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WASTEWATER AS A CONTROVERSIAL, CONTAMINATED YET COVETED RESOURCE IN SOUTH ASIA

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Introduction

The challenges posed by increasing water scarcity and water quality that result from economic growth are well documented (Worldwide Wildlife Fund, 2004). Equally well known are the important human development and welfare gains generated by improved access to water supply and sanitation (WSS). The Millennium Development Goals have targeted massive leaps in WSS coverage, specifically Target 10, to halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation.

Eighty-eight percent of the world's population growth until 2015 will occur in urban areas; almost all of this growth will be in the cities of developing countries. In India, population growth is estimated to take place not just in a few mega cities but in 40-45 cities with populations of over 100,000 people. As a result of population growth in Asian cities, between 2000-2025 most of the growth in urban water supply will occur in Asia.

However, the underside of this growth is the rapid expansion of wastewater and its "disposal" in water bodies downstream of urban centers. Only a small fraction of the urban water supplied to residences is lost: the standard calculation is that approximately 75-85% exits any city in the form of wastewater. Where the management of wastewater was once confined to the largest cities, increasing WSS coverage in developing countries now results in a widespread wastewater crisis in smaller towns and cities alike. Paradoxically, increased WSS coverage also in many cases results in increased agricultural water supply as a result of the rapidly growing practice of wastewater irrigation (Scott *et al*, 2004).

From both the treatment and reuse perspectives, it is critical to differentiate urban domestic sewage (primarily organic with the resulting high biochemical oxygen demand and nutrient loads) from commercial and industrial wastewater (with heavy metals, pharmaceutical by-products, solvents, and a variety of persistent organic compounds). The latter clearly poses higher risks to human health and the environment. Failure to re-engineer industrial production processes to recycle toxic compounds on-site coupled with the inability of municipal authorities to collect adequate wastewater disposal fees from industries, commercial establishments and residential areas to pay for safe treatment

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serves the short-term financial interests particularly of industries and commercial establishments that pollute vast volumes of water. However, this merely externalizes the costs by passing them on to downstream recipients of the "disposed" wastewater.

The urban-periurban-rural linkages resulting from water supply and wastewater disposal and reuse reinforce a set of inequalities that transcend purely urban or rural boundaries. The case descriptions below present a new angle on conventional water resources inequalities and are different from those that result, for example, from powerful interests capturing water within a solely agricultural context, or pollution faced by poor urban slum dwellers that serves urban elite interests. These urban-rural cross-overs and inequalities have not been fully explored either from water resources, social equity, or economic efficiency perspectives.

Rapid increases in WSS coverage in South Asia over the past decade and a half are particularly notable when considering the large population increases the region is experiencing. Figures 1 and 2 indicate the 2003 levels of access and improvements in water supply and sanitation, respectively, for the principal countries in South Asia and for the region as a whole. Data on Afghanistan and Maldives were incomplete.

Wastewater treatment levels in the region are chronically low, with the net result that very major increases in untreated wastewater volumes are being reused in agriculture. For example, it is estimated that 73% of the wastewater generated by Indian cities is untreated. In order to attempt to treat most of this wastewater, US$65 billion will have to be invested which is ten times more than the government of India plans to spend (Kumar, 2003). Although the U.N. Millennium Project Task Force on Water Sanitation has identified wastewater reuse in peri-urban agriculture as a priority action for research organizations, experience has shown that municipalities, farmers, and irrigation and agriculture departments are ill-equipped for the very rapid pace of change in urban-rural water transfers.

Urban wastewater normally contains water that has been used by city residents, industries, commercial establishments and hospitals. The amount of wastewater produced depends on the population of the city or town. As urban areas grow, additional volumes of water are supplied in an attempt by municipal authorities to meet the city's various water needs, resulting in a proportional increase in wastewater. In most areas of the world, only a small percentage of the wastewater is treated due to the high cost of most treatment technologies. A city's treatment capacity also invariably lags behind existing volumes of wastewater due to the ever-increasing water supply and the priority it is accorded. Many treatment plants also go into disuse or function at sub-optimal levels due to the lack of financial resources for plant operation and maintenance. As mentioned, wastewater quality is affected mainly by the volume and types of industrial effluents released and dilution with natural runoff and domestic wastewater. The wastewater is released—into drains, irrigation canals, and/or rivers or other water bodies—either totally untreated, after partial treatment, or after more complete treatment to the secondary or tertiary levels.

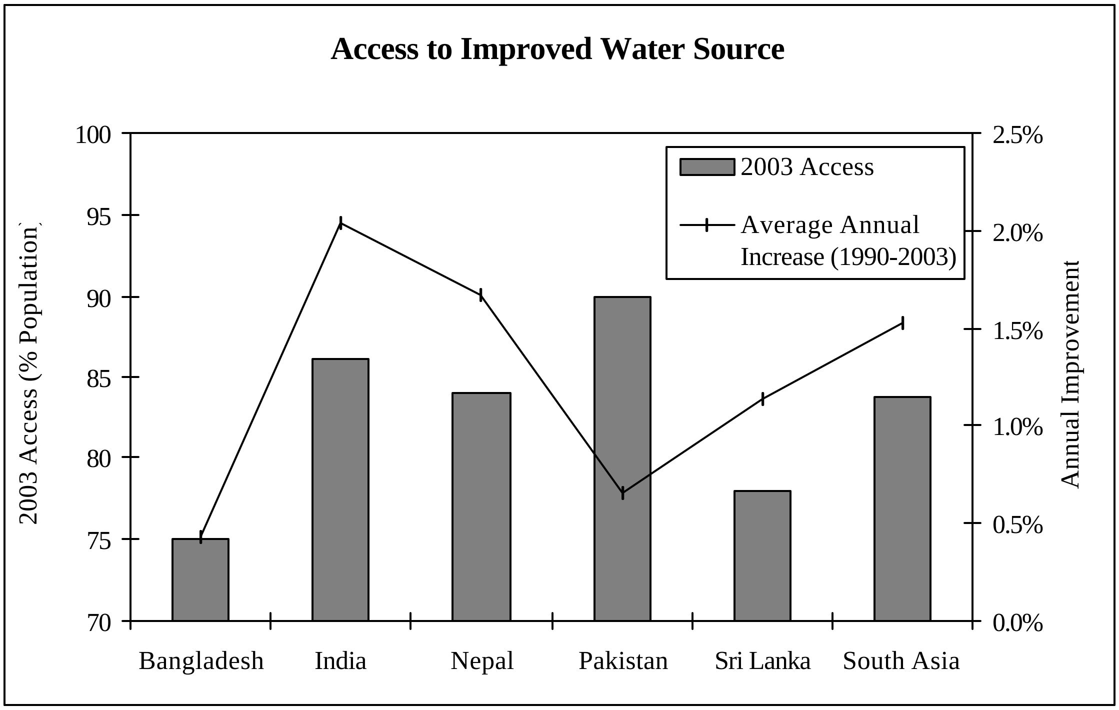

Figure 1: Access to Improved Water Source, South Asia, 1990 – 2003

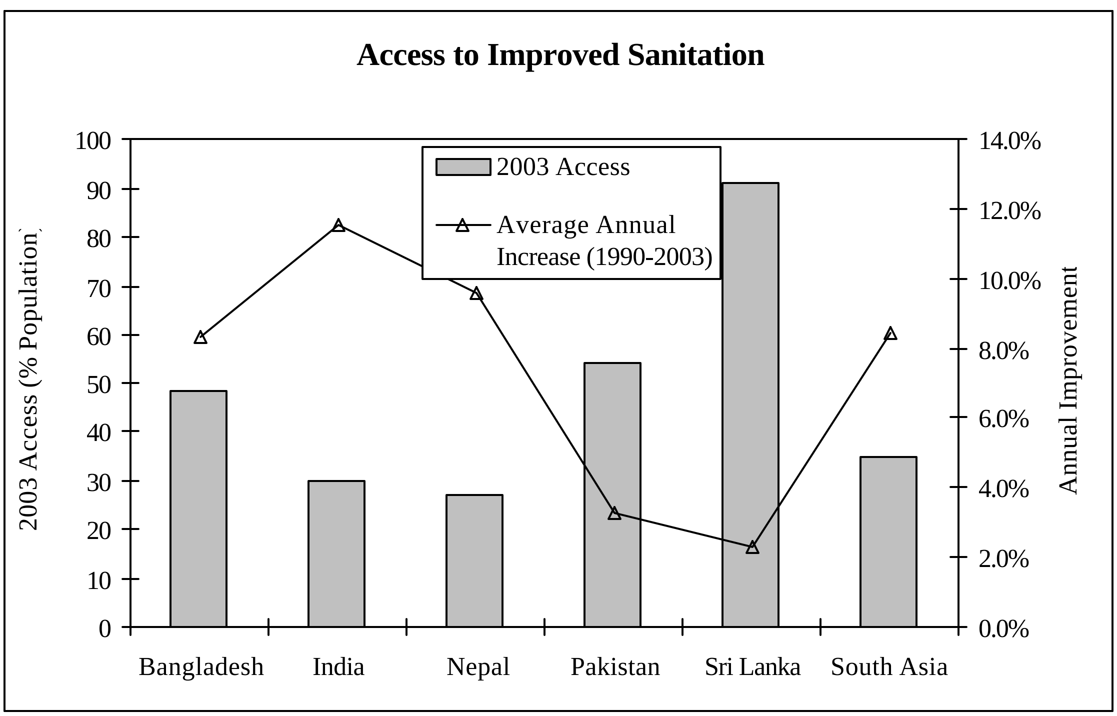

Figure 2: Access to Improved Sanitation, South Asia, 1990 – 2003

Livelihoods Supported by Wastewater

Wastewater is used by farmers for irrigation in many semi-arid, drought-prone regions around the globe where freshwater is scarce and agricultural land is located near cities (such as Addis Ababa, Ethiopia; Haroonabad, Pakistan; Dakar, Senegal; Cochabamba, Bolivia; and Irapuato and Guanajuato, Mexico) (Buechler and Devi, 2005). Wastewater is also used to support livestock production. Water scarcity drives farmers to make use of wastewater, which is often available year-round. Groundwater may be too expensive to access due to low water tables which necessitate the drilling of deep wells or groundwater may be too saline for use in agriculture. Fresh surface water may be available only intermittently during the rainy season, if at all. Any water source that requires pumping involves costs that are often not attached to the use of wastewater. The activities directly dependent on wastewater are practiced by different social groups on a small, medium or large scale and include, for example, agriculture, agro-forestry, livestock rearing, aquaculture and floriculture. Activities indirectly dependent on wastewater include the sale of seeds, pesticides and other inputs to wastewater farmers, rental of harvest machinery or equipment, agricultural labor, services related to the transportation of produce to markets, marketing of the produce, animal husbandry with purchased wastewater-irrigated fodder and the provision of fish fry for aquaculture. Many resource poor farmers (with and without land) and very poor agricultural laborers earn an income or gain food security through the use of this degraded resource (Buechler, 2004).

Wastewater quality affects the types of crops that farmers can cultivate and the types of livestock and fish that they can raise. Wastewater is more saline than freshwater due to dissolved solids originating in urban areas, and concentrated through high evaporation in arid, tropical climates. Salinity could restrict the variety of crops that can be cultivated. Since many types of grass fodder can be grown with saline wastewater, this water is more likely to be used in the urban and peri-urban areas for fodder production particularly where there is an urban demand for dairy products. However, the impacts of such imposed choices are not limited to a restriction in the types of crops that can be cultivated. With deteriorating wastewater quality, the health of the livestock can be harmed and the quality of their milk may decline which can transfer the health risks to humans who consume the milk. Dairy producers' incomes suffer if milk production per cattle falls. Similarly, many varieties of fish are sensitive to changes in water quality. The varieties of fish grown in a sewage pond would need to change if the quality deteriorated, and fishing would have to be stopped entirely if the water quality deteriorated substantially. Health problems can ensue for agricultural workers due to pathogenic bacteria, viruses and parasites present in the wastewater as well as for consumers of wastewater-irrigated produce particularly if the produce is not cooked before it is consumed. Hookworm infections are more common in agricultural workers who go barefoot in wastewater-irrigated fields (van der Hoek et al, 2002).

Case Studies

The case studies of cities in South Asia presented here demonstrate the water resources, social equity and economic dimensions of urban-rural inequalities outlined above.

Farmers in and around **Hyderabad**, Andhra Pradesh (A.P.) state, India, irrigate with wastewater. Wastewater is generated by the large and rapidly growing urban population of nearly 4 million people and discharged into the Musi River that flows through Hyderabad city (Buechler and Devi, 2005). The total amount of wastewater released that originates from the metro water supply is about 600,000 m^3/d. For 2011, due to population growth, there will be an increase in inter-basin transfers of water from the Manjira and Krishna rivers to Hyderabad to meet rising urban water demand; as a result, the sewage load is estimated to rise by this year to 2,560,000 m^3/d (HUDA, Draft Master Plan for 2011). Plans for new and upgraded existing plants aim to treat 630,000 m^3/d by 2006[3]. Wastewater is released into the river from sewage drains that jut out of the city walls along the river. The sewage drains are also located at several points downstream of the city and the wastewater from these flows into irrigation canals and, ultimately, into the river. Approximately 15,974 ha of land in and downstream of Hyderabad are irrigated with wastewater or a combination of wastewater and groundwater (Buechler and Devi, 2005). Urban, peri-urban and rural agriculture is supported by the use of wastewater. Farmers use wastewater to irrigate due mainly to the fact that freshwater is scarce; rainfall is low and sporadic (700-800 mm per year) and it is concentrated into four months of the year. Groundwater is difficult to access due to the hard rock morphology of the area and to over-draft. In the urban area, the main crop grown with wastewater is para grass, a type of fodder grass, cultivated for dairy production; banana leaves and coconut palm leaves are also harvested for ceremonial use and there is also some leafy vegetable production. Urban farmland is located in a thin strip within a 10 km stretch along the Musi River. Buffaloes used for dairy production are brought to the wastewater-filled river to bathe. In the peri-urban area, para grass is the main crop grown, in close proximity to expanding areas of vegetable and herb cultivation and vastly shrinking areas of paddy rice production. The declining wastewater quality has reduced paddy rice yields to such an extent that it is no longer a profitable activity in this area (field observations, Buechler and Devi 2005). The rapidly growing city has stimulated demand for dairy products and fresh vegetables. In the urban and peri-urban areas, year-round employment is generated on wastewater-irrigated fields for female and male agricultural laborers; the landless also rent in land to cultivate fodder grass or vegetables for sale in nearby markets or for use by their livestock. Most retain approximately 25% of the milk derived from the fodder grass fed to livestock for household use; vegetable producers similarly retain some of their crop or engage in barter for other types of vegetables to improve their family's nutrition. Skin irritations were common complaints among farmers and laborers in urban and rural wastewater-irrigated areas (Buechler et al, 2002). Ensink reports elevated levels of hookworm, *ascaris*, and *trichuris* in Musi wastewater (n.d.). In the rural areas, paddy rice remains the main crop cultivated with wastewater. Although the

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[3] Cases from around the world show that treatment plants often go into disuse soon after being built due to lack of public funds for operation and maintenance (Bhamoriya, 2004:129; Huibers et al, 2004:13; Rutkowski et al, n.d.).

water quality is better than in the peri-urban or urban areas, wastewater quality is also declining leading to greater pest infestations and reduced yields. In the wastewater-irrigated areas, forty-three percent of total household food consumption is derived from the paddy rice that they grow in their fields. Agricultural labor used for paddy harvesting comes from drought-prone, dryland areas in the same state and in surrounding states; the female and male laborers are paid in paddy thus improving household food security (Buechler and Devi, 2003).

As in most Indian cities, 97 per cent of domestic wastewater in Hyderabad receives little or no treatment and untreated industrial effluent as well as hospital and commercial waste is released with the domestic sewage into the river. Freshwater in the form of rainwater only flows into the river during the short monsoon season with its sporadic rain. With the burgeoning urban population and the corresponding increase in wastewater volumes, the scale of wastewater use for irrigation has increased while the wastewater quality continues to decline due mainly to greater industrial effluent loads (Buechler and Devi, 2005). There are 12 industrial areas within 30 kms of Hyderabad. The Common Effluent Treatment Plants (CETP's) are unable to treat effluents adequately due to the many types of effluents received and to the lack of pre-treatment in the industries. The CETP discharges its effluents into the Musi and other waterways as do the individual industries that do not bring their effluents to the CETP (they often dump it illegally into wells or canals or directly into the river) (Buechler and Devi, 2002). For the Musi, it is roughly estimated that about 7-15 million liters per day of industrial effluent is released into the sewage system (personal communication, Hyderabad Metropolitan Water Supply and Sewerage Board, 2003). This figure is set to increase due to the imminent completion of an industrial effluent pipeline from the industrial area of Patancheru to Hyderabad. In some peri-urban and rural areas downstream of Hyderabad, farmers are mixing groundwater with wastewater in an attempt to improve wastewater quality. However, only those who can afford to drill a deep well as well as run and maintain a pump can afford to use groundwater (Buechler and Devi, 2005). According to a study by Bhamoriya, farmers in and around **Vadodara** city, in Gujarat state, India, must also cope with deteriorating wastewater quality caused by illegal dumping of untreated industrial effluent into channels meant for treated wastewater; farmers are adding surface or groundwater to wastewater in order to combat deteriorating wastewater quality (Bhamoriya, 2004:133).

The **Kathmandu** Valley in Nepal, which is drained by the Bagmati River, has a rapidly growing metropolitan area of 1.4 million inhabitants, surrounded by agricultural land. Informal irrigation occurs in the urban and peri-urban areas of the valley, where lack of adequate wastewater treatment facilities and rainfall during the dry season has led to extensive use of poor quality wastewater for agriculture. The two principal methods used by farmers to access and use wastewater are the deliberate blocking of sewers, and the pumping of wastewater from the river. There are 1340 industries in the Kathmandu valley; carpet dyeing and washing is the largest polluter (Metcalf and Eddy, 2000). Treatment is mainly through lagoon systems but many of the treatment plants are in poor condition. The result is that nearly 75% of wastewater generated, which is only partially treated at best, drains into the valley's waterways. Sewage coverage in the municipal districts of the Kathmandu metropolitan area does not exceed 50%. Only 15-30% of the collected wastewater is treated before disposal. Government officials whose responsibilities include irrigation both at the state level (His Majesty's Department of Irrigation) and the district level (Kathmandu Valley District Irrigation) have no little or knowledge of the extent of formal and informal use of wastewater. **Bhaktapur** and **Kirtipu**r municipalities of the Kathmandu metropolitan area have populations of 72,543 and 40,835 respectively. Wastewater drains into the perennial Hanumante River and the Khasyang Khusung stream in Bhaktapur and the Chikhu Kola stream in Kirtipur. The average landholding size in Bhaktapur was .16 ha and 0.11 ha in Kirtipur. In summer the main crop is paddy, whereas in the winter season, farmers cultivate both vegetables and wheat, but the preference is for vegetables (84% of farmers in Bhaktapur cultivated only vegetables). Common vegetables include cauliflower, garlic, beans, and onions. These small farmers use wastewater because they have no access to an alternative water source. Farmers used untreated domestic sewage by plugging sewers to divert the sewer water; farmers along the Bagmati River diverted or pumped polluted river water. In Kirtipur, Chikhu Stream floodwaters often leave behind mounds of garbage, animal bones, and glass and crops are damaged due to the poor wastewater quality and over-fertilization of the crops. Farmers complained of skin irritations in all areas under wastewater irrigation (Rutkowski, Raschid and Buechler, in review).

In more than 80% of communities in Pakistan with a population of over 10,000 people untreated wastewater is used for irrigation. In **Haroonabad** and **Faisalabad**, Pakistan wastewater irrigation is used due to the close proximity of urban markets, the highly saline groundwater unfit for irrigation, frequent drought and low annual rainfall (198-600 mm), wastewater's reliability and its nutrient value. Wheat, cauliflower, spinach, eggplant, tomatoes, fodder sorghum and cotton were cultivated. Wastewater farmers earned US$300 more than non-wastewater farmers in these two areas. Faisalabad has a population of approximately 2 million people with many industries, particularly cotton processing units. On wastewater irrigated land around Faisalabad, the soil and crops showed signs of heavy metal contamination. Wheat showed high levels of cadmium. Near Haroonabad, however, a small city with no major industry, very little heavy metal contamination was found after 30 years of wastewater irrigation. Wastewater farmers and laborers who came into contact with the wastewater had a 4 to 5 fold higher risk of hookworm infection than a group of non-wastewater users (Ensink et al, 2004).

Conclusions

Wastewater is a growing practice due mainly to growing urban populations that are demanding cheaper, fresher, more nutritious, higher-protein food, but that simultaneously are capturing short-term gains by externalizing wastewater management costs on downstream rural areas. This urban growth entails that the locus of agricultural and dairy production shift increasingly to the fringes of cities and towns and that the types of crops grown reflect the altered demand. Small landowners and the landless can benefit from increased incomes as well as improved nutrition through the retention of a portion of their harvest or through in-kind remuneration for their agricultural labor. However, the risks are increasing for incomes, human health and the environment due mainly to increased industrial and commercial effluent that is mixed, untreated, with domestic wastewater. Declining wastewater quality is leading to yield reductions, increased pest and other infestations, salt and heavy-metal build-up in soils and higher concentrations of intestinal nematode eggs. Industry, commercial establishments and urban residents are provided fresh water by means of government investment in water supply, whereas farmers in the surrounding agricultural areas are increasingly being forced to use the same water after it has been polluted. Urban authorities must focus more attention and resources on wastewater, which goes hand in hand with the frontline issue of increased water supply coverage. In order to minimize water pollution and to help capture resources for wastewater treatment, industrial and commercial interests that so far have been free-riding their pollution load on downstream water users, must be placed under increased surveillance; revenue based on the polluter pays principle must also be collected and re-invested in wastewater management.

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