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# Wastewater Treatment in India

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**Abstract:** Water, food and energy securities are emerging as increasingly important and vital issues for India and the world. Most of the river basins in India and elsewhere are closing or closed and experiencing moderate to severe water shortages, brought on by the simultaneous effects of agricultural growth, industrialization and urbanization. Current and future fresh water demand could be met by enhancing water use efficiency and demand management. Thus, wastewater/low quality water is emerging as potential source for demand management after essential treatment. An estimated 38354 million litres per day (MLD) sewage is generated in major cities of India, but the sewage treatment capacity is only of 11786 MLD. Similarly, only 60% of industrial waste water, mostly large scale industries, is treated. Performance of state owned sewage treatment plants, for treating municipal waste water, and common effluent treatment plants, for treating effluent from small scale industries, is also not complying with prescribed standards. Thus, effluent from the treatment plants, often, not suitable for household purpose and reuse of the waste water is mostly restricted to agricultural and industrial purposes. Wastewater- irrigated fields generate great employment opportunity for female and male agricultural labourers to cultivate crops, vegetables, flowers, fodders that can be sold in nearby markets or for use by their livestock. However, there are higher risk associated to human health and the environment on use of wastewater especially in developing countries, where rarely the wastewater is treated and large volumes of untreated wastewater are being used in agriculture.

**Introduction:** The seriousness of the challenges associated with urban water supply and sanitation in India have been recognized in recent times. After decades of neglect, the first national effort to invest in the urban water and sanitation sector commenced in the 1970s, but was accorded considerable priority in the subsequent two decades as a part of different national- and state level schemes, culminating most recently in the 'Swacch Bharat Mission'. As most of the recent reports and commentaries, (M. Shah (2013) have highlighted, the problems of the urban water and sanitation sector in India are complex and shall need concerted efforts to sustain the policy momentum. This paper attempts to highlight the multidimensional nature of the challenge, and sets out recommendations for strengthening existing policies and their implementation. While the concerns of urban water and sanitation are faced in many countries in the global South, the scale of gaps in access and services in India poses a dilemma. According to the 2011 census, India has a total population of 1.21 billion, which is an addition of 181 million people during the decade of 2001–2011 (Census of India, 2011b). Although only 31.16 per cent of India is urban according to the Census of India, at 377 million, India's current urban population is larger than the entire population of United States which is the third most populous country in the world. As recent commentators have highlighted, if India fails to meet its MDG or the emerging SDG targets, the global targets would not be met. Unlike many other countries, India has the unenviable situation of needing to simultaneously improve access to water and sanitation, and responding to increasingly urgent environmental challenges. The policy responses need to provide for improved public health outcomes via universal access and improved service quality, while facing the challenge of increasingly severe water and resource constraints on one hand, and limited institutional and financial capacities on the other. This paper acknowledges that there has been considerable movement in the policy space: it takes the existing framework and initiatives as its starting point, critically examines them, and builds upon them.

**Water availability and use**: India accounts for 2.45% of land area and 4% of water resources of the world but represents 16% of the world population. Total utilizable water resource in the country has been estimated to be about 1123 BCM (690 BCM from surface and 433 BCM from ground), which is just 28% of the water derived from precipitation. About 85% (688 BCM) of water usage is being diverted for irrigation (Figure 1), which may increase to 1072 BCM by 2050. Major source for irrigation is groundwater. Annual groundwater recharge is about 433 BCM of which 212.5 BCM used for irrigation and 18.1 BCM for domestic and industrial use (CGWB, 2011). By 2025, demand for domestic and industrial water usage may increase to 29.2 BCM. Thus water availability for irrigation is expected to reduce to 162.3 BCM. With the present population growth-rate (1.9% per year), the population is expected to cross the 1.5 billion mark by 2050. Due to increasing population and all round development in the country, the per capita average annual freshwater availability has been reducing since 1951 from 5177 m 3 to 1869 m 3 , in 2001 and 1588 m3 , in 2010. It is expected to further reduce to 1341 m 3 in 2025 and 1140 m 3 in 2050. Hence, there is an urgent need for efficient water resource management through enhanced water use efficiency and waste water recycling.

**Wastewater production and treatment**: With rapid expansion of cities and domestic water supply, quantity of gray/wastewater is increasing in the same proportion. As per CPHEEO estimates about 70-80% of total water supplied for domestic use gets generated as wastewater. The per capita wastewater generation by the class-I cities and class-II towns, representing 72% of urban population in India, has been estimated to be around 98 lpcd while that from the National Capital Territory-Delhi alone (discharging 3,663 mld of wastewaters, 61% of which is treated) is over 220 lpcd (CPCB, 1999). As per CPCB estimates, the total wastewater generation from Class I cities (498) and Class II (410) towns in the country is around 35,558 and 2,696 MLD respectively. While, the installed sewage treatment capacity is just 11,553 and 233 MLD, respectively (Figure 2) thereby leading to a gap of 26,468 MLD in sewage treatment capacity. Maharashtra, Delhi, Uttar Pradesh, West Bengal and Gujarat are the major contributors of wastewater (63%; CPCB, 2007a). Further, as per the UNESCO and WWAP (2006) estimates (Van-Rooijen et al., 2008), the industrial water use productivity of India (IWP, in billion constant 1995 US$ per m 3 ) is the lowest (i.e. just 3.42) and about 1/30th of that for Japan and Republic of Korea. It is projected that by 2050, about 48.2 BCM (132 billion litres per day) of wastewaters (with a potential to meet 4.5% of the total irrigation water demand) would be generated thereby further widening this gap (Bhardwaj, 2005). Thus, overall analysis of water resources indicates that in coming years, there will be a twin edged problem to deal with reduced fresh water availability and increased wastewater generation due to increased population and industrialization.

**Wastewater use/ disposal:** Insufficient capacity of waste water treatment and increasing sewage generation pose big question of disposal of waste water. As a result, at present, significant portion of waste water being bypassed in STPs and sold to the nearby farmers on charge basis by the Water and Sewerage Board or most of the untreated waste water end up into river basins and indirectly used for irrigation. In areas like Vadodara, Gujarat, which lack alternative sources of water, one of the most lucrative income-generating activities for the lower social strata is the sale of wastewater and renting pumps to lift it (Bhamoriya, 2004). It has been reported that irrigation with sewage or sewage mixed with industrial effluents results in saving of 25 to 50 per cent of N and P fertilizer and leads to 15-27 % higher crop productivity, over the normal waters (Anonymous, 2004). It is estimated that in India about 73,000 ha of (Strauss and Blumenthal, 1990) per-urban agriculture is subject to wastewater irrigation. In peri-urban areas, farmers usually adopt year round, intensive vegetable production systems (300-400%

cropping intensity) or other perishable commodity like fodder and earn up to 4 times more from a unit land area compared to freshwater (Minhas and Samra, 2004). Major crops being irrigated with waste water are:

- **Cereals**: Along 10 km stretch of the Musi River (Hyderabad, Andhra Pradesh) where wastewater from Hyderabad is disposed-off, 2100 ha land is irrigated with waste water to cultivate paddy. Wheat is irrigated with waste water in Ahmedabad and Kanpur.
- **Vegetables**: In New Delhi, various vegetables are cultivated on 1700 ha land irrigated with wastewater in area around Keshopur and Okhla STPs. Vegetables like Cucurbits, eggplant, okra, and coriander in the summers; Spinach, mustard, cauliflower, and cabbage in the winters are grown at these place. In Hyderabad, vegetables are grown in Musi river basin all year round which includes spinach, amaranths, mint, coriander, etc.
- **Flowers:** Farmers in Kanpur grow roses and marigold with wastewater. In Hyderabad, the farmers cultivating Jasmine through wastewater.
- **Avenue trees and parks**: In Hyderabad, secondary treated wastewater is used to irrigate public parks and avenue trees. Fodder crops: In Hyderabad, along the Musi River about 10,000 ha of land is irrigated with wastewater to cultivate paragrass, a kind of fodder grass. Aquaculture: The East Kolkata sewage fisheries are the largest single wastewater use system in aquaculture in the world.
- **Agroforestry:** In the villages near Hubli-Dharwad in Karnataka, plantation trees viz., sapota, guava, coconut, mango, arecanut, teak, neem, banana, ramphal, curry leaf, pomegranate, lemon, galimara, mulberry, etc. are irrigated with waste water.

**Policies and institutional set-up for wastewater management:** Presently there are no separate regulations/ guidelines for safe handling, transport and disposal of wastewater in the country. The existing policies for regulating wastewater management are based on certain environmental laws and certain policies and legal provisions viz. Constitutional Provisions on sanitation and water pollution; National Environment Policy, 2006; National Sanitation Policy, 2008; Hazardous waste (Management and Handling) Rules, 1989; Municipalities Act; District Municipalities Act etc.. Creation of sewerage infrastructure for sewage disposal is responsibility of State governments/urban local bodies, though their efforts are supplemented through central schemes, such as National River Conservation Plan, National Lake Conservation Plan, Jawaharlal Nehru National Urban Renewal Mission, and Urban Infrastructure Scheme for Small and Medium Towns (MoEF, 2012). However, operation and maintenance of sewerage infrastructure including treatment plants are responsibilities of State governments/urban local bodies and their agencies. As per Water Act 1974, State Pollution Control Boards possesses statutory power to take action against any defaulting agency. Water Act 1974 also emphasizes utilization of treated sewage in irrigation, but this issue has been ignored by the State Governments.

**Bio-refineries wastewater treatment:** Bio-refineries for the production of fuel ethanol produce large volumes of highly polluted effluents. Anaerobic digestion is usually applied as a first treatment step for such highly loaded wastewaters. At present, the anaerobic biological treatment of biorefinery effluents is widely applied as an effective step in removing 90% of the Chemical Oxygen Demand (COD) in the effluent stream. During this stage, 80–90% BOD removal takes place and biochemical energy recovered is 85–90% as biogas (Pant and Adholeya, 2007; Satyawali and Balakrishnan, 2008). To reduce the BOD to acceptable standards, the effluent from an anaerobic digestion step requires further aerobic treatment. However, biological treatment processes alone are not sufficient to meet tightening environmental regulations (Pant and Adholeya, 2007).A proper choice of tertiary treatment can further reduce color and residual COD.

**Municipal wastewater treatment using constructed wetlands**: Constructed wetlands (CWs) are a viable treatment alternative for municipal wastewater, and numerous studies on their performance in municipal water treatment have been conducted. A good design constructed wetland should be able to maintain the wetland hydraulics, namely the hydraulic loading rates (HLR) and the hydraulic retention time (HRT), as it affects the treatment performance of a wetland (Kadlec and Wallace, 2009). Indian experience with constructed wetland systems is mostly on an experimental scale, treating different kinds of wastewater (Juwarkar et al., 1995; Billore et al., 1999, 2001, 2002; Jayakumar and Dandigi, 2002). One of the major constraints to field-scale constructed wetland systems in developing countries like India is the requirement of a relatively large land area that is not readily available. Subsurface (horizontal/ vertical) flow systems, generally associated with about a 100 times smaller size range and 3 times smaller HRTs (generally 2.9 days) than the surface flow systems (with about 9.3 days HRT, Kadlec, 2009), are therefore being considered to be the more suitable options for the developing countries. Shorter HRTs generally translate into smaller land requirement. Batch flow systems, with decreased detention time, have been reported to be associated with lower treatment area and higher pollutant removal efficiency (Kaur et al., 2012a, b). Thus, batch-fed vertical sub-surface flow wetlands seem to have an implication for better acceptability under Indian conditions.

**Post-harvest:** interventions Post-harvest interventions are an important component for health-risk reduction of wastewater-irrigated crops and are of particular importance to address possible on-farm pre-contamination, and also contamination that may occur after the crops leave the farm. The health hazards could be markedly lowered with adoption of some of the low cost practices such as repeated washings, exposure of the produce to sunlight and raising the crops on beds, removing the two outmost leaves of cabbage and also, cutting above some height from ground level (0.10 m; Minhas et al., 2006).

**Status and need for the knowledge and skills on the safe use of wastewater:** Wastewater is more saline due to dissolved solids originating in urban areas, and concentrated further through high evaporation in arid and tropical climates. Heavy use of wastewater in agriculture may cause salinity problem and can decline the land productivity. Excessive industrial release to the environment can lead to a buildup of toxic pollutants, which can in turn encourage the overgrowth of weeds, algae, and cyanobacteria and deteriorate groundwater and downstream water quality. Types of crops that farmers can raise are affected by the wastewater quality and the prevailing climatic conditions. In arid and semiarid regions, high evaporation rates cause wastewater to be more saline and thus calls for the cultivation of salt tolerant crops and varieties. As many fodder crops are salt tolerant therefore use of wastewater for fodder production in urban and peri-urban areas, particularly having urban demand for dairy products, may be encouraged. However, the health of the livestock fed on the wastewater irrigated fodder may be seriously impaired (as currently in Hyderabad) and the quality of milk may be affected with the consequent transference of the danger to the humans.

**Conclusion:** In developing countries like India, the problems associated with wastewater reuse arise from its lack of treatment. The challenge thus is to find such low-cost, low-tech, user friendly methods, which on one hand avoid threatening our substantial wastewater dependent livelihoods and on the other hand protect degradation of our valuable natural resources. The use of constructed wetlands is now being recognized as an efficient technology for wastewater treatment. Compared to the conventional treatment systems, constructed wetlands need lesser material and energy, are easily operated, have no sludge disposal problems and can be maintained by untrained personnel. Further these systems have lower construction, maintenance and operation costs as these are driven by natural energies of sun, wind, soil, microorganisms, plants and animals.

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