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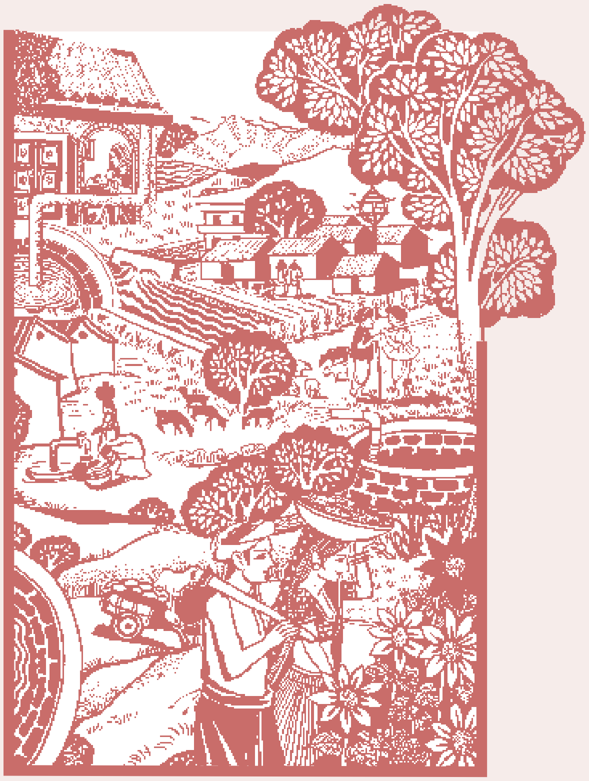
IWMI-TATA Water Policy Program



Growing Indian cities have the potential to support their peri-urban futures by providing irrigation water for food production. Over 1.1 million ha of land could be irrigated if the city waters are rendered safe for use. While the practice of periurban agriculture using city water is not a new phenomenon in India, its full potential has not been fully explored, due to poor/marginal quality and lack of adequate institutional arrangements and dialogue for its effective use. It is timely that inter-sectoral dialogue is focussed towards developing a well-integrated water development plan for cities, which includes irrigation water as well.

Water Policy Research

HIGHLIGHT

Cities as Sources of Irrigation Water:

An Indian Scenario

Priyanie Amerasinghe, Mahesh Jampani and Pay Drechsel

Cities as Sources of Irrigation Water: An Indian Scenario[1]

Research highlight based on Amerasinghe et al. 2012[2]

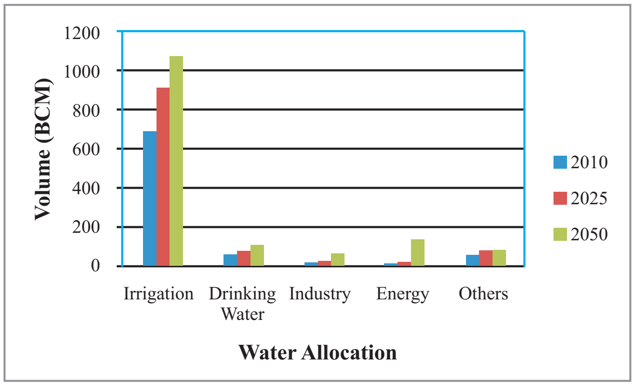
Introduction

Growing Indian cities have the potential to support their peri-urban futures by providing irrigation water for food production. Scientific evidence from world over indicates that urban/peri-urban landscapes are already responding to food price hikes influenced by unstable economies (Zezza et al. 2010). While the practice of peri-urban agriculture using city water is not a new phenomenon in India, its full potential has not been fully explored, due to poor/marginal quality and lack of adequate institutional arrangements and dialogue for its effective use (Scott 2004; Water Policy Briefing 2006; Amerasinghe et al. 2012). There are multiple sources of water in cities, which, if harnessed and stored, can become a valuable resource to complement irrigation water demands, especially in and around the cities. Such storage structures will have an added benefit of recharging the existing ponds and lakes as well as groundwater aquifers that are highly exploited and underreported, recover nutrients and reduce greenhouse gas (GHG) emissions in cities. Two main sources would be the domestic water supply, where nearly 70 -80 percent is returned to the environment, and rainwater, which often leads to urban flooding due to concretization of surfaces and inadequate capacities in storm water drains. This highlight is about the role of "Cities as Sources of Irrigation Water" and looks at population growth and related water demand, consequent irrigation potential, livelihoods and contribution to city food production. It specifically explores the potential irrigable land in and around cities, linked to the domestic/industrial water supply.

Water availability and population growth

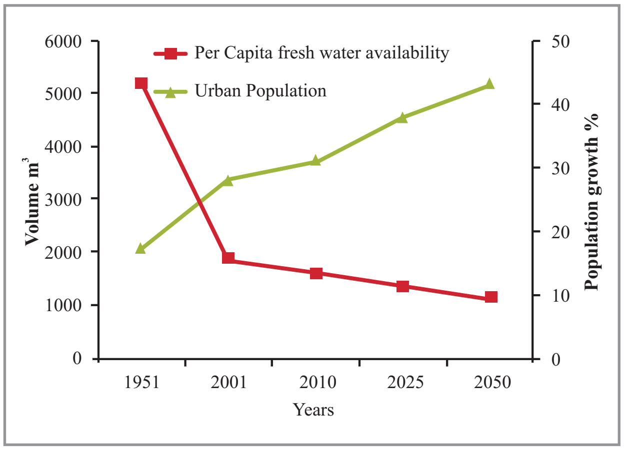
The waterscape in India is changing in response to population growth (increased water supply for domestic use and food production) and climate change phenomena. Country's utilisable water supply is estimated at 1123 BCM, with a contribution of 690 BCM from surface water and 433 BCM from ground water (CWC 2010). While the water demand projections are showing an increase for both irrigation and domestic use (Figure 1), the actual availability of water for irrigation is decreasing, with a demand gap of around 250 BCM (by 2050) (MoWR 2011), coupled with overall reductions in capita availability of fresh water (Figure 2). These overall trends call for prudent management of water resources, while planning for increased food production, especially to meet the demands of its people, and cities are no exception.

Figure 1 Water demand projections for India



Source: CWC 2010

Figure 2 Projected population growth and per capita fresh water availability for India

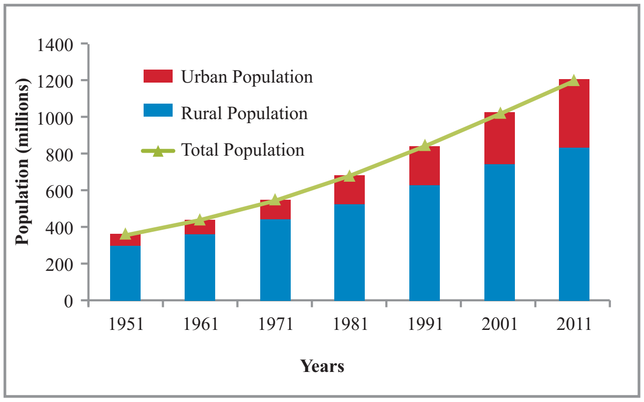


[1]This IWMI-Tata Highlight is based on research carried out with support from the International Water Management Institute (IWMI), Colombo. It is not externally peer-reviewed and the views expressed are of the authors alone and not of IWMI or its funding partners.

[2]This paper is available on request from p.reghu@cgiar.org

It is well documented that urban growth is occurring at a faster rate in the less developed than in developed countries (UN 2012). By 2030, more people will live in urban settings than in rural areas. A similar trend is seen in India, according to the latest census, where 31 percent of the population of India living in urban centres already (CoI 2011) (Figure 3). Seventy-percent of these people are in ‘Class 1 Urban Agglomerations (UA)’, which suggests that there is a growing potential to generate volumes of water that can be easily collected and stored for peri-urban usage. Further, census towns have increased from 1362 to 3894, indicating a high level of movement of people, who will demand for more domestic water, thus pointing to a large irrigation potential that may be waiting to be exploited for sustainable, resilient cities. Thus, developing appropriate storage structures, assessment of quality of water and adoption of safe reuse practices, for appropriate uses (WHO 2006; CSE 2011), in an integrated water management plan, can pave the way for workable solutions for city level food production.

Figure 3 Decadal urban and rural population trends in India



City waters and the peri-urban landscape

City waters have an impact on both the cities and its peri-urban landscape. Peri-urbanization is a phenomenon that is occurring all around us, and it is said that Indian rurality is fast diminishing with improved communication and transport. The definitions and typologies may vary (Brook et al. 2003; Narain and Nischal, 2007), however, in general, the cities that are growing fast, exhibit dynamic changes in their peri-urban landscapes, which is significantly influenced by the activities of the city centres. While, the changes in infrastructural, social, economic and political fronts can only be explained contextually, in the Indian context, agricultural production is witnessing the greatest changes, as it affords ready markets , livelihoods for the poor and a whole host of other fringe benefits (Buechler et al. 2002; Qadir et al. 2010). It has been observed that peri-urban agriculture is dominated by high value horticultural crops, cereal crops (rice), fodder crops, fruit orchards floriculture and in some cases aquaculture.

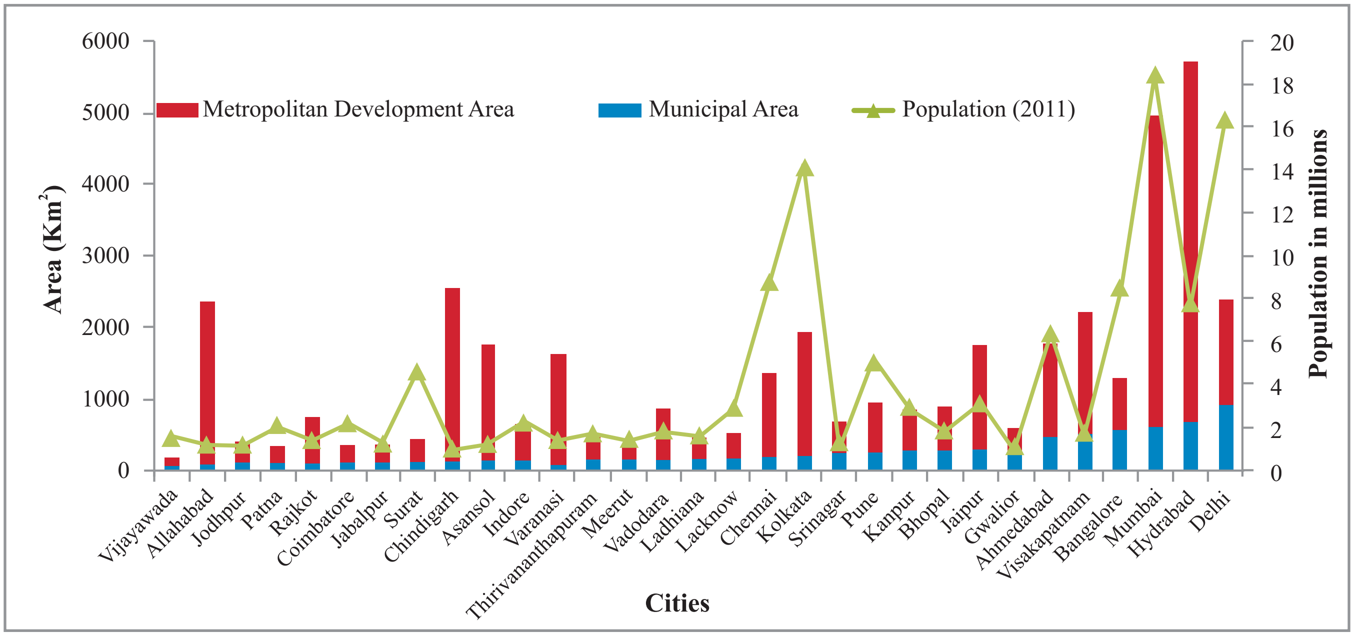
Peri-urban spaces that benefit from city waters can be studied by looking at the city development plans. For instance, the city boundary of Hyderabad was expanded in 2008, from 58 km^2 to 650 km^2, and has a metropolitan development perimeter of nearly 5000 km^2 (Figure 4). The Musi river which has been converted to a perennial river owing to the city waters, can irrigate over 10,000 ha of agriculture land along its peri-urban river banks. Thus, the metropolitan development areas can be one type of peri-urban space that can be easily studied for impacts of city waters. In 30 cities with over 1 million population, the spatial expansion patterns were not linked to the size of the city nor the population, and the area ranged from 110 – 5000 km^2, with Vijayawada and Hyderabad at two extremes (Figure 5). The drivers and dynamics of such spatial planning will become increasingly important, in implementing the government’s recent peri-urban vegetable initiative to feed the cities and support urban producers (MoA 2011). The Rs.300 crore[3] (1 $= Rs.43, 2011) peri-urban vegetable initiative, is a collaborative effort of the Horticulture Mission, Horticulture Board and Department of Agriculture, implemented by the state, and is aimed at building resiliency in food security, especially during volatile economic conditions and rising food prices. The programme provides incentives for urban and peri-urban clusters to produce perishable horticultural crops, and provides support for marketing and value addition.

Figure 4 City of Hyderabad with Greater Hyderabad Municipal Corporation (GHMC) and Hyderabad Metropolitan Development Authority (HMDA).

Source: Google Earth. Accessed in October 2012

[3]One crore = 10 million

Figure 5 City administrative and metropolitan development areas of 30 cities having a population more than 1 million



Sources: Municipal websites and personal communication of city authorities

Estimating the irrigable land using city waters

Assessments on wastewater irrigated agriculture and livelihood benefits of wastewater are complex. Estimates of potential irrigable land using simple or complex methods have been attempted (Raschid-Sally 2010; van Rooijen et al. 2010). Ideally, estimation of potential irrigable land with wastewater will require a number of parameters, including crop types, soil quality, climatic conditions, and water quality. However, very little information is available on such data in the public domain for cities.

In India, the wastewater collected through the sewerage network systems is a mixture of domestic water, storm water and industrial effluents. The total wastewater generation for the country has been estimated at 38254 mld including Class I cities (498), Class II towns (410) and coastal cities (35) CPCB, (2009). Currently, there is treatment capacity for only 11,787 mld. Based on the information collected from selected case studies of major cities, it was found that treated wastewater supplied through piped systems can irrigated around 6 ha per mld (Amerasinghe et al. 2012). However, when wastewater is emptied to open water ways, estimations can become more complex, as it mixes with other streams of water, and irrigable land area increases up to 39 ha per mld. Cumulatively, the total wastewater generated (treated/untreated) can irrigate around 1.1 million ha of land in urban and peri-urban settings, if released to water ways. Most Indian cities discharge their city waters into natural waterways (Table 1). In 30 cities with over 1 million population, the wastewater generated ranged from 108 – 3520 mld. Assuming that 50 percent of the generated wastewater will be used for farming, about 1.6 lakh[4] ha could be irrigated (Table 1). Even if coastal cities where most of the wastewater enters the ocean are disregarded, still about 1.21 lakh ha could be irrigated or the wastewater perhaps used for aquaculture. While these figures can be over or under estimations, it gives a rough idea of the volumes of city water potentially available for specialized high-value irrigated agriculture in city proximity, and the share of fresh water which could be transferred from agriculture to urban needs.

Table 1 Potential Irrigable land with wastewater, in 30 cities, with over 1 million population.

City	WW Disposal	Sewage generated (mld)*	Potential irrigable land with WW (ha)**
Rajkot	Nyari and Aji Rivers	108	982
Coimbatore	Noyyal River	128	1164
Jabalpur	Narmada and Pariyat Rivers	144	1309
Gwalior	Swarnarekha and Morar Rivers	152	1382

Vijayawada	Krishna River	164	1491
Visakhapatnam	Bay of bengal	176	1600
Meerut	Kali River	184	1673
Jodhpur	Jojri River	184	1673
Srinagar	Dal Lake and Jhelum River	184	1673
Asansol	Damodar River	188	1709
Allahabad	Yamuna and Ganga Rivers	200	1818
Vadodara	Vishwamitri River	216	1964
Indore	Khan River	218	1985
Varanasi	Ganges river	262	2385
Chandigarh	Canals to Ghaggar River	264	2400
Patna	Ganga River	288	2618
Ludhiana	Buddha Nallah and Canals to Satluj River	332	3018
Bhopal	Lakes and to Betwa River	360	3273
Lucknow	Gomti River	440	4000
Kanpur	Pandu and Ganga Rivers	480	4364
Pune	Mula-Mutha River	624	5673
Jaipur	Canals to Dhund River	640	5818
Surat	Tapi River	680	6182
Bangalore	Vrishabhavathi and Dakshina Pinkini Rivers	792	7200
Ahmadabad	Sabarmati River	824	7491
Chennai	Bay of Bengal	880	8000
Hyderabad	Musi River	1024	9309
Kolkata	Hooghly River	1300	11818
Mumbai	Mithi River	2702	24567
Delhi	Yamuna River	3520	32000

*80 percent of water supply to the city. **irrigable land if 50 percent of wastewater generated is utilised for agriculture; Irrigation requirement for horticultural crops was assumed at 55 m^3/day/ha

Livelihoods and health impacts

The primary users of city waters are smallholder farmers living in cities as well as peri-urban areas. In southern regions, rivers have become perennial because of city waters, and farmers use it because of ready availability (Buechler and Mekala 2005; Qadir et al. 2010). In a world-wide survey it was revealed that, more livelihoods are likely to be sustained through informal than formal wastewater-related activities (Raschid-Sally and Jayakody 2008), primarily due to lack of institutional support, and poor water quality. Across the country, wastewater is used for all types of cereal and fodder crops, fruit orchards and floriculture, but horticultural crops are by far the commonest, because they provide quick economic returns. In some cities, aquaculture is also popular, notably the East Calcutta Wetlands, that receive large amounts of city water. Financial benefits doubled when okra (Abelmoschus esculentus) was cultivated during the summer season, using treated wastewater in Delhi. Income from milk production also doubled for farmers who used wastewater for fodder production. However, an inventory of wastewater dependent livelihoods is lacking in order to assess the wastewater-driven economies within India. Case studies from Delhi and Kanpur show that wastewater irrigated crop cultivation was more profitable than using groundwater. Most farmers state that cost savings on inputs, especially fertilizer is a boon, as evidenced by field studies (Amerasinghe et al. 2012). Thus, the nutrient value (NPK) of 5000 mld municipal water from coastal Class I cities and Class II towns, at INR 1,091 million (wastewater, INR 76 million; nutrients, INR 1,015 million) (CPCB 2009), shows the value of wastewater that contributes towards costs savings for the farmer. While these estimates are theoretical, it heralds the recognition of city municipal water as an important resource.

While the municipal water is a useful source of irrigation, it can also carry many hazard agents that are injurious to human health (Drechsel et al. 2010). A number of studies from Delhi, Varanasi and Kanpur have shown the presence of biological and chemical contaminants, in water, soil and crops (Amerasinghe et al. 2012). Public health concerns have been raised over high prevalence of helminth ova in commonly consumed vegetables like mint, lettuce, spinach, celery and parsley. Farming communities in Hyderabad had helminth infections that were associated with the wastewater farming. Overall, morbidity rates were also higher for wastewater farmers in Hyderabad, compared to the control group that used groundwater for irrigation (Srinivasan and Reddy 2009). Elevated levels of heavy metals (Cd, Pb, Ni, Cd, Cr, Cu, Fe, Mn, Ni), have been detected in plants and soils of wastewater irrigated plots. Urine and blood samples of wastewater farmers in Kanpur had heavy metals and pesticides, indicating that there are health impacts that need to be concerned with. Therefore, safe irrigation practices must be adopted to minimize direct and indirect health impacts to farmers as well as consumers (Bos et al. 2010). Capacity building and training on safe use of wastewater must be adopted across a wide group of stakeholders, including the farmers (WHO 2006). In this regard, the regulatory bodies have a key role to play ensuring that water for food production is rendered safe.

Towards inter-sectoral dialogue and policy support

Today, the Planning Commission of India recognises urban and peri-urban agriculture as part of the agriculture economy, and supports it through a policy process. A well-integrated city water programme can boost the food production, and will provide the safe irrigation water that is much needed in cities. This can be spatio-economically designed to encompass the peri-urban areas so that areas for irrigation can be expanded. Further, if safe use of city water is promoted, it can support kitchen gardens with micro-drip and sprinkler irrigation, which will become a boon to women who engage in urban horticulture and floriculture. Affordable micro-irrigation kits can also be targeted at scale using local self-help groups and schools. However, such programmes require inter-sectoral planning between the urban authorities, agriculture/horticulture departments and also the regulatory authorities, such as the pollution control, health and sanitation divisions. This exercise can strengthen the real-time assessment of water generation from cities, aided by geographic information systems (GIS) (Amerasinghe et al. 2009) and hydrological/hydrogeological modelling (van Rooijen et al. 2010), to see how a city-based irrigation systems can be developed for sustainable irrigation futures of urban and peri-urban areas.

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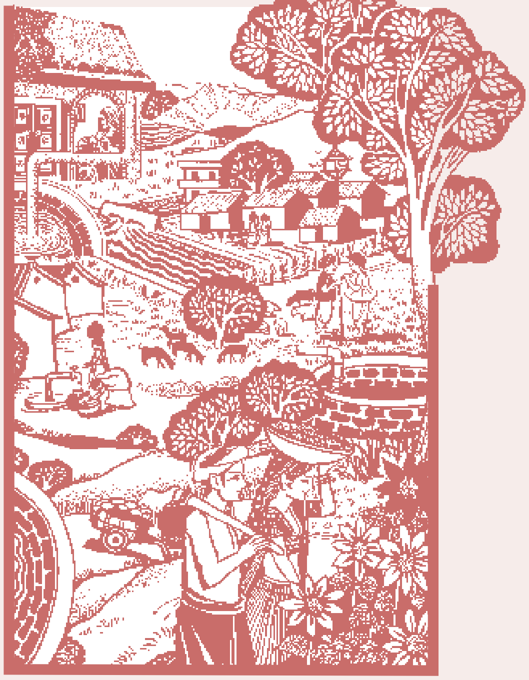

About the IWMI-Tata Program and Water Policy Highlights

The IWMI-Tata Water Policy Program (ITP) was launched in 2000 as a co-equal partnership between the International Water Management Institute (IWMI), Colombo and Sir Ratan Tata Trust (SRTT), Mumbai. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resource management. Its objective is to help policy makers at the central, state and local levels address their water challenges – in areas such as sustainable groundwater management, water scarcity, and rural poverty – by translating research findings into practical policy recommendations. Through this program, IWMI collaborates with a range of partners across India to identify, analyze and document relevant water-management approaches and current practices. These practices are assessed and synthesized for maximum policy impact in the series on Water Policy Highlights and IWMI-Tata Comments.

Water Policy Highlights are pre-publication discussion papers developed primarily as the basis for discussion during ITP's Annual Partners' Meet. The research underlying these Highlights was funded with support from IWMI, Colombo and SRTT, Mumbai. However, the Highlights are not externally peer-reviewed and the views expressed are of the author/s alone and not of ITP or either of its funding partners.

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