with technology, the institutions determine the transaction and transformation (production) costs (North, 1990). The current paper presents an institutional analysis of wastewater treatment and reuse scenario.

For more than 30 years now, wastewater from the Hyderabad city has been flowing into Musi river untreated. A couple of decades ago, when the population of Hyderabad was quite small, it was not considered an issue of river pollution. However in the last ten years (1991-2001), the population of Hyderabad has increased by 19.3% (JNNURM, 2005) resulting in increased wastewater flows into the Musi river leading to further deterioration. The Musi river receives fresh water from rains during June, July and August and would have remained dry, but for the 700 million liters of untreated wastewater released into it every day from the city drains. This water is extensively used for irrigation of leafy vegetables on a small scale, para grass and paady. About 2100 ha of para grass and 10,000 ha of paddy is cultivated with un-treated wastewater (Mekala, 2006).

Initial estimates show that more than 7000 households depend directly or indirectly on para grass grown in urban and peri-urban areas for income generation and food security and about 58000 households in 16 villages further downstream of Musi river depend on wastewater irrigation for paddy cultivation for their food security (Mekala. 2006). However, since the wastewater is untreated, its use in agriculture is associated with certain

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The analysis presented in this paper forms a part of the research, which is being carried out for the PhD thesis by the first author.

health and environmental risks. Untreated wastewater caries helminthes, protozoa, bacteria and viruses (arranged in order of highest risk to lowest risk), which can cause number of health problems among farmers and consumers, if no proper precautions are taken. One study by Jeroen Ensink of IWMI on helminth infections among wastewater farmers shows that a number of other factors like sanitation facilities and defecation practices influence the health of people more than wastewater irrigation. Diarrhea and retarded growth among young children is also very common in wastewater irrigated areas. Soil contamination and groundwater pollution are the major environmental problems of wastewater. It was found that, in all wastewater irrigated areas, the groundwater is so saline that it cannot be used for potable purposes (Buechler and Mekala, 2003). Also, paddy yields have decreased by 40-50% over the years due to soil contamination by continuous wastewater irrigation (Buechler and Mekala, 2005). The socio-economic impacts include – loss of work days due to bad health, expenses incurred on medication and reduction in yields.

The challenge is to improve the river health and minimize the negative effects of wastewater irrigation without compromising on the livelihoods of the people dependent on it. International Water Management Institute (IWMI) has identified certain options to minimize these ill effects which include - community based decentralized treatment systems; regular monitoring of irrigation water quality; prevent mixing of household wastewater with industrial wastewater; change in cultivation and cropping practices; awareness and education to farmers, vendors and consumers of wastewater products on health, hygiene and sanitation and regular anti-helminthic medication programs. However, very little understanding is gained on the overall institutional framework of wastewater markets.

The objective of institutional analysis in the current study in the Hyderabad context is to determine the extent and the character of the observed gap between declared rules (formal) and rules-in-use (informal practices) in the context of wastewater disposal, use and its adverse impact on environment and people. This gap has been used as an indicator to suggest that a change in the existing institutional framework of wastewater treatment and reuse scenario is essential. The results of this analysis are used to formulate recommendations for possible change such that performance can be better and transaction costs are less in the new institutional framework. The current paper presents part of this analysis and recommendations for change using Hyderabad as a case study.

The data and information for the institutional analysis is collected from primary survey (100 respondents), personal interviews and secondary sources from different documents, institutions and government organizations concerned with and related to wastewater law, policy and administration in Hyderabad. The scope of this paper is restricted to the analysis of the gaps between the declared rules of the Hyderabad Metro Water Supply and Sewerage Board and the current rules-in-use.

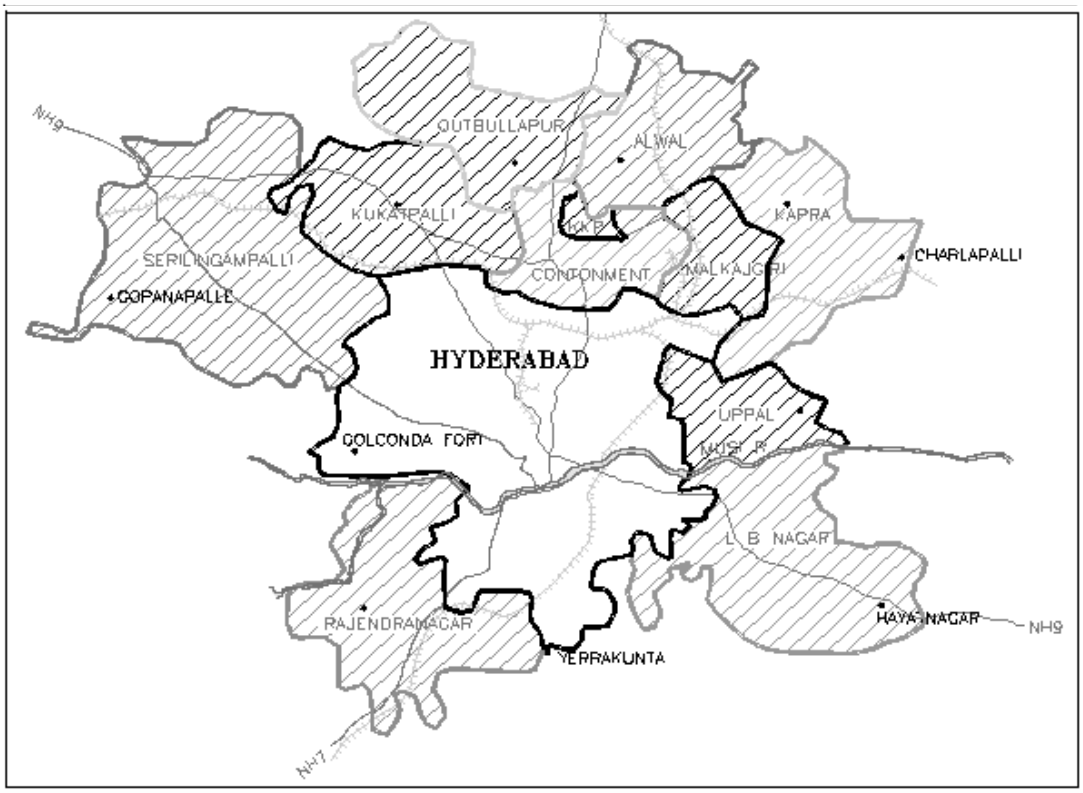
2. PHYSICAL SETTING

Hyderabad is the fifth largest city in India and has lately become an information technology hub creating thousands of new jobs. The 625 sq km area under the Greater Hyderabad Municipal Corporation (GHMC), which has a population of 67 lakhs (The Hindu newspaper. April 16, 2007). The population projections for 2011 for the twin cities (Hyderabad and Secunderabad) range from 9.5 to 11.3 million people (HUDA, draft master plan for 2011). The Musi river, which is a tributary of Krishna river flows from west to east right through the heart of Hyderabad and all the wastewater from the main city area flows into Musi river and more than 90% of it is untreated. The natural drainage area (see figure 1) of river Musi within the limits of twin cities covers Municipal Corporation of Hyderabad, Osmania university, Secunderabad cantonment area and three surrounding municipalities viz., Uppal, Malkajigiri and Gaddiannaram and partially covers five surrounding municipalities viz., L.B.Nagar, Rajendranagar, Kukatpally, Quthbullapur and Kapra. All the domestic and industrial sewage currently flows into Musi river polluting it completely.

The inflow of domestic and industrial wastewater into the Musi river is currently more than 700 million litres per day of which more than 90% is untreated and used for irrigation in the downstream areas (see figure 2). With no/decreasing fresh water inflows from the upstream areas, Musi river has mainly become a natural

sewage drain for Hyderabad with detrimental effects on the environment and people downstream of the city. Table 1 indicates the quality of Musi river water at various locations [A is in the city, B is on the fringe of the city, C is peri-urban and D & E are in the rural areas along the river downstream of Hyderabad].

Figure 1: Hyderabad City with Surrounding Municipalities



Source: HMWSSB, 2006

Table 1: Results of Monthly Water Samples Collected from November 2005 to July 2006

Sample locations	Mean Total nitrogen mg/L	Mean BOD mg/L	Mean EC µs/Cm	Mean DO mg/L
A [Amberpet)	35.78	151.55	1367	0.122
B (Peerzadiguda)	32.9	98.22	1636	0.162
BC (between B & Gowrelli)	34.35	62.55	1636	0.318
D (Pillaipally)	30.97	40.55	1705	2.9
E (Battugudam)	18.325	27	1753	3.722

Source: Dr. Robert Simmons & team [IWMI] as part of a BMZ project & reproduced here with permission.

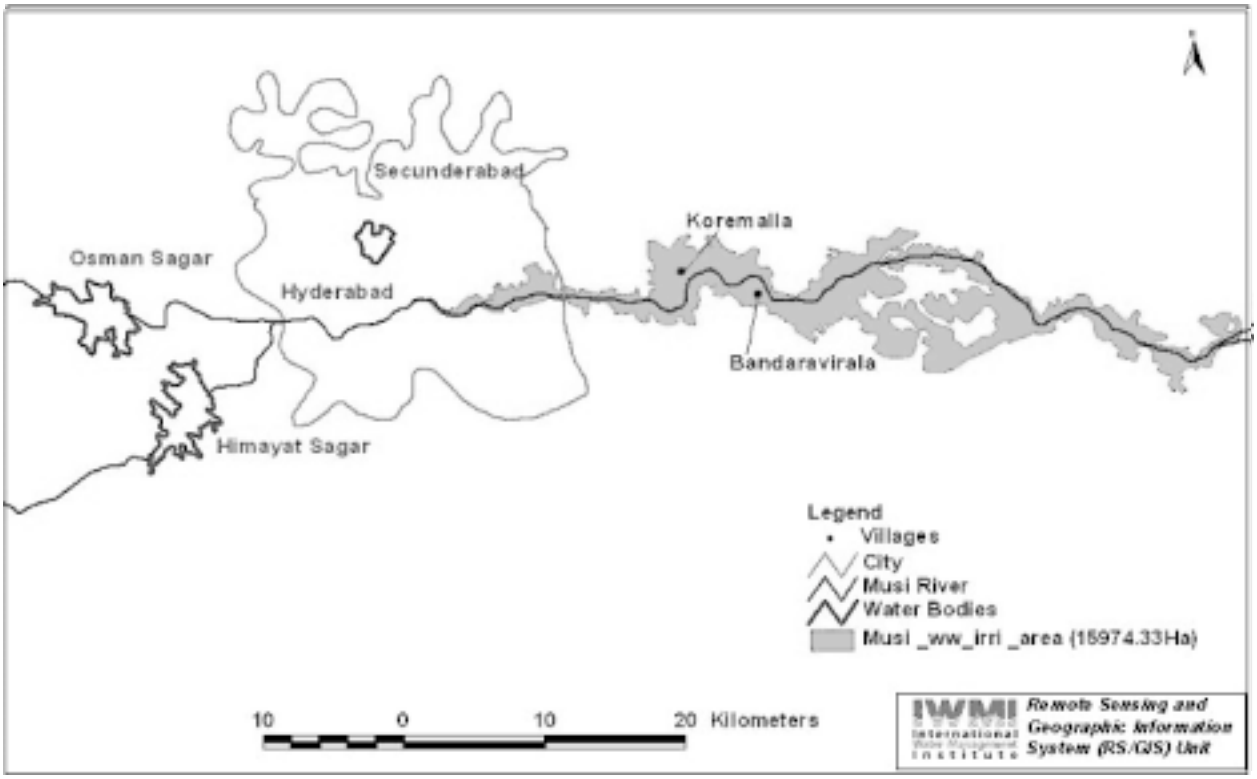
3. RESULTS AND DISCUSSIONS OF THE INSTITUTIONAL ANALYSIS

Institutions can be both formal and informal. In addition to written laws, rules and protocols, informal procedures, norms and practices accepted by society and followed over several years become part of the institutional framework. According to Merrey (1993), certain patterns of norms and behaviors persist because

they are valued by people for practical and other reasons. In such cases, informal rules have a tendency to override formal rules. This is common in many developing societies, making the enforcement of formal rules very difficult and thereby affecting performance (Bandaragoda and Firdousi, 1992). Formal and informal institutions coexist in many societies. Informal rules and practices, which replace declared laws, rules and regulations, are referred to as "rules-in-use" by Bandaragoda (2000). A number of such rules-in-use exist in the current wastewater disposal and reuse situation in this case study which are discussed in this section.

This section presents the gaps between the declared rules and rules-in-use, reasons for these gaps and consequences of non-compliance.

Figure 2: Wastewater Irrigated Agriculture Along Musi River



Source: Landsat Image. 2005. IWMI Hyderabad, India Office.

3.1 Gaps between Declared Rules and Rules-in-Use

The Hyderabad Metropolitan Water Supply and Sewerage Act No 15 of 1989 make provision for water supply, sewage and sewage treatment in the Hyderabad Metropolitan Area and for matters connected therewith. The current section presents the declared rules and the actual rules-in-use, the magnitude of the gap between the two and the reasons for such a gap. As mentioned earlier, this gap is used as an indicator to analyse the current institutional set up and the requisite change required to make the system of wastewater disposal, treatment and use more efficient and less harmful to the environment and humans.

3.1.1 Declared Rule - Chapter V: Sewerage and sewage treatment works

Section 54: Certain matters not to be passed into the Board sewers and sewage treatment works: Save as otherwise provided in the Water (Prevention and Control of Pollution) Act, 1974, relating to discharge and disposal of industrial effluents and other objectionable effluents, no person shall throw empty, or turn into any board sewers,

a) any matter likely to damage or interfere with the free maintenance or execution or otherwise to effect prejudicially the progress of work; or
b) any roof water; or
c) any chemical, refuse or wastewater or stream or any other industrial effluent from any type of industry, trade and business which may cause danger or nuisance or may be prejudicial to the health or;
d) any dangerous petroleum or petroleum products.

3.1.1.1 Rule-In-Use

a) In Hyderabad, disposing of solid waste in the public open drains is a common practice and no penalties are imposed on people who commit such an offence. Many times, sewage drains have been seen to overflow due to blockages causing public nuisance and creating an environment congenial for germs to thrive. The main reason for this is that there is no provision for proper solid waste disposal in the city. Only in some areas, the municipality is active in collection and disposal of waste and in most parts of the city, people have to make their own provisions for solid waste disposal. Households who cannot or do not want to pay for their solid waste disposal, blindly dump their waste into sewerage drains or river (people living close to the river).
b) Most houses and apartment buildings in Hyderabad do not have rain water harvesting systems and hence most roof water ends up in drains mixing with the sewage water and finally enters the Musi river. Old buildings were not mandated by law to have rain water harvesting structures and do not intend to invest in them now. New builders have got away with this rule for various reasons (see section 64 below in point 3.1.3).
c) A number of small and large industries have been known to illegally dump their effluents either directly into the sewage drains or into the river resulting in severe pollution and adverse impact on the fish and crops in the areas down stream of Hyderabad. There are a number of probable reasons for this kind of behavior (greed, lack of treatment facilities, expensive treatment facilities, lack of concern for nature, lack of monitoring and strict enforcement of rules), but no detailed studies are available to pin-point the reasons.
d) In a number of personal interviews with farmers in the peri-urban areas of Hyderabad, farmers have complained about the dumping of various kinds of unknown chemicals and petroleum products in the river causing severe crop losses to farmers.

3.1.2 Declared Rule - Section 60. New premises not to be erected without drains or sewers:

(1) In area in which board sewers are provided, it shall not be lawful to erect or to re-erect any premises or to occupy any such premises unless,
    (a) a sewer be constructed of such size, materials and descriptions at such level and with such fall as shall appear to the board to be necessary for the effectual sewerage of such premises;
    (b) there have been provided and set upon such premises such appliances and fittings as may appear to the board to be necessary for the purpose of gathering or receiving the filth and any other polluted and obnoxious matter from and conveying the same off, the said premises and of effectually flushing the drain of the said premises and every fixture connected therewith.
(2) The sewer so constructed shall empty into a board sewer.
(3) The provisions of this section shall be applicable to premises any part of which is situated within a distance of thirty-five meters from a board sewer.

3.1.2.1 Rules-In-Use

Builders and people in general have violated this rule time and again. New houses and buildings are erected with no sewerage in place often emptying their sewage into the next/nearest vacant plot or fresh water

lake polluting the groundwater or lake. The reason for this is that it takes initial investment on the part of the builders to layout a sewerage network and they save money and effort by not laying out the network and in turn sell the plots for a little less price to people who are more than willing to buy it even without a sewer network in place because of the high demand for space. Often people construct their own sewer drains during the construction of their house, but if there is no house constructed in the neighboring plot, and if the owner of the neighboring plot does not intend to construct a house for a long time, then, the continuity of the sewer line is broken and often the empty plots are filled with sewage water creating mosquito problems and bad odour and an unsightly view to all those around. Community sense is often lacking in urban areas and collective action is often not possible due to varying interests of the people.

3.1.3 Declared Rule - Section 64. Sewage and rainwater for drains to be distinct

Whenever it is provided in this chapter that steps shall or may be taken for the effectual drainage of any premises, it shall be competent to the board to require that there shall be one drain for filth and polluted water and an entirely distinct drain for rain water and unpolluted sub-soil water or both rain water unpolluted sub-soil water each emptying into separate Board sewer or Corporation drain or other suitable places.

3.1.3.1 Rules-In-Use

With a sudden increase in the population, the existing sewerage network of Hyderabad became inadequate to carry all the sewage of the city, hence emptying sewage into the storm water drains and finally releasing the untreated sewage water into the Musi River. Also, most households do not have rainwater harvesting structures in place and hence all the rainwater from rooftops ultimately ends in the sewage channels and finally drains into the river. Many of the new houses now install rainwater-harvesting structures to comply with the rules but often these rainwater structures go into dis-use after sometime because of lack of maintenance of the structures and lack of interest and awareness of the people. There are a number of reasons why people do not have rainwater harvesting structure viz., lack of interest, lack of technical know-how, lack of space and lack of awareness of the value of rainwater among the people.

3.1.4 Declared Rule - Section 65. Appointment of places for the emptying of sewers and disposal of sewage

The board may cause any or all the board sewers to empty into, and all the sewage to be disposed of at such places either within or outside Hyderabad metropolitan area or in any places in the state, as it considers suitable:

a. Provided that no place which has not been before the commencement of this chapter used for any of the purposes specified in this section shall, after such commencement, be used therefore without the approval of the Board;
b. Provided further that on and after such date as may be appointed by the Board in this behalf, no sewage shall be discharged into any water-course until it has been treated in such manner as may be prescribed in the by-laws made in this behalf.

3.1.4.1 Rule- In-Use

Currently there are only two sewage treatment plants in Hyderabad. One at Necklace road with a treatment capacity (upto secondary level) of 20 mld and another at Amberpet with a treatment capacity (upto primary level only) of 113 mld. More than 90% of wastewater undergoes no treatment and is directly discharged into the Musi river. The main reason for this is that wastewater treatment is an expensive process and most municipalities and water boards could not afford to set up new treatment plants with increase in wastewater supply without outside help. As per the rule, water boards can charge only 35% of the water supply charges as a sewerage cess and often this money is not enough to actually treat the wastewater.

However, a new project called "Abatement of Pollution of River Musi" has been launched in a drive to clean the river. Government of India and Government of Andhra Pradesh will share the capital cost of the project. It is proposed that the National Rivers Conservation Directorate (NRCD) under the 10th Plan will provide funds to the state government to the tune of 70% of the total capital cost and remaining 30% of the capital costs will be paid by the state government itself. In addition to their share in the capital cost, NRCD will also share operation and maintenance costs of the plant for first six months. The assets created under the project will be property of the state government and the state government will be responsible for its proper operation and maintenance then after.

Table 2: Location and Capacities of Proposed Sewage Treatment Plants

Plant	2007 (mld)	2021 (mld)
Amberpet	339	815
Nagole	172	366
Nalla-cheruvu	30	134
Attapur	51	121
Total	592	1436

Source: HMWSSB Master Plan, January 2008

The current status of the completion of different STPs under the Abatement of Pollution of River Musi project [under the NRAP assistance] is shown in Table 3.

Table 3: Status of the STP Under the Abatement of Pollution of River Musi Project

STP location	Capacity	% completed	Date of completion
Amberpet	339 mld	85% completed	31-12-2007
Nagole	172 mld	77% completed	31-03-2008
Nalla-cheruvu	30 mld	55% completed	31-03-2008
Attapur	51 mld	Tender stage	31-12-2008

Source: HMWSSB. January 2008

3.1.5 Declared Rule - Section 75: Regulations regarding sewage:

The board may with the previous approval of the government, make regulations to carry out the purposes of this chapter. In making any regulation under this section, the board may provide that a breach thereof shall be punishable with fine, which may extend to one thousand rupees and in case of continuing breach with an additional fine which may extend to hundred rupees per day during which the breach continues after receipt of a notice from the Board to discontinue such breach.

3.1.5.1 Rules-In-Use

From personal interviews with people, it is seen that often people do not pay fines even after repeated warnings from the water board officials. At the same time, a field study conducted in Hyderabad, India by Raghavendra (2006) suggests that households were actually unhappy with the poor performance (poor measurement of domestic water consumption and institutional indifference towards improving the quality of service) of the HMWSSB. Some households in Hyderabad receive municipal water supply once every other day and some others once in a week even though both pay the same monthly flat rate (depending upon the diameter of the

supply pipes. This difference in quantities of water supplied also de-motivates people and reduces trust on authorities. Hence, the problem lies both with people's attitude and the water board's performance.

3.1.6 Declared Water Quality Guidelines

Table 4 presents the water quality guidelines for different uses as per the Central Pollution Control Board.

Table 4: Water Quality Criterion for Designated Use as Per CPCB

Designated-Best-Use	Criteria
Drinking water source without conventional treatment but after disinfection [Drinkable quality]	1. Total coliforms organism MPN/100ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6 mg/l or more 4. Biochemical Oxygen Demand 5 days 20°C 2 mg/l or less
Outdoor bathing (Organized) [Swimmable quality]	1. Total coliforms organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5, Dissolved Oxygen 5 mg/l or more 2. Biochemical Oxygen Demand 5 days 20°C 3 mg/l or less
Drinking water source after conventional treatment and disinfection [Drinkable quality after treatment]	1. Total coliforms organism MPN/100ml shall be 5000 or less pH between 6 to 9, Dissolved Oxygen 4 mg/l or more 2. Biochemical Oxygen Demand 5 days 20°C 3 mg/l or less
Propagation of wild life and fisheries [Fishable quality]	1. pH between 6.5 to 8.5, Dissolved Oxygen 4mg/l or more 2. Free Ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal [Boatable quality]	1. pH betwwn 6.0 to 8.5 2. Electrical Conductivity at 25°C max., 2250 micro mhos/cm 3. Sodium absorption ratio max., 26 4. Boron max., 2 mg/l

Source:http://www.cpcb.nic.in/Water/waterqualitycriteria.html

3.1.7 Current Practice

Table 1 and Table 5 clearly indicate that Musi river water downstream of Hyderabad is not fit for any uses as mentioned by the Central Pollution Control Board (CPCB) (see Table 5) and yet, Musi river water has been extensively used for irrigation of more than 10,000 ha of para grass and paddy in peri-urban Hyderabad. In many countries of the developing world, farmers use wastewater out of necessity and it is a reality that cannot be denied or effectively banned (Buechler *et al*. 2002). The main reason for the non-compliance of farmers with the prescribed guidelines for water quality is lack of alternate sources of irrigation and benefits derived from the crop production. In the rural areas downstream of Hyderabad which use Musi wastewater, it was found that wastewater irrigated paddy contributes almost 43% of household food consumption and that households with more than one acre of land and more than five household members grow vegetables like tomatoes, chillies, eggplant and corn for household use on part of their land (Buechler and Mekala. 2003).

Table 5: Quality of Water in River Musi at Various Points as it Passes through Hyderabad.

S.No	Composite Samples at	pH	DO (mg/l)	TDS (mg/l)	BOD (mg/l)	COD (mg/l)	TKN (mg/l)	Faecal Coliform MPN/100ml x10 ^{5}
1.	Nagole Bridge	6.90	Nil	1102	112	219	14	2.9
2.	Musoorambagh	6.86	Nil	962	97	156	13	3.1
3.	Chadarghat Br	6.80	Nil	930	105	187	12	2.8
4.	Imliban Station	6.74	Nil	970	74	143	11	4.00
5.	Puranapul	7.20	0.8	808	86	174	12	2.70
6.	Attapur Bridgel	7.22	2.0	740	65	139	13	1.80
7.	Bapughat	7.42	2.1	620	46	87	10	1.60

Samples tested: November 2001
Source: Reproduced from the project report prepared by MWH India Private Limited on the Musi River Conservation Project. Volume 1, January 2002.

4. CONCLUSIONS

The mismatch between declared rules and rules-in-use and the reasons for the gap suggest that the institutional framework is weak and does not actually support or facilitate the implementation of all the declared rules. The key conclusions that can be drawn from the above analysis are:

1. The declared rules are too idealistic and ambitious considering the available capacity of the organizations who are supposed to ensure their implementation. (the relevant organizations and their roles is not within the scope of this paper).
2. The rules have been declared two decades ago (1987) and have not kept pace with the changing socio-economic condition of the city, rapid population growth and the people and hence there is a big gap between the declared rules and rules-in-use.
3. The cost of water supply, treatment of wastewater and others have increased tremendously. However, the pricing of water and sewerage services has not kept pace with this price rise.
4. The government and water boards have always concentrated on ensuring the water supply to the cities, but wastewater treatment and disposal have always been given low importence on the agenda and hence never provided enough budget outlay for the same.
5. Often, urban people are not aware of the gravity of problems associated with the wastewater disposal and treatment and hence apathy towards such issues.

5. CHANGES REQUIRED IN THE INSTITUTIONAL SET-UP

There is an urgent need to make certain changes in the current institutional set-up to improve the wastewater situation in Hyderabad and minimize the adverse effects before it gets too expensive for the society in general. The following actions are recommended based on the above analysis:

1. Increase awareness among people on the need to protect our rivers and other fresh water sources. Most people surveyed (100 respondents) in the study were not even aware how much they paid for their water and sewerage services.
2. Need to increase the general efficiency of the water boards to cater to the needs of the people and also cope with the increasing demand for high quality water and better urban quality of life. There is a need for dynamic leaders in water related institutions / organizations who could improve the general efficiency of

these organizations to deliver the outputs at a lesser cost.

3. The budget allocations for environment have been very poor (0.02 % of the total outlay) and there is a case for increased allocations for wastewater treatment and improve the quality of our rivers.

4. Need to change the pricing strategy for the water supply and increase the sewerage cess (currently 35% of the water supply charges) to cover the maintenance costs for the new treatment plants.

5. Of the 100 respondents surveyed in this study, more than 40% of them said that they were willing to pay for wastewater treatment provided they were given the guarantee that their money would be used to right use and with high efficiency. Therefore, to gain the trust of the people, before the water boards actually increase the sewerage cess in the water bills, it is essential that they first invest (loan money from central and state governments) in treatment plants and start treating the wastewater. Once people can clearly see change in the quality of river water, then government can increase the sewer cess.

6. In addition to liquid waste management, the solid waste management of the city also needs to be improved to prevent illegal dumping of solid waste into the city drains and river. Otherwise, the very purpose of treatment of wastewater would be defeated.

7. Until and unless the industrial wastes are pre-treated before release into the river, the river can never be made clean. Strict monitoring and high penalties are essential to prevent illegal dumping of industrial wastewater into the river.

Finally, it is concluded that there is a need for change in the behaviors of different stakeholders, organizations and adapt existing rules to bring the desired changes in the overall institutional set-up.

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