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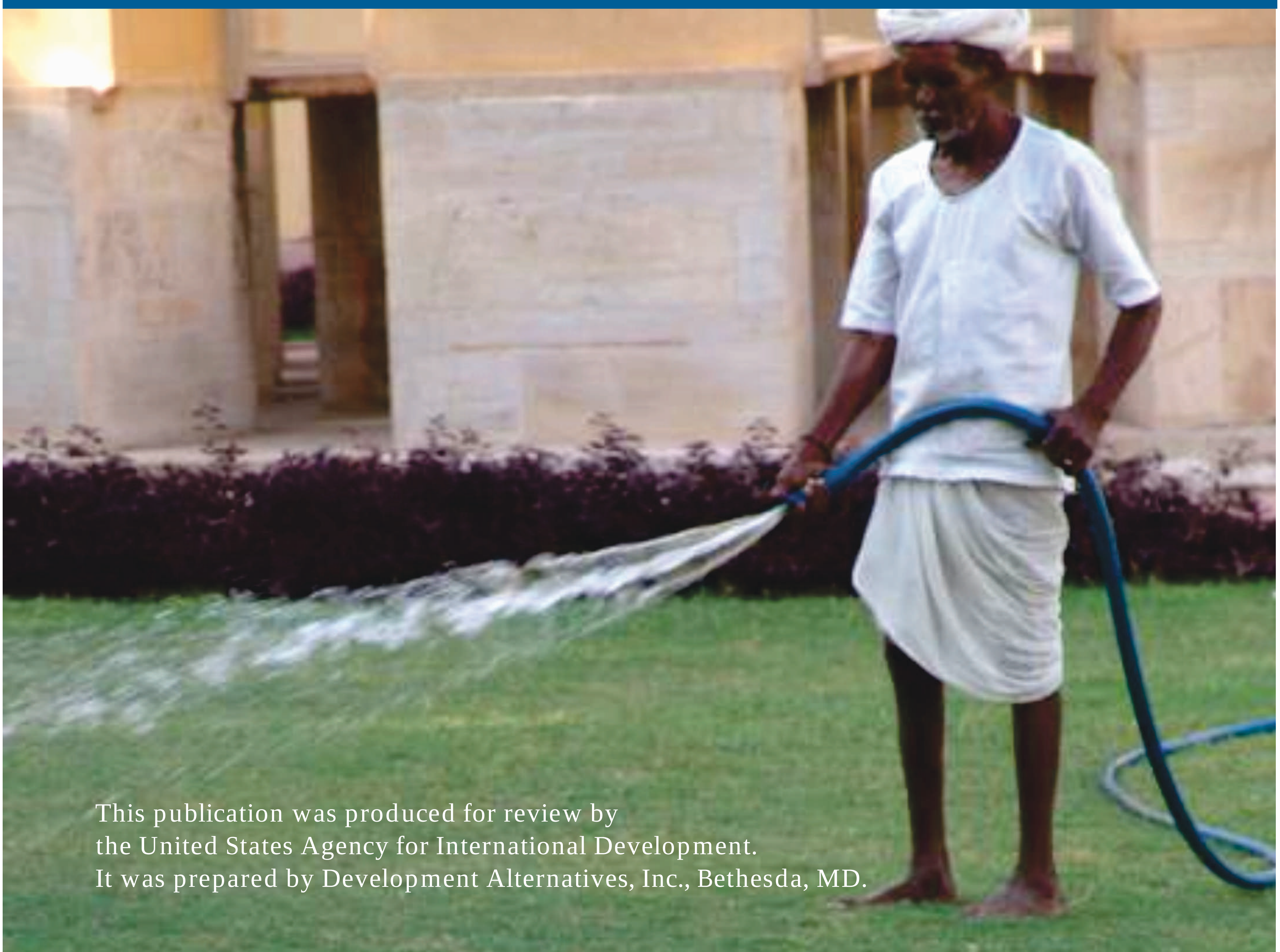
Municipal Water Use Efficiency Guideline
A Review of Three Cities:
Faridabad, Jaipur, and Pune

Water Analysis, Systems, and Innovations Program



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Cover photo: Watering a public garden by handheld hose in Jaipur. Photograph by Bahman Sheikh.

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ABBREVIATIONS AND ACRONYMS

AIILSG	All India Institute of Local Self Government
CGWB	Central Ground Water Board
CII	Confederation of Indian Industries
DAI	Development Alternatives, Inc.
ECBC	Energy Conservation Building Code
GoH	Government of Haryana
GoI	Government of India
GoR	Government of Rajasthan
GRIHA	Green Rating for Integrated Habitat Assessment
HSIDC	Haryana State Industrial Development Corporation
HUDA	Haryana Urban Development Authority
IGBC	Indian Green Building Council
IPCC	Intergovernmental Panel on Climate Change
JDA	Jaipur Development Authority
JMC	Jaipur Municipal Corporation, known as Jaipur Nagar Nigam (JNN)
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
LEED	Leadership in Energy and Environmental Design
Lpcd	Liters per capita per day
MCF	Municipal Corporation of Faridabad
MLD	Million liters per day
NAPCC	National Action Plan on Climate Change
NWM	National Water Mission
NRW	Non-revenue water
PHED	Public Health Engineering Department
PMC	Pune Municipal Corporation
RWH	Rainwater harvesting
RSEP	Rajasthan State Environmental Policy
RSPCB	Rajasthan State Pollution Control Board
RO	Reverse Osmosis
SAPCC	State Action Plan on Climate Change
SLB	Service Level Benchmark
STP	Sewage (Wastewater) Treatment Plant, also known as water pollution control plant (WPCP)
SEZ	Special Economic Zone
SWPR	State Water Policy Rajasthan
USAID	United States Agency for International Development
WAISP	Water Analysis, Innovations, and Systems Program
WC	Water Closet (also, Bathroom, Restroom, Toilet)

I. INTRODUCTION

WAISP Background

The Water Analysis, Innovations, and Systems Program (WAISP) is a project funded by the U.S. Agency for International Development (USAID/India). The overall goal of the program is to increase the security of potable water supply and sanitation services by building resilience to global climate change, and advance sustainable approaches to provision of multiple use water services for potable and productive applications.

WAISP began by conducting a water sector assessment of seven states in India, which looked specifically at water vulnerability in relation to climate change, food security, and health (available as a separate report completed June 2011). The program then carried out three city-level analyses for ways to improve water efficiency in representative cities—Faridabad, Jaipur, and Pune, which were identified as having potential for national replication.

For USAID/India, the inter-linkages between water resources and climate change, food security, and health are of paramount importance. India faces multiple challenges relating to competing uses of scarce water resources—between household and municipal consumption, agriculture, industrial, and ecosystem services. Furthermore, projected impacts of climate change indicate a higher variability in precipitation, with more frequent droughts and floods, and general stress on the hydrologic regime. Unrestricted groundwater exploitation by all sectors in the absence of adequate regulation and pricing is already severely impacting water scarce areas.

India faces multiple challenges relating to competing uses of scarce water resources-between household and municipal consumption, agriculture, industrial, and ecosystem services... Unrestricted groundwater exploitation by all sectors in the absence of adequate regulation and pricing is already severely impacting water scarce areas.

For the second program component, WAISP conducted a series of consultative meetings with USAID, the Confederation of Indian Industry's (CII) Triveni Water Institute, and officials within various municipalities. The guiding principles for selecting Faridabad, Jaipur, and Pune were: (1) water scarcity with high potential for growth; (2) feasible within a one-year time frame; (3) likelihood of donors and the municipalities to follow-up with longer-term initiatives based on the results; (4) interest to focus on the interface across the urban built environment and industry; (5) linkages with CII's networks for follow-up.

The results of WAISP's second component are presented in three separate reports, one for each city—Faridabad, Jaipur, and Pune—as a Guideline for Water Use Efficiency. This Review of Three Cities report presents a summary view of all three. In it, we present salient findings and trends from research, surveys, and stakeholder consultations with respect to existing water and sanitation infrastructure, potential climate change vulnerabilities, the legal framework, and survey results. The final section suggests priority opportunities to improve urban water use efficiency drawing on the experience from these three city-level exercises. Notwithstanding differing local conditions across the country, many of these opportunities are relevant for other cities. Indeed, the guidelines are designed to serve as a decision-support resource for municipal, state, and national officials in India to better understand and address water resource constraints facing the country.

National Context

The Draft National Water Policy of June 2012 states: "Even while it is recognized that States have the right to frame suitable policies, laws and regulations on water; there is a felt need to evolve a broad over-arching national legal framework of general principles on water to lead the way for essential legislation on water governance in every State of the Union and devolution of necessary authority to the lower tiers of government to deal with the local water situation."

Water is a "State" subject in India, which means that the states are free to pursue their own policies regarding its use, and have exclusive power to legislate on this subject.[1] The central government provides funds to states from its budget to improve water resource management and has an advisory role in this sector, which flow from the issuance of guidelines. The Draft National Water Policy of June 2012 states: "Even while it is recognized that States have the right to frame suitable policies, laws and regulations on water; there is a felt need to evolve a broad over-arching national legal framework of general principles on water to lead the way for essential legislation on water governance in every State of the Union and devolution of necessary authority to the lower tiers of government to deal with the local water situation (GoI, 2012a)."

Furthermore, the Government of India's Approach Paper for the 12th Five Year Plan (2011) observed "It is necessary to match our use, through improvement in efficiency, with the annual replenishable water supply that the country receives. Available evidence suggests that with increased use of water, mostly on an unsustainable basis, the country is headed towards a grave water crisis" (GoI, 2011a). The Approach Paper commented "…the real solution has to come from greater efficiency in water use." It also emphasized the need to set up a National Water Commission (NWC) to monitor compliance with the national water strategy.

Following this approach, the Draft Twelfth Five Year Plan (2012-2017) released by the Planning Commission, Government of India (GoI) has analyzed the water situation generally, and in the specific context of industries. The Plan document quotes estimates of the "2030 Water Resources Group" which indicates that if current demand patterns continue, about half of the demand for water will be unmet by 2030, and therefore recommends a paradigm shift and reform agenda to address the challenge. Inter alia this shift includes "definite targets for recycling and reuse

[1] However, the national Parliament has the power to legislate the regulation and development of interstate rivers.

of water by Indian industry to move in conformity with international standards" (Planning Commission, GoI, 2012)." The agenda for reforms in the 12th Plan will have four thrust areas:

- Agenda 1: Focus on demand management, reducing intra-city inequity and on quality of water supplied
- Agenda 2: Protection of water bodies
- Agenda 3: Water supply scheme conjoined with a sewage component
- Agenda 4: Recycling and Reuse of Treated Wastewater

Additionally, the Plan document acknowledges the need for industries to adopt best international practices to improve water use efficiency. It suggests two ways in which this can happen:

- Reducing the consumption of fresh water through alternative water-efficient technologies or processes in various manufacturing activities; and
- Reusing and recycling wastewater from water intensive activities, and making the reclaimed water available for use in the secondary activities.

City Profiles

Faridabad, Jaipur, and Pune are situated in the states of Haryana, Rajasthan, and Maharahstra, respectively. Faridabad is located in the southeastern part of the state, 32 Km from Delhi, with the Yamuna River flowing very near the city along its northern side, moving away as it travels south. Faridabad developed as an industrial city after partition, and currently 20% of the city area is occupied by industries. The present Municipal area of Faridabad is 208 km^2, and has remained constant since the establishment of the Municipal Corporation of Faridabad (MCF) in 1992. Of this area, 156.79 Km^2 is urbanized. Faridabad is divided into 107 sectors; 89 come under the MCF, while Haryana Urban Development Authority (HUDA) administers the remaining 18 sectors. Apart from providing basic infrastructure in developing a sector, HUDA also maintains these areas for five years. If such sectors fall under the jurisdiction of MCF, assets are later transferred to MCF for maintenance. However water supply,

Figure 1: Location of Jaipur, Faridabad, and Pune

sewerage, and waste management functions are the responsibility of MCF from inception, irrespective of whether it is administered by MCF or not.

Jaipur, the capital of Rajasthan, is the tenth largest city in India. The Jaipur Development Authority (JDA), established in 1982, is responsible for infrastructure development within the city area of 288.4 km^2. Tourism is the most important economic activity as it is among the most important tourist destinations in India. In addition to the direct economic contribution of the hospitality industry, tourism has an important multiplier effect on other commercial activities and service industries. Textiles and gem polishing are also important industrial activities. In Sanganer municipal zone in the southern part of Jaipur city, dyeing and block printing is a household industry. The block prints are famous throughout India for the dyeing technique used. This activity consumes a lot of water, and the wastewater generated presents challenges.

Photo: Bahman Sheikh

Stream near fabric dyeing industries with heavily polluted water used by nearby farmers for irrigation

Pune city, the second largest metropolitan city in Maharashtra and the ninth largest in India, is considered the cultural capital of the state. Over the last century, Pune has transformed itself from an educational-cultural center to a major industrial hub. The automotive sector is prominent in Pune, with domestic and international firms manufacturing here. All segments of the automotive industry are represented, from two-wheelers and auto-rickshaws, to cars, tractors, tempos, excavators, and trucks. Information technology and higher education are the two other major drivers of change in Pune city's economy.

Table 1 provides an overview of the geographical area and population of the three cities.

Table 1: Area and Population of Faridabad, Pune and Jaipur

Feature	Faridabad	Pune	Jaipur
Area (sq km)	207.88	243.87	288.4
Population as per 2011 Census	1,404,653	3,115,431	3,073,350
Density of Population (per km^2)	6,757	12,775	10,656

2. WATER INFRASTRUCTURE AND CLIMATE CHANGE

Water Supply

The water supply infrastructure in Faridabad and Pune is managed by the respective Municipal Corporations, whereas in Jaipur the Public Health Engineering Department (PHED) is responsible for supplying water to the city. Faridabad depends primarily on groundwater as its source of water. This was also the case in Jaipur until some years ago when the pipeline from Bisalpur dam, 117 km away, was completed. Even so, the wide variations in inter-year rainfall can affect supply availability significantly. The supply falls short of gross demand in Faridabad and Jaipur, especially if the demand from the industrial sector is taken into account.

Pune, on the other hand, has had the topographic advantage of being located in a valley, which has access to four water reservoirs, providing for adequate supply. However, in 2012 less than normal rainfall resulted in an unusual scarcity situation which prompted the Pune Municipal Corporation (PMC) to adopt a number of austerity measures. Average supply rates also do not reveal the intra-city disparities, particularly in slum areas and unauthorized developments. For instance, PMC officials indicate that the supply varies from 40 liters per capita per day (Lpcd) in some parts of the city, to 400 Lpcd in others. Table 2 provides key aspects of water supply status in the three cities.

Table 2: Water Supply Status

Description	Faridabad	Jaipur	Pune
Sources of water	420 tubewells and 2 Ranney wells along Yamuna river bed	Bisalpur dam and 1897 tubewells	Four dams at Panshet, Varasgaon, Temghar, Khadakwasla
Total Water Demand (MLD)	387	419.7	420.58
Total Water Supplied (MLD)	240	413.0	732.0
Per capita supply (liters/day)	140	85	194

Another key concern is the proportion of non-revenue water (NRW)[2], which is estimated to vary between 30% for Pune and Jaipur, and as high as 52% in the case of Faridabad. If accurate, this would essentially mean that nearly one-third to half of the water that is pumped, treated, and distributed for supply does not reach the end user. This represents a potentially large cost to the utility operations.

[2] NRW is water produced for supply, that is lost before reaching an end user. Losses may be technical (such as network leakage), or administrative (such as illegal connections).

In addition, the extent of metering varies widely: Jaipur reports nearly universal metering, but the proportion of metered connections was as low as 30% in Pune. The failure to measure consumption necessarily debilitates effective water supply management and weakens cost recovery. Taken together, NRW and unmetered connections, have serious implications on the efficiency of the water supply system and its ability to improve service and reliability in the long term. The GoI stipulates a Service Level Benchmark (SLB) for NRW at 20%, as well as 100% metering (GoI, 2008a). National government support is available through the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), a flagship program providing incentives for reforms in municipal administration and basic urban services to meet these benchmarks.

Table 3: Non-Revenue Water and Metering

Feature	Faridabad	Pune	Jaipur
Non-Revenue Water (est.)	52.7 %	30 %	36 %
Metered Connections	52 %	29.7 %	98 %

Wastewater Treatment and Reuse

There are no reliable data available on actual volumes of sewage generated in Indian cities. A gross estimate of sewage generated is made by assuming that 80% of water supplied in the system would be converted into sewage. Computing these figures suggests that the installed capacity in all three cities falls short of requirements by a wide margin (Table 4). This is exacerbated by the shortfalls in percentage of the population covered, which remain very high in Faridabad and Jaipur. The SLB set by GoI for access by municipal properties to sewage networks is 100%.

Table 4: Sewerage Treatment Infrastructure

Description	Faridabad	Pune	Jaipur
Installed capacity (MLD)	160	527	202 (work on additional 60 MLD in progress)
Estimated volume of sewage produced (80% of water supplied in MLD)	192	585	330
Estimated % households with access to sewerage line	50	97	65

The national benchmark for wastewater reuse is 20% and some efforts to reuse wastewater have been made. PHED Jaipur has started work on laying a pipeline to transport one million liters of treated wastewater per day from Delawas sewage treatment plant (STP) to the Mahindra Special Economic Zone (SEZ) nearly 20 km away, for reuse as part of a public-private partnership project. Elsewhere in Jaipur, about 34 million liters per day (MLD) of treated wastewater from two STPs are being directed into Man Sagar Lake, which had previously been choked by silting and untreated wastewater flows. In one large garden maintained by Jaipur Municipal Corporation (JNN-Jaipur Nagar Nigam), treated wastewater is being used for irrigation: the Jawahar Circle garden has an in situ tertiary treatment plant of one MLD capacity, which uses bio-reactor technology. The JDA and JNN are working together to scale up this initiative.

On a smaller scale, some "green building" projects for private housing in Pune are including small-loop recycling systems with dedicated sewage treatment plants. However, in Faridabad there is very little evidence of any systematic initiative in this regard, except for individual real estate companies who are installing dual plumbing as part of water conservation efforts. Dual plumbing allows for graywater reuse (wastewater from kitchen sinks and showers) for garden irrigation, for example.

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Summary of Climate Change Vulnerability

Globally, the issue of sustainable freshwater availability is expected to be exacerbated by climate change (Bates, 2008), and the adverse impacts of a changing climate makes achieving development objectives all the more difficult. Locally, the hydrologic profiles of Jaipur, Faridabad, and Pune are unique, but all exhibit various forms of climate-related vulnerabilities[3] in the short and long-term, most notably in water-scarce Jaipur.

The Intergovernmental Panel on Climate Change (IPCC) developed a set of scenarios for greenhouse gas emissions in the future world taking into account different directions of demographic change, economic development, and technological change. Four different storylines called A1, A2, B1, and B2 were developed with different assumptions. Of these storylines, the A1 scenario family describes a future world of very rapid economic growth, global population that

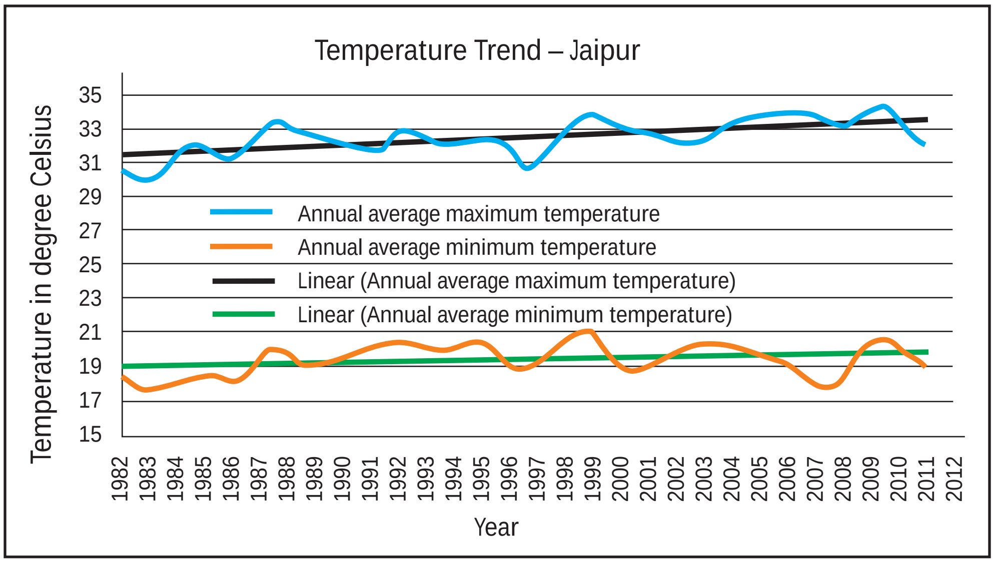
[3] The IPCC 2000a publication defines vulnerability as "the extent to which a natural or social system is susceptible to sustaining damage from climate change, and is a function of the magnitude of climate change, the sensitivity of the system to changes in climate and the ability to adapt the system to changes in climate."

An analysis of one-day extreme rainfall series based on historical meteorological records in India showed an increase in intensity of extreme rainfall over Gujarat (Saurashtra and Kutch), East Rajasthan, coastal Andhra Pradesh, Orissa, West Bengal and parts of northern India (Indo-UK, 2012).

peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies (IPCC, 2000). The A1 scenario family further develops into three groups describing alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B).

Climate change scenarios for India under the A1B scenario of emissions project a warming on the order of 0.5^0 to 1.5^0C in the 2020s and up to 3^0C in the 2050s, against the baseline of the 1970s. Climate models further project that the maximum warming is expected over the northern parts of India and over the Himalayas (Indo-UK, 2012), with an increase in seasonal (monsoon) rainfall of 10% in the 2020s and 15-20% in the 2050s against the 1970s baseline. An analysis of one-day extreme rainfall series based on historical meteorological records in India showed an increase in intensity of extreme rainfall over Gujarat (Saurashtra and Kutch), East Rajasthan, coastal Andhra Pradesh, Orissa, West Bengal and parts of northern India (Indo-UK, 2012). The study also concluded that there was a significant decrease in intensity as well as frequency of rainfall over Chattisgarh, Jharkhand, and some parts of north India. Warming trends as indicated by average maximum and minimum temperatures in Jaipur are show in Figure 2.

Figure 2: Jaipur Temperature Trends 1982-2012



It is important to note that significant variability in forecasts can occur across the different storylines, and based on different scales of analysis (such as global, regional, local). For purposes of the three city Guideline reports, in order to assess the water resource-related vulnerabilities due to climate change, climate events affecting water resources for Faridabad, Jaipur, and Pune were first identified. Then, the probability of occurrence of these events in each city was determined. The probability of occurrence is the likelihood that such an event may occur, based on a scale of low/medium/high, as presented in Table 5. Upon determining the nature of the likely impacts from these events, the municipality's preparedness to mitigate these impacts, is considered.

Table 5: Probability of Occurrence and Impacts of Certain Climate Change Events for Faridabad, Jaipur, and Pune

Climate Events	Probability of Event	Potential Impact	Vulnerability	
			Short-term (2020s)	Long-term (2050s)
Scanty rainfall in rainy seasons	**Faridabad - Medium** **Jaipur - Low** **Pune - Medium**	• Reduced groundwater recharge • Drought	**Faridabad - Medium** **Jaipur - Medium**	**Faridabad - High** **Jaipur - High**
Wetter non-rainy seasons	**All - Low**	• Water logging • Floods	**All - Low**	**Jaipur - Medium** **Pune - Medium**
Hotter summers	**Faridabad - Medium** **Jaipur - Medium** **Pune - Medium**	• Reduced groundwater recharge • Drought	**Faridabad - Medium** **Jaipur - Medium**	**Faridabad - Medium** **Jaipur - High**
Storms and intensive rainfall	**Jaipur - Medium** **Faridabad - Medium** **Pune - Low**	• Water logging • Floods • Reduced groundwater recharge	**Faridabad - Medium** **Jaipur - Medium** **Pune - Medium**	**Faridabad - High** **Jaipur - High** **Pune - High**

Reduced Recharge

The level of groundwater exploitation in India presents a cause for significant concern. Among the cities studied, Pune had the only safe level of groundwater development[4] at 70%, while Faridabad is over 90%, and Jaipur is a severely problematic 600% (GoI, 2006a, and Sunda, 2012). While Jaipur already withdraws groundwater at an unsustainable rate, Faridabad is trending in the same direction, even if less severe. Recharge depends primarily on annual rainfall and canal seepage. Moreover, as recharge rates reduce, water quality deteriorates. Jaipur already reports high concentrations of fluoride and nitrate pollution, as well as salinity in some areas, while Faridabad has also reported increased salinity levels.

[4] Percentage of annual groundwater draft to net annual groundwater availability.

Solutions to curb overexploitation include restricting groundwater extraction and new drilling, and increasing artificial recharge through rainwater harvesting and channeled percolation. For its part, the Government of Rajasthan has declared that drilling tube wells is strictly prohibited in its overexploited "dark zone." The Groundwater Department of Government of Rajasthan and Jaipur Development Authority have also vigorously promoted rainwater harvesting, though more is required to ensure the efficacy of these investments to achieve the intended results. In sum, since reduced recharge is a problem associated with three of the four climate change impacts noted in the above table, and all three cities face medium level vulnerabilities in the short term, and medium to high vulnerabilities in the long-term, this looming threat is an important one to address. This assumes greater significance, since its seriousness is still not perceived by many residents of these cities.

Droughts

The Ministry of Agriculture has classified Faridabad as a chronically drought affected area, due to deficient monsoon rains, groundwater overexploitation, and insufficient freshwater availability.

The Indian Meteorological Department defines "meteorological drought" as a situation when the deficiency of rainfall at a meteorological sub-division level is 25% or more of the long-term average of that sub-division for a given period. The drought is considered 'moderate', if the deficiency is between 26% and 50%, and 'severe' if it is more than 50% (Dourte, 2012). The impacts of drought can be loss of crop and livelihood, among others.

The Ministry of Agriculture has classified Faridabad as a chronically drought affected area, due to deficient monsoon rains, groundwater overexploitation, and insufficient freshwater availability. It ranks drought impacts as "moderate," though with greater warming in the 2020s and 2050s, the water demand-supply gap is expected to increase. Future population growth would further increase the vulnerability of the city.

In Jaipur, the situation is worse – it experiences drought once every five years according to estimates in the Drought Management Manual of the State of Rajasthan (GoR, undated a). The manual outlines steps to manage drought situations, addressed at the state level, with local level implementation. Therefore, preparedness seems strong for scenarios for the 2020s, while the management plans will need to be revisited for later years. For its part, Pune has low vulnerability to drought, the situation in 2012 notwithstanding. However, in the future, competing demands for water from other regions sharing Pune's current sources may present vulnerabilities.

Waterlogging and Floods

Climate models for India suggest that, in the future, the quantum as well as intensity of monsoonal rainfall is expected to increase, with greater vulnerability in 2050s than in the 2020s. Floods in urban areas can occur during monsoons due to extreme storm events, inadequate drainage planning, choking of drainage systems, and unplanned growth or settlements.

In the eastern boundary of Faridabad, the Yamuna River causes recurrent floods, and there are also several *nallahs* (local streams) that flood. Excessive rainfall, excessive discharge of water from upstream dams, dam bursts and flashfloods upstream of the Yamuna can also result in flooding. The Disaster Management Plan of the MCF ranks impact from flooding as "high", and the City Development Plan of Faridabad acknowledges the inadequacy of storm water drainage networks. Efforts are underway to address these service gaps, but keeping up with population growth will pose an increasingly stiff challenge to these initiatives.

Although the State of Rajasthan lies in a semi-arid region, there have been instances of floods in many areas during the monsoons. In the Flood Management Manual for State of Rajasthan, Jaipur is classified as a flood prone area as it falls in the basin of the Banas River, though it tends to drain well (GoR, undated b). However, in August 2012, Jaipur experienced a downpour of 170 millimeters of rainfall in a period of two hours.[5] The highest such rainfall witnessed since 1981, the event caused flooding and water logging in several parts of the city.[6]

In Pune, 10 of the last 15 years have yielded more than the average rainfall (TuTiempo, 2012). Development in the city has occurred in unsuitable areas along drainage banks, and other land use changes have decreased tree cover and increased the quantity of paved area. While flooding may not be widespread in the city during rainfall events, in some areas, this has reduced water absorption to the ground and contributed to storm drain flow from runoff, straining drainage systems in some areas. Vulnerability to water logging and flooding, therefore, is considered "medium" in the short run.

[5] See http://www.indianexpress.com/news/flood-in-rajasthan-jaipur-goes-under/995105

[6] See http://economictimes.indiatimes.com/heaviest-rainfall-in-31-years-floods-jaipur/articleshowpics/15613625.cms

3. LEGAL AND POLICY FRAMEWORK RELATED TO WATER USE EFFICIENCY

Water is a "State" subject in India, but related legislation and policies span many institutions at the national, state, and local levels. There is some discussion about transferring water to the "Concurrent" list, which would empower greater central government authority on the topic.[7] For their part, of the three cities reviewed, all have progressive policies and laws of various kinds that encourage water use efficiency and conservation. Despite many existing measures to promote water use efficiency, the lack of a holistic regulatory and institutional framework leads to an ad-hoc and uncoordinated implementation approach. In addition, weak enforcement mechanisms and economic instruments mean that policies often do not generate the intended results. This suggests that improvements can be made particularly with respect to streamlining and clarifying institutional roles and responsibilities, and focusing on effective implementation.

Indeed, an effective legal framework requires four principal elements: (1) standards; (2) management control tools to apply the standards, such as licensing or permitting; (3) enforcement monitoring, complete with an established frequency as well as a reporting mechanism; (4) meaningful sanctions, or consequences for non-compliance. These can be supplemented with well-conceived incentives that encourage behavior change and provide the support needed to facilitate compliance and ensure the success of such policies.

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Starting from the central level, under India's National Action Plan on Climate Change (NAPCC), the National Water Mission (NWM) is one of the eight national level strategy documents to address water management under a changing climate scenario. The NWM recommends identifying water efficiency improvement as one of the principal measures to improve resilience to the adverse impacts of climate change and has the stated goal of increasing water use efficiency by 20 percent. In addition, the Ministry of Water Resources has announced its intention to launch the National Bureau for Water Use Efficiency. The proposed methods to improve water use efficiency under the NWM are as follows:

- Label water efficient products (similar to the energy efficiency certification provided by the Bureau of Energy Efficiency).
- Minimum standards for water use for commercial buildings (similar to the Energy Conservation Building Code (ECBC) which sets minimum energy performance standards for commercial buildings). Use of water efficient fixtures

[7] See for example "Parliamentary panel suggests putting water in concurrent list": India Water Review; July 13, 2012 (Source: http://www.indiawaterreview.in/Story/TopNews/parliamentary-panel-suggests-putting-water-in-concurrent-list/778/15

can be made mandatory in all new construction and remodeling involving replacement of plumbing fixtures in government buildings and commercial complexes.

- Highlight the impacts of savings through using water efficient products so that the general public becomes conscious about adopting these products.
- In the presence of proper water tariffs, water savings can be directly linked with cost savings and thus could be an incentive to adopt water efficient fixtures.
- Provide incentives to save water using labeled products.
- Enact laws which would make it mandatory for the consumers to adopt water saving devices and also ensure strict monitoring for quality parameters.
- Assess the market potential of water saving products and the possibility of public private partnerships.
- Funds may be ring fenced (protecting the transfer of assets) for developing water saving measures and assisting potential stakeholders and investors.

Much of this is reinforced by the Environmental Impact Assessment notification 2006 (amended in 2009), of GoI, which pertains to environmental approvals for all large construction projects in the country (GoH, 2006; GoH, 2008). The Ministry of Environment and Forests has issued a manual with applicable norms and standards, applied at the state level (GoI, 2010). This includes measures relating to low flow WCs, discharge standards for treated wastewater, rainwater harvesting (RWH) systems, among others.

The 12th Five Year Plan proposes to make water audits a "recurring feature" of industrial activity as a first step toward improving water use efficiency in the industrial sector. The Planning Commission is working with leading representatives of Indian industry and the Ministry of Corporate Affairs to make it mandatory for companies to include details of their water footprint in their annual report.

At the implementation level, the central government also offers support to states through the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), a national flagship program launched in 2005 to upgrade social and economic infrastructure in cities and provision of basic services to urban poor, among other reforms. The JNNURM provides budget support on a shared basis to the respective urban local bodies to implement these reforms and to achieve service level benchmarks (SLBs) including in water supply and sanitation. In this sense, JNNURM has been a driver of change in the sector. All three cities reviewed receive support from JNNURM.

The 12th Five Year Plan proposes to make water audits a "recurring feature" of industrial activity as a first step toward improving water use efficiency in the industrial sector. The Planning Commission is working with leading representatives of Indian industry and the Ministry of Corporate Affairs to make it mandatory for companies to include details of their water footprint in their annual report. Simultaneously, the Planning Commission is also working with other government institutions to develop benchmarks for specific water use in different industries, which would be considered while granting approvals for industrial projects. The second step proposed is determining charges for water use based on graduated, volume-based rates, with incentives incorporated for RWH and reuse practices. The third step would be public validation of the industrial water audits and tracking compliance with industrial commitments for water use reductions through environmental regulatory institutions.

Summary of the State and Municipal Legal Framework for Faridabad, Haryana

Faridabad is the only town in the State of Haryana where the Municipal Corporation is responsible for water supply rather than the Public Works Department. MCF is responsible for the provision and implementation of all core municipal services, including water supply and sewerage, in its jurisdictional area. However, MCF shares its responsibilities for the provision of services with other agencies, including the Housing and Urban Development Authority (HUDA), the Town and Country Planning Department, the Haryana Housing Board, the Haryana State Industrial Development Corporation (HSIDC), etc. In addition to this, Faridabad is one of the National Capital Region cities (NCR), and therefore subject to the National Capital Region Planning Board Act, 1985 under the Ministry of Urban Development, GoI. Understandably, the multiplicity of agencies and the consequent overlap and fragmentation of roles and responsibilities is one of the basic issues complicating effective municipal water resources management.

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The NCR Regional Plan 2021, which was approved and notified in 2005, lists a large number of projects involving Faridabad with suggested policy changes, strategies and implementation plans. It includes proposals in the water sector as well as for sewerage, solid waste management, and drainage. On top of this, the Central Ground Water Board (CGWB), Faridabad has a presence in the city and performs a host of functions including monitoring ground water observation wells for quantity and quality, hydrological and hydro-meteorological studies, water balance studies and regulation of groundwater.

CGWB classified the Municipal Corporation of Faridabad and Ballabhgarh as a 'notified area' for control and regulation of groundwater in 1998 (GoH, 1998). Rainwater harvesting was declared mandatory in all institutions and residential colonies in notified areas for more than the last decade. For its part, the MCF has declared that rainwater harvesting is mandatory in all new buildings with rooftop areas of 100 m^2 or more since 2006-2007 (GoI, 2006b, 2006c). The Haryana Urban Development Authority (Erection of Buildings) Regulations, 1979 were amended in 2001 to make rainwater harvesting mandatory for construction of buildings on plots allotted by HUDA with a roof area of 100 m^2 or more (HUDA, 2001, bylaw 81A), but WAISP's survey suggested that compliance with these guidelines remains poor. Apparently 150 rainwater harvesting structures were to be constructed in accordance with the detailed project report to augment water supply in Faridabad, of which 117 have been completed and 13 are in progress. According to a news report, MCF has constructed around 110 rainwater harvesting pits. While nearly 70 pits are in working condition, the remaining 40 lie defunct. In a few cases, rainwater harvesting pits were properly constructed in buildings but not systematically attached for groundwater for recharge.

The CGWB has also banned new tube well drilling in notified areas, but has no powers to ensure compliance (UNESCAP, 2012). The Haryana State Groundwater Management and Regulation Bill, 2008 considers it "essential to undertake groundwater recharge through rainwater harvesting and using water from other sources in all residential, commercial and other premises and open spaces in the manner prescribed" (Section 23). The draft law requires local authorities to impose a condition for providing appropriate rainwater harvesting structures in the building plans having rooftop areas of 500 m^2 or more. The Bill, however, has not been adopted yet.

...the Haryana State Groundwater Management and Regulation Bill, 2008 recommends that authorities formulate guidelines for recycling and reuse of treated wastewater by all infrastructure developers, special economic zones (SEZs), multiplexes, and industrial and housing societies.

State government regulations regarding reuse and recycling of water are less explicit, being more advisory in nature, as recommendations. For instance, the Haryana State Groundwater Management and Regulation Bill, 2008 recommends that authorities formulate guidelines for recycling and reuse of treated wastewater by all infrastructure developers, special economic zones (SEZs), multiplexes, and industrial and housing societies. The Action Plan for Abatement of Pollution formulated by Haryana Pollution Control Board for Faridabad includes recycling and reusing treated industrial effluents. Similarly, the strategies described in the Industrial and Investment Policy of Haryana (2011) includes efficient use of water resources, and re-cycling wastewater (GoH, 2011).

Additionally, the Haryana State Urban Water Policy 2012 intends to achieve water conservation by preventing wastage from open or leaking faucets and unmetered connections. It has proposed mandatory metered connections to all consumers within a period of one year from the date of notification of the policy (30 April, 2012).

Summary of the State and Municipal Legal Framework for Jaipur

Measures to improve water efficiency have been given a fair amount of consideration over the past decade in Rajasthan State, and continue to receive greater attention in light of the acknowledgment of the water crisis facing the city of Jaipur. The State Water Policy of Rajasthan (SWPR, 2010) has numerous provisions promoting water use efficiency. For the industrial sector, the SWPR proposes water recycling facilities and the use of treated urban sewage water for cooling and other processes. It also proposes a water audit program for all industries. Similarly, the Rajasthan State Environmental Policy (RSEP) 2010 supports mandatory water audits of water utilities and industries (as does the Rajasthan State Action Plan on Climate Change—SAPCC, 2011). The RSEP includes the assessment of NRW, and mandatory water metering for water-intensive industries as mechanism to assure conservation. The JDA (Jaipur Region Building) Regulations, 2010 also provides for wastewater recycling (regulation 8.15). In addition, JNN and JDA have been pursuing recycling and reuse in a limited manner for garden irrigation purposes. The Rajasthan Industrial and Investment Promotion Policy (2010) also acknowledges the benefits of dual-flush toilets, water efficient showerheads, graywater reuse for irrigation, and dual plumbing systems to separate wastewater from graywater to facilitate reuse, among other approaches.

The State Government of Rajasthan has strongly supported RWH, and has made it compulsory for all new and existing buildings and government offices on plots over 300 m^2 to install RWH systems. To promote RWH, the Rajasthan government has introduced a system of incentives and has drafted proposals for disincentives. The State Government has also sought to make rainwater harvesting mandatory for industries.

Summary of the State and Municipal Legal Framework for Pune, Maharashtra

The Maharashtra Groundwater (Development and Management) Bill, 2009 also has great potential to promote water conservation by enjoining state authorities to issue necessary guidelines for rainwater harvesting to recharge groundwater...

There are a number of laws in Maharashtra that relate to or affect the potential for water and wastewater recycling and reuse, and water use efficiency in particular cities. At the most general level, this includes legislation like the Maharashtra Jeevan Authority Act, 1976, which prohibits any consumers of municipally supplied water to cause or allow it to be wasted. The Maharashtra Groundwater (Development and Management) Bill, 2009 also has great potential to promote water conservation by enjoining state authorities to issue necessary guidelines for rainwater harvesting to recharge groundwater (Section 9). This Bill was passed in 2012, but is not yet notified. One pre-reform legislation credited with some success, is the Maharashtra Groundwater (Regulation for Drinking Water Purposes) Act, 1993 (Phansalkar, 2006). It is one of the earliest attempts in the country to directly link the regulation of access to groundwater with drinking water in order to prevent overexploitation.

Pune Municipal Corporation has become proactive in pursuing water conservation measures, as evidenced during the 2012 drought. For example, PMC banned the use of drinking water and groundwater for vehicle washing at car washing centers.

The PMC has also forbidden the sale of drinking water outside of city limits, which prevents private sector contractors from supplying unserved areas within the PMC, and also from diverting their cargo to customers outside the city. Using drinking water for building construction is also prohibited under the Bombay Provincial Municipal Corporation Act.

Another forward-looking step by PMC has been the “Eco-housing scheme”, established in 2008 under technical assistance provided by USAID. It is an incentive scheme for builders that has a set of mandatory and non-mandatory criteria relating to various environmental aspects of a housing development for residential buildings, building complexes, and single-family residences. PMC has also initiated steps to expand metering to cover to all water connections.

Recycling and reuse of water has been taken up by the city and state governments at different points of time during the last 15 years, but it is yet to be part of a comprehensive regulatory framework. However, there are some excellent wastewater management practices in place with private sector participation, from which important lessons may be drawn (The annexes of case studies to WAISP's city-level Water Use Efficiency Guideline reports provide details).

4. WATER USE SURVEY

Survey Methodology and Scope

WAISP designed and implemented a primary survey to supplement other primary and secondary data and qualitative information collected on water and wastewater trends in each city. The surveys assessed the pattern of water use within each city area across different segments of water users, including domestic and commercial (but not industrial). While it had a limited scope, the survey yielded valuable reinforcing information that, when taken in concert with other data sources and studies, suggest trends which may be helpful to decision-makers interested in identifying opportunities for water use optimization.

In each of the three cities the survey, conducted in October and November 2012, probed water use across 14 categories of water users, including households, commercial establishments, and educational and health institutions. The survey questionnaires used by the team during interviews were designed separately for each category of water use. The set of questions for the residential sector was more detailed because of its relatively larger role in urban water demand and consumption. Other categories of water users were administered shorter survey instruments, with varying types and numbers of questions in order to elicit the most relevant responses particular to those categories. The survey was designed by the WASIP team and carried out by the All India Institute of Local Self Government (AIILSG).

An overall target sample size of 500 per city was selected and divided among the various water using categories. The largest number of respondents was residential/domestic users (in all, 960), and the smallest number of samples were from swim clubs, laundries, and crematoria. The sample size is deemed sufficient for most categories to enable data analysis and factual enumeration of responses, though responses may not be representative of the sectors for which only a few surveys were conducted. Due to time constraints, it was not possible to collect certain kinds of quantitative data, such as leakage rates or actual costs paid for water. These factors notwithstanding, information gleaned from the surveys provide insights into current practices and trends, and provide lessons and help identify opportunities to improve water use optimization.

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Summary of Findings

Across the three cities, we found more similarities than differences with regard to general water use practices. All cities indicate a very broad scope to improve urban water use efficiency. Table 6 provides selected data on water use practices among the residential segment and six other segments of water users. The detailed data sets on water use among all 14 segments appear in the respective city reports.

Table 6: Summary data on water use

	User category	Faridabad	Jaipur	Pune
	A. Residential (% households reporting)			
1	Access to municipal water supply	81	97	97
2	Dependence on municipal supply	72	89	67
3	Metered connections	32	85	12
4	Functioning meters	73	96	72
5	Use of dual flush in toilet	6	9	7
6	Use of water filter for drinking	63	64	64
7	Garden/ potted plants	39	67	66
8	Ownership of vehicles	40	96	85
9	Vehicles washed	40	32	62
10	Ownership of washing machine	73	73	51
11	Own front-loading machines	18	10	20
12	Rainwater harvested	6	5	10
	B. Service stations (Numbers reporting)			
1	**Total No. surveyed**	**20**	**17**	**23**
2	Metered supply	10	13	3
3	Mechanised washing	6	5	4
4	Water reused/recirculated	6	7	4
5	Use of dual-flush in toilets	0	3	0
	C. Public gardens/parks (Numbers reporting)			
1	**Total No, surveyed**	**5**	**6**	**8**
2	Using municipal supply	0	3	8
3	Dual-flush toilets	0	1	0
4	Rainwater harvesting arrangement	2	4	1
	D. Hotels (Numbers reporting)			
1	**Total No. surveyed**	**19**	**23**	**20**
2	Using municipal supply	12	13	20
3	Metered supply	10	14	14
4	Water audit done	6	19	3
	E. Transport hub (Numbers reporting)			
1	**Total No. surveyed**	**4**	**5**	**5**
2	Using municipal supply	2	5	5
3	Metered supply	1	5	2
5	Dual flush toilets	0	1	0

Table continued on next page...

	User category	Faridabad	Jaipur	Pune
	F. Shopping malls (Numbers reporting)			
1	**Total No. surveyed**	**4**	**4**	**4**
2	Using municipal supply	0	2	4
3	Dual flush toilets	0	3	0
4	Watering of garden with hand-held hose	3	3	2
5	Opportunities to recycle water	1	3	1
6	Awareness of rainwater harvesting technology	0	2	1
	G. Health care facilities (Numbers reporting)			
1	**Total No. surveyed**	**30**	**32**	**27**
2	Using municipal supply	28	18	27
3	Metered connections	20	18	11
4	Water use audited	10	23	8
5	Treated waste water reused	10	11	2

The surveys bolster recommendations supported by other conclusions drawn from the identified climate change vulnerabilities, strengths and weaknesses of the legal and policy framework, and other studies. The salient findings are presented below, with summary inferences immediately thereafter.

1. Most customers surveyed in the residential segment (81% – 97%) have access to municipal water supplies, but the degree of total dependence varies across cities, as rows A1 and A2 in Table 6 indicate. Those who do not and those who receive an inadequate volume, resort to their “own” sources, which includes direct groundwater extraction or purchasing from tankers, which also taps groundwater. The deficiency in municipal supply encourages uncontrolled and unsustainable overdraft of groundwater aquifers. Intermittent water service also causes concern with respect to water quality.
2. Very low levels of end-user metering –12% in Pune and 32% in Faridabad – does not enable billing along volumetric, graduated block-rate tariffs, which would improve water management and cost recovery. Even where meters exist, they are not necessarily functioning; the proportion of non-functional meters was reported to be around 28% in both Faidabad and Pune. Jaipur has done well in this regard, where 85% of the residents reported metered connections, and 96% of the installed meters were reportedly functioning. Flat rate tariffs and below-cost rates encourage water wastage. Consumers need a reason to conserve and improve efficiency, and market signals are critical to behavior change, such as repairing leaks and investing in water saving appliances and fixtures.

3. Nearly two-thirds of consumers treat their municipal drinking water supply (row A6 of Table 6), perceiving the quality to be inadequate or unsafe. Those with the financial capacity to do so filter water with granular media, ceramic filters, disinfectants, or reverse osmosis (RO) membrane filters. In most cases, point-of-use treatment also generates a certain percentage of water loss from filter backwash or RO brine reject.
4. Unregulated fixtures and appliances result in excessively inefficient water use. The lack of flow data and labeling does not allow consumers to make informed choices to conserve water. For example, “rain” showerheads, promoted to the upscale market as a luxury by merchants, are not uncommon in top hotels and high-income households. Flush toilets are another example where huge potential exists to direct developers and consumers to much more efficient dual flush models. As Table 6 shows, use of dual-flush cisterns is very low in homes as well as in public toilets, and this includes Jaipur – a “water-aware” city.
5. Over 30% of schools and government offices use pour flush toilets, and these tend to provide poor sanitation and hygiene. Upgrading WCs would contribute to improvements in health indicators. Provision of dual flush systems, particularly if coupled with graywater reuse, would preserve optimal water efficiency.
6. Hand-held irrigation of gardens and landscapes is too widely prevalent and results in uneven, inefficient, and excessive water use in nearly all sectors.
7. Manual vehicle washing is also prevalent, despite being inefficient and resulting in significant water waste. This is especially problematic at bus depots and railway stations, where buses and coaches are washed by hand. The survey noted that wash water simply drains to municipal sewers, while opportunities exist to treat this water for on-site reuse for washing. It is costly and inefficient to utilize drinking quality water for this purpose.
8. Urbanization has resulted in the expansion of impervious surfaces, further limiting groundwater recharge. In some areas, appropriately designed rainwater harvesting systems may reduce this impact. However, RWH is practiced effectively by only a minority of customers.
9. A general lack of awareness about the value of water, scarcity of water, and the need for conservation is a big factor in continued use of inefficient practices and technologies.
10. Areas with small and medium-sized enterprises often do not properly treat effluents. For instance, the survey noted that, where printing and dyeing units within residential areas discharge directly to municipal drains, this may impact the functioning of treatment plants. Decentralized common effluent treatment units offer potentially viable alternatives.

Photo: Bahman Sheikh

Water-wasting “rainshower” in a 3-star hotel bathroom

Residential Buildings

Most residents rely on municipal water supply
Fewer residents rely exclusively on a private water source (borehole, dug well or tankers)
Municipal water service is not completely metered, and not all meters are functional
Fixtures and appliances are purchased on the basis of aesthetics and affordability, with no regard to efficiency
The majority of residents wash dishes under running water – use of dishwashers is limited
Few residents have rainwater harvesting systems
Most residents treat their water; reverse osmosis appears to be a preferred method
Most residents use single-flush toilets (WCs) or manual pour flush toilets
Top-loading washing machines are more prevalent than more efficient front loading machines
Home gardens are mostly watered by hand
Some residents wash vehicles using a hose or bucket
Water intensive desert coolers are used for air conditioning

Schools

The majority of schools receive water from the municipal network – but not all
WCs are mostly generally single flush or pour flush
Very few schools have invested in rainwater harvesting systems
Schoolyard landscaping is irrigated mostly by hand-held hose
Some school vehicles are washed by hand with water

Photos: AIILSG

School drinking water taps with automatic shut-off in Pune

School drinking water taps left open

Religious Facilities

Most surveyed religious facilities' water services are not metered, except in Jaipur
WCs are mostly single or pour flush
Landscaping is watered manually
Majority of staff and worshippers are not aware of the need for water conservation, except in Pune

Healthcare Facilities

Most surveyed healthcare facilities' water services are metered, except in Pune
WCs are mostly single or pour flush systems
Very large volumes of water are used for dialysis at healthcare facilities
Nearly all healthcare facilities, except in Pune, treat water before use through filtration and/or reverse osmosis
Many facilities maintain large landscaped areas that are watered manually
Hospitals invest in water audits, awareness programs, and water reuse to some extent

Service Stations

All surveyed service stations' water services are metered in Faridabad and Jaipur, but none in Pune
Most service stations offer manual car washing service
WCs are mostly single or pour flush models
Some stations are reusing water to varying degrees across these cities

Hotels

Over 60% of hotels receive water from the municipal network, though in Pune it is 100%
A high percentage of hotel water supply is metered across these cities
Hotels invest in audits and awareness programs and practice water reuse
A large percentage of hotels use in house water treatment prior to use
Only upscale hotels use dish washers
Except for Jaipur, most hotels in Pune and Faridabad used single flush toilets
Water saving for urinals was prevalent in Jaipur and Pune, and considerably lower for Faridabad
Hotels use a mix of hand held hose, fixed and movable sprinklers to irrigate gardens

Restaurants

Most restaurants receive water from the municipal network in Pune and Jaipur, but the rate is much lower in Faridabad
Except in Pune, restaurants generally have metered connections
Quite a few restaurants treat water through filtration and/or reverse osmosis before use
Very few restaurants use dish washers, most wash dishes manually
Restaurant WCs are mostly single flush, flush valve, or pour flush systems
Very few restaurants invest in water saving urinals
Most restaurants clean WCs by washing with water, except in Jaipur where sweeping and mopping are practiced
Nearly all restaurant landscaping is watered manually
A small percentage of restaurants use running water to thaw food

Government Offices

Majority of Government offices have access to the municipal water supply
WCs at government offices are pour flush or single flush systems
Landscaping at nearly all government offices is watered manually by hose
A mix of hosing or wiping is used for cleaning government vehicles

Gardens and Parks

Not all gardens and parks are connected to the municipal water network
While all gardens have metered connections in Jaipur, none of have meters in Pune
WCs at parks and gardens are mostly single flush systems and pour flush buckets
Hosing is the prevalent mode for irrigation except in Jaipur, where sprinklers and drip irrigation is also used
Gardens in Jaipur demonstrated much higher rain water harvesting as compared to Faridabad and Pune

Transport Facilities

Except for Pune, surveyed facilities in Faridabad and Jaipur are not completely dependent on municipal supplies
Cleaning of buses and railway wagons is performed by manual hosing
Only airports have dual flush WCs, while single flush prevails at railways, and bus stops have a mix of single flush and pour flush
Generally, airports are mopped clean, railway platforms swept, and bus station floors washed with water
Toilets are mopped at airports, and washed at railway stations and bus stops
Use of water efficient urinals is restricted to airports

Shopping Malls

About half of the surveyed shopping malls have their own source of water
Use of WC's with single flush systems is predominant across the three cities
Most malls sweep their floors; few use water and mop
All malls use cooling towers
Landscaping at most of the malls is watered manually
Jaipur reported a much higher percentage level of recycling and reuse as compared to Faridabad and Pune.

Laundries

More laundries in Faridabad and Jaipur have access to municipal water compared to Pune
Top loading washing machines and manual laundries are most common
Most laundries do not reuse the laundry wastewater

Crematoria

All surveyed crematoria have access to municipal water supply
Not all connections are metered
WCs at Faridabad and Jaipur are dual flush, though Pune reported single flush
Landscaping at crematoria is watered manually

Swim Clubs

Nearly all of the swim clubs have their own source of water
Swim clubs routinely filter swimming pool water
Back wash from filters is discharged to municipal sewers

5. OPPORTUNITIES AND RECOMMENDATIONS FOR WATER USE EFFICIENCY

Based on WAISP's survey analysis and findings, extensive opportunities to improve water use efficiency exist across Faridabad, Jaipur, and Pune, many with applicability more broadly across India. WAISP particularly sought inter-related opportunities for action, noting potential projects, technology options, as well as legal reforms.

1. **Legal and Policy Instruments.** While several mechanisms are in place to encourage water conservation, policy makers should more thoughtfully consider specific instruments that will genuinely drive behavior change. This requires as much analysis regarding the type of mechanism as it does the level of incentive or penalty—otherwise consumers will maintain the status quo. One major priority area nationally should relate to labeling plumbing fixtures and appliances, and establishing flow standards. The reality of wholesale markets in surveyed cities is that even vendors of plumbing fixtures are unaware of the flow rates of the products they sell. These are sold on the basis of aesthetics and price alone, since consumers (and even vendors) generally have no information about their water efficiency.

   While India lags behind other countries in introducing water efficient technologies and enacting laws making them mandatory, the country would not start from scratch. The Bureau of Indian Standards (BIS) is the premier agency in India assigned the task of developing standards, marking, quality certification, and quality control on a wide range of products and processes. A few BIS standards prescribe guidelines and certify sanitary products like cisterns, commodes, faucets, etc.[8] While BIS standards are not binding, they can serve as a starting point toward achieving such standards. The energy Standards and Labeling Program of the Ministry of Power,[9] GoI which was launched in 2006 provides a good lesson in this regard. It is currently invoked for 12 appliances, for four of which, it has been made mandatory since January 2010.

   Moreover, voluntary standards such as from green rating certification programs like the Indian Green Building Council (IGBC) Green Homes, Leadership in Energy and Environmental Design (LEED) India, and Green Rating for

[8] *See*, for example, IS 774:2004 - standard for flushing cistern for water closets and urinals (non-plastic) cisterns; IS 2326:1987 - automatic flushing cisterns for urinals and IS 7231:1994 - specification for plastic flushing cisterns for water closets and urinals.

[9] http://powermin.nic.in/JSP_SERVLETS/internal.jsp

Integrated Habitat Assessment (GRIHA), also provide important model approaches from which to consider minimum requirements. Many opportunities, then, exist to improve water conservation through legal and policy reforms:

- Universal labeling requirements for water fixtures and appliances can be the first step toward establishing national standards for flow rates. This will begin to educate consumers and developers, and encourage vendors to stock these items. Rebates, taxes, and other economic instruments can be used to encourage or require efficient equipment, and discourage use of inefficient equipment and models, but these must be carefully designed in order to truly change behavior.

- As economic growth in India has accelerated, more families have been switching to flush toilets from manual systems. Studies of domestic water use indicate that 40 liters of the 135 Lpcd (30%) are used just for flushing. Less than 10% of households reported using dual-flush cisterns in their toilets (Row A5 of Table 6). In public toilets, the rate of use if dual-flush cisterns was even lower. Making these mandatory and providing incentives for their use, or disincentives for single flush systems, would have an important water conservation impact. Similar measures promoting waterless urinals and low-flush systems across institutional end-users would conserve vast quantities of water.

- As lifestyles are changing, washing machines are becoming a standard home appliance. The household survey shows that half to three-fouths of the households reported using washing machines (Row A11 of Table 6) and 80%-90% of these machines were the top-loading type, which typically consume more water. Discussions with the service engineers of a well- known consumer durable company revealed that a top-loading washing machine of 5kg capacity of that particular company requires about 30% more water (about 20 litres) per normal wash cycle, as compared to a front- loading machine of comparable capacity. However, the price of a front—loading machine is typically about Rs. 7,000 to

Photo: AIILSG

Variety of fixtures sold at wholesale market in Jaipur

Rs. 8,000 higher, and the demand for this category of goods is price-elastic. Water conservation campaigns, cost-based water tariffs, and tax rebates or other incentives can induce families to select water efficient appliances. The technical representatives informed that there is a product development process which is aiming to make the machines even more water efficient by reusing water within a wash cycle. Appropriate government policies can reinforce such eco-friendly initiatives.

- Policy mechanisms with technical and/or financial support for graywater reuse in new developments, and incentives for retrofitting existing developments, would encourage conservation. In particular, kitchen faucets generate graywater that can be reused within the household, for gardening, or in desert coolers.

- One important institutional measure would be to consider establishing water demand management units across urban water supply authorities. Such a unit could support municipal level conservation efforts through outreach campaigns, assist with enforcement, and engage users through technical assistance relating to fixtures, rainwater harvesting, graywater reuse, and other household or colony-level conservation initiatives.

- In addition, when the extent of metering is low—the survey indicates that 12% of households in Pune and 32% in Faridabad reported metered water connections—the consumers do not feel the need to acquire any information on flow rates, since they would not have to pay more for consuming more water. The World Bank had observed in 2006: “In the absence of systematic metering (only about 50% of the connections are metered) and because the poor reliability of meter reading in a non-permanent water supply situation, bills are often established on assessed consumption or simply on a lump sum basis …Revenues from residential customers are way below O&M costs: domestic tariffs are sufficient to cover only 10% of O&M costs in cities with metered consumption and 15% in cities with unmetered consumption.”

  The reforms in the Power sector in India provide a number of important lessons, which can be adapted to the water sector. Till 1996, electric power supply to domestic consumers in several states used to pay a flat tariff, because meters did not work for various resaons, After reforms in the power sector were implemented, metering became mandatory, and this is reported to have brought in efficiencies, both in the supply situation as well as greater consumer satisfaction because of more reliable supply.

2. **Water Recycling.** The survey of transport hubs—railway and bus depots—revealed that washing is typically done by hosing and the water is never reused. However, water used to wash railway coaches and buses in maintenance depots can be reused. The required technology would remove grease and dirt rather than full tertiary treatment to drinking water standards. The Jaipur Railway alone accesses 30 borewells in addition to municipal water supply for cleaning purposes. Washing a single coach requires, on average 230 liters of water, and approximately 190 coaches are washed daily. This consumes approximately 43,700 liters of water/day, and the effluent is discharged to common drains. Over the course of one year, waver savings could be equivalent to the volume in six olympic-sized swimming pools. This recommendation for water reuse is as applicable to any other city in India as Jaipur, and moreover, similar approaches may be taken at bus depots in washing buses. Our survey found that 100 to 200 liters of water are required to wash one bus. At one station in Faridabad (Ballabhargh), some 45 buses are washed daily. Again, less costly treatment for reuse is viable and highly replicable nationwide.

3. **Decentralized Small/Medium Enterprises Wastewater Treatment and Reuse.** Important small and medium-sized enterprises in cities represent multiple opportunities for engagement to improve water use efficiency. In Jaipur and Faridabad, for example, the textile dyeing and printing industry uses large volumes of water. The discharge from these units can be treated and reused by installing decentralized combined sewage treatment plants and reusing the water for alternate uses, including agricultural irrigation. Moreover, incentives for this already exist with the JNNURM program, whereby a combined state and national government subsidy of 50% is available. In Tamil Nadu, Tirupur has some good examples of treatment plants which have achieved zero discharge, and recover the brine solution essential for the dyeing process.

4. **Decentralized Residential Wastewater Treatment and Reuse**. Irrigation of public gardens presents an interesting opportunity to rethink multiple elements related to urban design. Over 100 public gardens in Pune, and 450 in Faridabad provide the opportunity for establishing decentralized wastewater treatment units to then enable wastewater reuse. Treated wastewater from nearby colonies could be treated on-site at the garden for in-situ reuse for garden irrigation. Space permitting, ecologically


Photo: AIILSG

Bus depot in Faridabad

sensitive approaches such as root zone treatment[10] could be considered on the premises of public gardens. Additions for rainwater harvesting and even groundwater recharge may be contemplated as appropriate for each location. As is being discussed in many water conscious cities around the world, it is not necessary to irrigate gardens with water treated to drinking quality standards.

5. **Awareness and Outreach**. It is necessary to substantially increase the level of awareness regarding the need for water use efficiency and conservation across all water users. India must move beyond the old ads to turn off faucets while brushing teeth or shaving, to really embrace meaningful change.

   The survey could not examine all faucets and toilets, but some leaks were observed and an estimated 10% of faucets in households in Pune were found leaking. A steadily leaking faucet leaking at a rate of 1.5 liters per hour, if undetected, can amount to a loss of 36 liters in a day. This would represent one-quarter of the SLB of 135 lts/per capita per day and the average per capita water supplied per day in the three cities surveyed. If the figures for Pune can be generalized, simple prevention of leakage at the household level could possibly result in achieving at least half of the target set by the National Water Mission.

   However, since many users in water scarce places already do not receive a sufficient volume of municipal water supply, awareness campaigns need to be tailored toward optimization and water loss prevention, and not necessarily messages promoting the “reduction in water consumption.” Such efforts require multi-faceted approaches: Explain the value and need for RWH, and provide technological support and financing to enable the adoption of simple systems at the household and colony levels; design creative outreach campaigns, such as through houses of worship, which have unique water requirements as well as the ability to convey the sacred importance of water; demonstrate technologies, such as root zone treatment and graywater reuse systems to prove concepts in the local context; do not overlook simple solutions, including technologies and behaviors—sweeping instead of hosing with water, fixing leaks immediately, promoting inexpensive but efficient faucet aerators and low-flow shower heads will all combine to make a significant impact in a populous city.

[10] Also called “constructed wetlands”, these are man-made wastewater treatment systems designed with natural processes as found in natural wetland ecosystems, relying on plants, soil and microbial life to treat waste.

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