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Periurban Water Use, Human Health and Well-being. Emerging Issues in South Asia

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Urbanization in the twentieth century

Urbanization has been one of the most pronounced trends of the twentieth century. Rapid urban expansion in many nations – in particular the growth of small urban centers – goes hand in hand with the growth of what are called 'periurban' areas that combine 'urban' and 'rural' characteristics and present new challenges to urban growth management (Tacoli 2006). The mixture of urban and agricultural land use has been recognized as characteristic of the vernacular urban fringe of Asian megacities. This landscape has been variously called the 'Desakota' (McGee 1991), the rural-urban fringe or the periurban interface (Allen 2003; Narain & Nischal 2007).

For the purposes of this paper, we refer to periurban in two different ways; first, to denote villages near the peripheries of expanding cities and second, to denote parts of cities that are away from the core, and located toward the peripheries. That is, they are within the jurisdiction of urban authorities, but located away from the centre. This distinction is important in understanding the implications of water use for human health and well-being; the major effects of urbanization on water use and human health in the former case occur through the gradual acquisition of the villages' land and water resources for urban expansion, on account of which periurban residents lose access to water of sufficient quality and quantity. In the latter case, the effects come from lack of tenure or social exclusion, and the outcomes of a planning process that favors the core over the periphery.

Implications of urbanization processes for the water access of periurban residents

It is widely acknowledged that periurban areas serve as receptacles for urban waste and as a source of resources like land and water that are needed to sustain urban expansion. Periurban settlements tend to be at the receiving end of urban development and bear the brunt of the development of urban residential and industrial areas.

Urbanization affects the access of periurban residents to water in several ways (Narain 2009a); these have specific implications for human health and well-being. Human well-being refers to the ability of people to live the kind of life that they value. Pressures on the water sources of periurban locations can come from many quarters; farmers' access to water may be adversely affected as groundwater is tapped for other uses, such as industry, farm-houses, recreation and conservation. People's access to water sources diminishes as the lands on which they are located are acquired for urban and residential purposes. Factories relocated from the city core to peripheries may pollute local water sources. Besides, inhabitants of periurban settlements often tend to be outside the ambit of the provision of organized sources of water supply, since many of them lack a formal tenurial status.

Lack of access to adequate safe drinking water and sanitation, in turn, is known to cause severe health problems. These can be grouped into the following categories:

i) Water-borne diseases, such as diarrhea, dysentery, cholera and typhoid, caused by the consumption of contaminated water

ii) Water-washed diseases such as skin and eye infections caused by insufficient water for personal hygiene

iii) Water-based or other water related diseases such as malaria, bilharzia, elephantiasis and river blindness, related to exposure to unsafe water situations

Most of the diseases mentioned above are the result of poverty and social exclusion. This makes residents of periurban settlements particularly vulnerable to diseases and poor health.

The health implications of the use of wastewater in periurban agriculture

Studies in several Asian and African cities show the rising importance of urban wastewater in agricultural production; in certain Asian and African countries, wastewater agriculture accounts for over 50 percent of urban vegetable supply (IWMI 2003). Studies across 50 cities in Asia, Africa and Latin America show that wastewater irrigation is practiced in three-quarters of the cities (IWMI 2006). In South Asia, in Pakistan for instance, wastewater irrigation provides a quarter of all vegetables produced (IWMI 2006).

Table 1 shows the volume of wastewater generated in different South Asian countries.

TABLE 1: Estimated volumes of wastewater (million m^3/year) in Asia

Country	Sewage in urban areas	Industrial effleunts	Total wastewater
Bangladesh	525	200	725
Bhutan	3.9	0.3	4.2
India*	3250	140	3390
Pakistan	NA	NA	NA
Sri Lanka	350	225	950

* 23 metropolitan cities only
Source: UNESCAP 2000.

Wastewater is an important form of urban-rural water flows. It is known to be an important source of irrigation for periurban agriculture in South Asia. Studies have demonstrated its role in sustaining periurban livelihoods in India, Pakistan, Bangladesh and Sri Lanka. Wastewater provides farmers with a nutrient rich source of water, often avoiding the need for costly chemical fertilizers. It is estimated that wastewater farmers typically earn 30–40 per cent more per year than farmers using conventional irrigation water (IWMI 2006). It is used often to produce rice and fish as well. In India, and other South Asian countries, it is also used to grow fodder for livestock and thus contributes to thriving small-scale enterprises based on providing milk for city dwellers. In addition, the use of wastewater for floriculture is also common.

In parts of periurban Gurgaon in Northwest India researched by the author of this paper, for instance, the use of wastewater for irrigation is a very organized activity, with farmers applying to the sewerage division of the Irrigation Department for permission to install pipes to irrigate their fields for a modest annual payment (Narain 2010). This then emerges as a cheap source of irrigation that avoids, on the one hand, the need for chemical fertilizers and, on the other, the need for costly pumping of water. In the absence of canal irrigation and when the groundwater is saline, wastewater is often the chief source of irrigation, allowing farmers to overcome the constraints posed by the absence of alternative sources of irrigation. This opens up new opportunities for farmers, enabling them to take up, for instance, the cultivation of such crops as paddy (Narain 2009b; Narain 2010). It also allows farmers to grow crops that are more sensitive to water stress, such as vegetables (IWMI 2003). Besides, the use of wastewater for agriculture has several ecological benefits. It serves as a positive way to dispose of urban sewage water (Feenstra et al. 2000). It offers an opportunity for increasing food and environmental security by avoiding direct pollution of rivers and surface water, conserving a significant proportion of river basin waters and disposing of municipal wastewater in a low-cost, sanitary manner (WII & IWMI 2006). Sometimes the importance of sewerage irrigation can increase in the vicinity of urbanizing locations; as lands are gradually acquired for urban purposes, periurban residents may lose access to irrigation sources like tubewells located on those lands, increasing their reliance on sewage-based irrigation, as observed in a study in Budheda village in India (Narain 2010).

In periurban Delhi, wastewater is being used for agriculture, that is, growing vegetables, foodgrain and horticulture crops and aquaculture (WII & IWMI 2006). Similar observations are made with regard to the periurban area around Kolkatta (Kundu et al. 2001). While the periurban agriculture in the rural fringe area of the city was traditionally confined to the production of rice, wheat, potato and vegetables, as in other rural areas of West Bengal, with the use of sewage irrigation, three productive activities grew in popularity, namely pisciculture, vegetable and paddy culture, all of which utilize the city's sewage and garbage. Sewage fed agriculture and sewage fed aquaculture emerged as the major forms of cultivation. More than 50 percent of the work force was reported to be directly engaged in sewage fed agriculture (rice and vegetables) in the waste recycling region. Wastewater based agriculture has also been reported to be important in several other South Asian locations, namely, periurban parts of Hyderabad, Haroonabad district in Pakistan, Rajshahi in Bangladesh and Kurunegala in Sri Lanka (Feenstra et al. 2000; Buechler & Devi 2003).

Though the WHO (World Health Organization) advises treatment of wastewater before application to fields to protect farmers and crop consumers, in Pakistan, India and other countries of the region, farmers use this water without any treatment as treatment plants are expensive; besides, farmers are willing to use this water without further treatment, since the composition of the wastewater allows them to increase the fertility of the soils substantively.

While this practice helps create livelihoods for a significant population of vulnerable communities (mainly small and marginal farmers and the landless), its use is known to cause potential health risks to communities exposed to wastewater as well as to consumers of fish or crops produced from it. Wastewater contains a wide spectrum of pathogens and sometimes heavy metals and organic compounds that are hazardous to the environment and human health.

The use of wastewater for agriculture is known to have three main health implications. First, prolonged contact with wastewater can expose farmers and their families to health risks such as parasitic worm and pathogenic viruses and bacteria. Second, there is a risk to consumers if vegetables are irrigated with wastewater; and third, wastewater canals can act as habitats for disease vectors, such as snails and mosquitoes.

The people who face the greatest potential risks from the use of wastewater for agriculture are agricultural field workers and their families, crop-handlers, consumers and those living near irrigated fields. Direct contact with untreated wastewater through flood or furrow irrigation can lead to increased helminth infection (mainly Ascaris lumbricoides – roundworm, Trichuris trichiura – whipworm, Ancylostoma duodenale and Nector americanus – hookworm). Two case studies that examined the impact of untreated wastewater on health, environment and income in Pakistan indicated higher hookworm infections in farmers and farm workers who used wastewater for irrigation than those who did not (Ensink et al. 2004). The main risk for the public arises when vegetable or salad crops grown with untreated wastewater are consumed raw. This can be linked to cholera and typhoid as well as to faecal bacterial diseases, bacterial diarrhoea and dysentery among consumers of wastewater-irrigated produce.

In a study carried out by the International Water Management Institute (IWMI) in Pakistan, the level of faecal coliform bacteria and helminth eggs in wastewater used around Haroonabad district of Pakistan far exceeded the level recommended by the WHO (Feenstra et al. 2000). In the farming community exposed to wastewater near Haroonabad, the prevalence of diarrheal diseases and hookworm infections was very high. The prevalence of these diseases was especially high among male farm workers. This group was highly exposed to wastewater, as they did a lot of the work in the fields manually and barefoot. In children of these farmers the prevalence of diarrheal diseases was also higher than in the control population. For crop consumers, the chance of a hookworm infection seemed slightly increased.

Irrigation water contaminated by sewage and industrial effluents that in turn contaminates soils and vegetables is known to be an important contributor to the presence of heavy metals beyond limits permissible under the Indian Prevention of Food Adulteration Act, 1954 (Marshall et al. 2005). Prolonged consumption of heavy metals in foodstuffs is known to lead to disruption of numerous biological and biochemical processes in the human body. While some elements such as arsenic, cadmium, and chromium act as carcinogens, others such as mercury and lead are associated with developmental abnormalities in children.

A review of the Wastewater Agriculture and Sanitation for Poverty Alleviation in Asia (WASPA) project in the towns of Rajshahi in Bangladesh and Kurunegala in Sri Lanka found that it was not only limited access to sanitation which contributed to wastewater flows; rather, other more important sources of pollution were identified such as discharges from small industries and leakage from poorly maintained or inadequate septic tanks. The situation necessitated the involvement of a broad range of stakeholders; the multi-stakeholder approach of Learning Alliances and participatory planning cycle provided a useful framework for addressing this problem.

Pockets of deprivation: poor access to safe water and sanitation as a cause of disease in periurban areas

Access to organized sources of drinking water is shaped by the land tenure status. This may leave a large proportion of the population of a city – in particular, periurban residents – outside the ambit of the provision of organized sources of water supply. This population has to depend on unorganized sources of drinking water, notably groundwater supplies that are often contaminated and unfit for human consumption. Very often periurban residents live in areas that lack formal tenurial status, depriving them of access to organized sources of drinking water supply. Maria (2008) estimated that only about 43 percent of the population of Delhi lives in settlements where the responsibility of the DJB (Delhi Jal Board) to provide individual water supply is well-defined and implemented; apart from the planned colonies and regularized unauthorized colonies, it is only the urban villages that fall under the purview of water provision by the DJB. This leaves the population residing in JJ clusters, resettlement colonies, non-regularized unauthorized colonies, slum designated areas and rural villages outside the ambit of the role of the DJB. Many of these settlements are at the peripheries of the city, and lack access to organized sources of water supply (Narain forthcoming).

There often are wide variations in access to safe drinking water between the core and the periphery areas, with the latter at a stark disadvantage. Datta et al. (2001) noted 87 percent of the total water consumption in Delhi to be for domestic purposes. The existing water supply distribution in the city, however, is highly non-uniform, having seasonal variations from zone to zone, within zones, within colonies and from floor to floor (Zerah 2000). Rohilla et al. (1999) reported that the cantonment area in the central southwest with a lower population density got 509–650 lpcd (litres per capita daily), while some northwestern and northern areas with high population density received as less as 25–31 lpcd. Delhi's villages, however, spread over 50 per cent of the area, covering west, northwest and North Delhi, got less than 5 percent of the water consumption for the city.

In the absence of access to organized sources of drinking water supply, a large proportion of the households in the peripheral areas depend upon hand pumps or tubewells that are not safe sources (Kundu 2008). Studies have shown the presence of coliforms of faecal origin in a majority of samples collected for observation; microbial contamination of groundwater is known to be widespread and even deeper layers of groundwater may not be regarded as free from disease-causing microorganisms (Sharma et al. 2003). This is understood to be a major factor in explaining the incidence of epidemics and variety of skin diseases in the peripheral towns, especially in the low income and slum areas. Several waterborne diseases such as cholera, diarrhea, and gastroenteritis are known to be a common cause of poor health and high morbidity in developing countries. Sharma et al. (2003) note Cholera to be endemic in Delhi and its peripheral areas. Children under the age of five constituted about 33 percent of the cases in their study. The male:female ratio was 1.5:1. Enhanced surveillance, however, helped to reduce the figure from 48 percent in 2003 to 37 percent in 2005.

Diminishing access of periurban residents to water: implications for quality of life

Within the South Asian region, the growth of cities has been led by a mix of factors at various levels. On the one hand, neo-liberal policies have given greater space to large transnational corporations; governments are introducing policies for a greater involvement of private corporations, such as policies for the establishment of special economic zones in India; at the same time, local networks and alliances at various levels have given a boost to these processes. Cities like Gurgaon and Hyderabad in India have grown rapidly in the post-liberalization era, encouraged by government policies to allow a greater role for private enterprise. A similar trend of urban expansion is noted in other rapidly expanding parts of the region, such as Khulna in Bangladesh and the Kathmandu valley in Nepal.

As the demand for the water in the cities in the region has grown, they have looked farther and farther afield for their water sources; the phenomenon of acquiring water from other uses, notably agriculture, in cities like Kathmandu, Ahmedabad and Chennai and also in smaller towns and urban centres has become common (Meinzen-Dick 2000). Water transfers may be private, unplanned and ad hoc, with individual well owners pumping water into tankers to be sold in the city, or public and planned, with water districts taking water from villages for selling to the city, with or without compensation for the villages. For Kathmandu, Shrestha & Shukla (2010) reported 116 water tanker entrepreneurs operating 217 water tankers in the Kathmandu valley, transporting water to the residents of the city to meet the city's water supply-demand gap. Much of this water, as reported by Shrestha, carries metals beyond safe and permissible levels for human consumption.

However, it is not simply that periurban residents lose access to water as it is physically transported to the cities, but also that the water resources at their own locations may be pre-empted by the resource rich who are able to afford extraction from deep aquifers. Urbanization processes often bring the urban elite into the peripheries, looking for cheap land or other avenues in which to invest their surplus financial resources. They can afford costly water extraction technologies, depriving the locals of access to this resource. For instance, in a village called Sadhraana in periurban Gurgaon in the state of Haryana, the local residents have been left chasing the water table as farm-houses – a major 'rural' land use of the 'urban' elite – have pre-empted the groundwater using submersible pump-sets, digging much deeper than the local residents (Narain 2010). This has placed the resource out of the reach of the small and marginal farmers. When the groundwater underlying their farmhouses is saline, the farm-house owners have bought small parcels of land overlying the fresh groundwater and transported groundwater through underground pipes to their farm-houses over distances of 2–3 kms. The falling water table has rendered domestic hand-pumps useless and increased the distance walked by women to collect water for their household needs, adversely affecting their quality of life and severely restricting their choice of sources for water collection. Thus, the appropriation of water for more 'urban' uses impacts on health and well-being not only in terms of the incidence of disease, but also in terms of women's increased drudgery and time spent collecting water.

This is clearly an outcome of the legal and institutional framework for groundwater access in India. There are no *de jure* rights in groundwater in India; but de facto, all landowners have the right to groundwater underlying their land. The Easement Act (1882) allows private usufructuary rights in groundwater by viewing it as an easement inseparably connected to land. The Transfer of Property Act 1882 provides that easements (in this case groundwater) can be given to one only if the dominant heritage (in this case land) is also transferred. Conversely, the Land Acquisition Act asserts that if someone is interested in getting rights over the groundwater, one would have to be interested in the land. Thus, groundwater is viewed essentially as a chattel attached to land. There exists, at the same time, no limit to how much water a landowner may draw, in contrast to a legal structure that specifies property rights setting absolute limits to collective and individual withdrawals. This legal framework is therefore considered conducive neither to equity, nor to sustainability in groundwater use and management. It implies that once the lands are acquired or once the land ownership changes hands, access to groundwater *de facto* changes hands as well.

The usual articulation of the rural-urban water problem is in terms of rural water supplies being pre-empted for urban use. However, to understand the implications of urbanization for periurban water use, one needs to look at the wider variety of ways in which urbanization affects rural water use, rather than the actual transfer of water from rural to urban areas alone. As cities grow and urban populations multiply, urban authorities typically respond through supply augmentation by creating additional water supply infrastructure. The supply of water to cities involves the development and building of water treatment plants that are usually built on land acquired from the peripheral villages. When periurban residents lose this land, they also lose access to water sources located on those lands – such as tubewells, which are an important source of water not only for irrigation but also for drinking and other domestic purposes. Similarly, when water needs to be transported from distant sources to meet the requirements of the city, it is through canals and channels that pass through the peripheral villages and for which land is acquired from the peripheral areas. Once the land goes, the periurban residents lose access to sources of water that may be located on that land. In other words, periurban residents lose both land and water in order to provide water to the growing city (Narain 2010). Thus, the ecological footprint of the city spilling over into the rural periphery deprives the residents of the latter of access to water of a sufficient quality and quantity, with adverse implications for their health and well-being.

In a village called Sultanpur, in periurban Gurgaon, among the Panchayat land that was proposed to be acquired for the development of the Reliance SEZ (Special Economic Zone) was land over which was installed a water supply tank managed and operated by the PHED (Public Health and Engineering Department) (Narain 2007). This tank was the source of the drinking water supply for much of the village. With the acquisition of this tract of land for the development of an SEZ the villagers access to an important source of water supply. Besides, the acquisition of land for the construction of a highway also inconvenienced periurban residents of this village by affecting their routes and access to water sources. Since the local groundwater is saline, the residents of Sultanpur obtain water from a handpump at a distance of about 1.5 km on the other side of a railway track. With the construction of the highway, they had to divert their route to the point of water collection and walk a longer distance.

Not only do periurban residents live under constant uncertainty about the security of their tenure, but they also lose access to water on account of the withering away of social capital. When water users do not have access to their own sources of water, they borrow from those who do – however, the continual process of land acquisition and transformation in periurban areas may deprive them of their ability to mobilize these forms of social capital as they lose access to the land of their kith and kin. In general, social capital tends to be eroded in periurban locations, increasing the periurban residents' vulnerability to a diminishing and unsure water supply.

Very often water treatment plants to supply water to the city are located in the peripheral villages. This can have adverse impacts on local conditions. In a village called Basai in Gurgaon on the outskirts of Delhi a water treatment plant that was built to supply water to Gurgaon city was a mixed blessing for Basai's residents (Narain & Nischal 2007). On the one hand, it made available drinking water to the residents of Basai and provided irrigation to some farmers as well. On the other hand, the location of the water treatment plant caused the local water table level to rise, posing a threat to buildings in the region. Broken pipes and leaks from the water treatment plant led to an increase in the mosquito population and became a cause of several vector borne diseases. It was identified as a 'nuisance' by some of the village residents. Here, too, we notice the implications for the quality of human life.

Many industries are located at the edge of the city because the wastes that they produce rarely receive adequate treatment. Community members take advantage of the fact that in periurban areas the regulatory capacity of the government authorities is weak, particularly in those areas that are outside the municipal boundaries (Parkinson & Tayler 2003). The location of factories near the boundary of the Shahpur Khurd village in Faridabad on the outskirts of Delhi, researched by the author of this paper, was identified as a perpetual source of noise and groundwater pollution; the untreated wastes from the factories found their way into the groundwater aquifers (Narain & Nischal 2007). These factories had been relocated from Delhi and were identified as a nuisance by periurban residents. Residents complained of a vibrating sensation in the ground throughout the day caused by their operation. They strongly felt that these factories should be located at least a certain distance away from the village, and particularly from religious places. The relocation of these factories at the village periphery contaminated village aquifers with pollutants, rendering them unfit for human consumption. The factories also discharged their wastes into local village ponds, reducing their attractiveness and usefulness as local water sources.

The above illustrations show the variety of ways in which urbanization processes erode the access of periurban residents to sources of water of a sufficient quality and quantity. The impact on human health and well-being results not only from the consumption of contaminated water and reduced access to safe water – as is commonly thought – but also, and even more so, from making the tasks of collecting water more strenuous and difficult for periurban residents. The usual narrative of the rural-urban water problem holds that villagers are losing water to the city. This narrative needs to be rephrased to understand that the loss of periurban resident's water is a result not so much of the diversion of water, but rather of the acquisition of lands that support urban expansion. Policies for improving health in periurban locations need to take cognizance of the flows of water between rural and urban areas and use that as a basis for planning interventions.

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