International Finance Corporation
World Bank Group

RAJASTHAN

Water Assessment

POTENTIAL FOR PRIVATE SECTOR INTERVENTIONS

Report for

International Finance Corporation

Maruti Suzuki Building

3 & 4 Floor, Plot No: 1, Nelson Mandela Road, Vasant Kunj,

New Delhi 110070, INDIA

Telephone (91-11) 4111-1000

Facsimile (91-11) 4111-1001, 4111-1002

URL www.ifc.org

IFC, a member of the World Bank Group, is the largest global development institution focused exclusively on the private sector. We help developing countries achieve sustainable growth by financing investment, mobilizing capital in international financial markets, and providing advisory services to businesses and governments. In FY12, our investments reached an all-time high of more than $20 billion, leveraging the power of the private sector to create jobs, spark innovation, and tackle the world's most pressing development challenges. For more information, visit www.ifc.org.

The report is developed as a part of the Netherlands-IFC South Asia Water Partnership, and we wish to acknowledge the funding support of the Ministry of Economic Affairs, Agriculture and Innovation of the Netherlands.

Author

Sweta Mirdha Hooda

Consultant and Researcher

Email sweta.mirdha@gmail.com

This report is the result of extensive research by the author into government and policy documents, reports, books, papers, newspaper and magazine articles, and information in the public domain. Many of the author's views are based on observations made at water related conferences and events; discussions with state and central government officials, researchers, non-governmental organizations, officials of private companies working in the Rajasthan water sector, and citizens from across the state. The author's general familiarity with Rajasthan from years of living and travelling around the state, particularly with the water landscape, helped offers deeper perspective for the report. Certain information, including quantitative data, presented in this report was obtained from publicly available indirect sources, therefore level of accuracy of such data cannot be guaranteed. Due to the fluid nature of developments that this report tracks certain information in this report may be dated. Wherever possible, effort was made to give due recognition to individuals and publications for information gathered from their work.

FOREWORD

Water is an essential natural resource; a key building block of life. However, water use has grown at over twice the population growth rate in the last century. As a result, an increasing number of regions are now chronically short of water. Over 1.4 billion people currently live in river basins where use of water exceeds minimum recharge levels.

If current water practices continue unchecked, future projections indicate that, by 2025, two-thirds of the world population could be living under severe water stress conditions. Managing and ensuring sustainable use of scarce water resources is one of the main development challenges facing countries, states, and corporations around the world. IFC is committed to working in the water sector, as water has become an increasing business risk for our clients.

In India, Rajasthan is one of the most water deprived states with respect to rainfall and per capita water availability. The state faces acute water scarcity challenges as rainfall patterns are impacted by climate change. Increasing agricultural and industrial demand is placing additional pressure on the state's dwindling water resources. Rajasthan has some of the lowest supplies of drinking water in India with only 162 of 222 towns in the state receiving regular supply of drinking water with the poor being the most affected.

Rajasthan needs more holistic and integrated management of its water resources. Collective action is necessary to bring together the public sector, the private sector, civil society, and other stakeholders to work together towards integrated and participatory solutions for water resources planning and management.

This report provides an in-depth and comprehensive overview of the challenges of drinking water supply, water quality, and agriculture-water in Rajasthan with a focus on potential private sector engagements. The report offers solutions such as improved technologies and practices for optimal farm productivity, awareness building and infrastructure development through community engagement.

IFC is committed to assisting the government of Rajasthan in developing a multi-stakeholder, integrated approach to address the state's water challenges. As a knowledge partner to the government of Rajasthan, IFC is already working with the state to promote the state as a preferred investment destination for sustainable private sector led growth. Leveraging upon this, IFC seeks to utilize its convening ability to mobilize key stakeholders among private sector, government, civil society, and academia through collective action to design and implement a Rajasthan Water Initiative.

The water initiative aims to make a profound difference to farmers' lives by improving water and agriculture management practices, thereby providing extra income and sustaining rural livelihoods. This report provides a sound base for developing a framework for effective public-private partnership that is necessary to transform Rajasthan into a water secure state.

Thomas Davenport

IFC Regional Director - South Asia

Author's note

Water is essential to life. Access to clean water is considered to be part of the Right to Life under Article 21 of the Indian Constitution.[1] Ultimately, the water we consume comes from rainfall, which is vulnerable to climate change. Rajasthan, with its semi-arid and arid conditions, is particularly at risk from decreasing water resources.[2] Studies have shown that Rajasthan is among regions with greatest sensitivity to climate and lowest capability to adapt to its vagaries.[3] The mindless overexploitation of groundwater[4] in the state has led to aquifers no longer being able to naturally replenish themselves. This has led to serious consequences that already threaten the dignity of life.[5]

In the absence of surface water resources in some areas of the state, drinking water is often physically transported over long distances, an unsustainable practice even in the short term. Ironically, while this practice establishes that water is not free, and may be even more precious than fuel, it is still a challenge to communicate to citizens the precious nature of this limited resource, and the associated costs of developing and supplying water for public use. The 'water is free' mindset poses a serious bottleneck to reform in the sector.

Rajasthan is in the grip of severe food insecurity with 22 of its districts labeled as most food insecure.[6] Its population growth is among the highest in the country.[7] At the same time, it is at highest risk from drought and famine in India.[8] The state's water landscape has myriad challenges, and time is running out. Success will depend on setting priorities to achieve highest positive impact.

This report analyzes the water crisis in Rajasthan and suggests how the private sector can participate by offering sustainable and scalable solutions. Hopefully, it will provide momentum to address this critical issue.

Sweta Mirdha Hooda

[1] Excerpts from the Kerala High Court in a ruling on the issue of excessive groundwater exploitation "Ground water is a national wealth and it belongs to the entire society...it is nectar, sustaining life on earth...state as a trustee is under a legal duty to protect the natural resources (meant for public use)…inaction of the State in this regard (groundwater protection) will tantamount to infringement of the right to life of the people guaranteed under Article 21 of the Constitution of India". 2004 (1) KLT 73, Perumatty Grama Panchayat vs. State of Kerala (also known as the landmark Coca Cola case).

[2] Climate Change 2007: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Cambridge University Press

[3] Rajasthan State Action Plan on Climate Change (2012), Government of Rajasthan

[4] More than 80 percent of the state is in the overexploited/critical category for groundwater.

[5] 90 percent of drinking water and over 70 percent of irrigation water comes from groundwater. About 80 percent of all economically usable water in Rajasthan has already been used.

[6] Food Security Atlas of Rural Rajasthan, 2010, Institute for Human Development and World Food Program

[7] State has experienced a decadal population growth rate of 21.44 percent- higher than the 17.64 percent national average.

[8] Climate Change Impacts, Mitigation and Adaptation Science for Generating Policy Options in Rajasthan, Rajasthan Pollution Control Board (2010), Government of Rajasthan. Also Ray and Shewale et al (2001)- on the basis of percentage area in India affected by moderate to severe drought in the124-year period between 1875-1998.

Executive Summary

1 Introduction to the State

The northwestern state of Rajasthan, with a land area of 34.3 million hectares or 10.4 percent of India's total area, is the largest Indian state. 5.6 percent of the country's total population or 68.6 million live in the state, of which over 75 percent live in rural areas. The state has experienced a decadal population growth rate of 21.44 percent, which is among the highest in the country. An estimated 24.8 percent of the population lives below poverty line (BPL). The gross state domestic product (GSDP) in 2011-12 was $76.8 billion. Current per capita income is $1,122. Tertiary sector contributes 44.6 percent to GSDP, followed by primary sector at 29.2 and secondary sector at 26.2 percent. Agriculture/allied employ two-thirds of the state labor force and contribute roughly 26 percent of the GSDP.

2 Water Resource Scenario

Studies have shown Rajasthan is among regions with greatest climate sensitivity and lowest adaptive capability. Rajasthan has only 1.16 percent of the country's total surface water resources or 21.71 billion cubic meters (BCM), however 16.05 BCM of this is economically usable. The state has created capacity to harness and store 11.29 BCM, or around 70 percent of available water. The state has 1.72 percent of the country's groundwater, translating into 11.36 BCM. Dependent on inflows into the rivers, 17.88 BCM is allocated through inter-state agreements, although not dependable due to political compulsions of the upper riparian states. On paper, water use can be expanded by a further 30 percent. However more realistic assessment of additional availability is economically usable water or 21 percent. This is broken down in figure below, which accounts for the use of 79 percent of the 45.09 BCM of economically available water.

Water Resource Summary for Rajasthan

Category	Availability in BCM (as percentage of economically usable water) (1)	Usage in BCM (as percentage of economically usable water) (2)	Percentage used (2)/(1)
Internal surface water	21.71		5252
(a) Economically usable	16.05 (35.6)	11.29 (31.6)	70
(b) Economically non-usable	5.66		
Groundwater	11.36 (25.2)	11.77 (39.3)	104
Inter-state/external water	17.88 (39.2)	12.66 (35.4)	71
Total state water resources	50.96		70*
Total economically usable state water resources	**45.09 (100)**	**35.72 (100)**	**79**

*Source: Planning Department (Government of Rajasthan) and Water Sector Performance (Reddy) * Total water usage as percentage of total state water resources*

2.1 Rainfall

The state has the highest incidence of drought in the country. Between 1901 and 2002 there have been 48 drought years of varied intensity, which means that the chance of occurrence of a meteorological drought in the state is 47 percent.

2.2 Groundwater

In Rajasthan, the annual water table loss is 1 to 3 meters. The gross annual draft of groundwater in the state is 13 BCM against a recharge of only 10.4 BCM. Around 90 percent of drinking water and 73 percent of water for irrigation is met by groundwater. Underground exploitation of water has shot up from 35 percent in 1984 to 138 percent in 2008, and is likely to reach 189.1, 221.4 and 259.1 percent in 2015, 2020 and 2025 respectively. To quantify the dismal situation, of the 249 blocks in the state about 80 percent are either over-exploited or critical.

Groundwater Trend by Block in Rajasthan

Number of blocks in the category (groundwater exploitation rate)	1984	1988	2001	2008
Over exploited (>100 percent)	12	41	86	168
Critical (90 to 100 percent)	11	26	80	28
Semi-critical (70 to 90 percent)	10	34	21	20
Safe (<70 percent)	203	135	49	32

Source: Groundwater Status of Blocks, PHED, Government of Rajasthan (2008 data excludes Taranagar)

2.3 Surface Water Resources and River Basins

Rajasthan is divided into fourteen river basins and an outside basin. The surface water available in all basins is 25,931 million cubic meters (MCM), of this only 60 percent or 16,054 MCM is considered economically usable. Surface water resources are scarce and confined to the south and southeast of the state. Almost all river basins are over exploited, with no groundwater available for further irrigation projects.

3 Water Demand-Supply Gap

Agricultural use of water accounts for the consumption of 83 percent of available water resources in the state, drinking water for 11 percent, and industry/other uses for 6 percent. The current demand-supply deficit is 8 BCM, and is expected to go up to 9 BCM by 2015. The average per capita water availability is expected to drop below 450 cubic meters by 2050, which is below the international minimum of 500 cubic meters or absolute water scarcity. 88.5 percent of villages/habitations in the state receive less than 40 liters per capita per day (lpcd) of water. Rajasthan has the highest proportion of households reporting purchase of water. In the urban context, the demand for water (1,803.84 million liters per day or MLD) outstrips installed capacity (1,798.91 MLD) and supply of water (1,475.71 MLD).

3.1 Industrial Water Demand

Rajasthan is undergoing an industrial transformation. Industrial water demand in Rajasthan was around 45.5 million cubic meters (MCM) per year in 1995, projected to grow to 138.44 MCM/year in 2045.

4 Drinking Water Supply

70 percent of habitations in the state face problems getting potable drinking water. The available water has high total dissolved solids (TDS), salinity, fluoride, and nitrates. The canal systems are the only reliable drinking water sources in the region.

4.1 Rural Drinking Water Supply 85 percent of all rural water supply schemes are dependent on groundwater.

Water loss due to leakage is 40 to 50 percent. 30 percent or 34,880 rural habitations have problems with water quality. Of these more than half have multiple quality problems. Over half of rural habitations or 65,415 are fully covered while 32 percent have no coverage.

4.2 Urban Drinking Water Supply

Frequency of water supply in urban areas varies; once in 24 hours for 161 towns, once in 48 hours for 49 towns, and once in 72 hours in 12 towns. During summer, when the crisis is at its height, water is often transported to towns in trains and tankers. Only 10 percent or 23 towns got more than 100 liters per capita per day (lpcd) water against the 135 lpcd standard.

5 Water Quality and Water Logging

In the national context, 74 percent of all habitations with multiple quality issues in the country are located in Rajasthan, including 51 percent of all fluoride affected areas, and 42 percent of all saline affected areas. Water logging is the other major threat to surface water quality as seen in the canal command areas (CCAs).

5.1 Groundwater Quality

The major problems associated with groundwater quality are fluoride, nitrate, and salinity. In addition, many parts of the state encounter TDS levels above 1,000 mg/liter against the WHO standard of 500 mg/liter.

5.2 Surface Water Quality

The two major causes of surface water pollution are sewage water and industrial effluent. None of the towns in the state, except Jaipur, have sewage collection, treatment, and disposal systems.

5.3 Industrial Effluent

Major water polluting industries in the state are dyeing and printing, smelters, thermal power plants, major brick/lime kilns, stone crushers, and mines. Effluents discharged from these industries mainly contain alkalis, residual dyes, starches and cellulose, soluble salts with mainly sodium and calcium, silicates, oils, and other impurities. The effluents are discharged untreated due to the lack of economically viable technologies.

5.4 Water Logging

Water logging is a severe problem in outside basin and Chambal basin. The causes are seepage from canals in the outside basin, and over irrigation in the Chambal basin. As a result of rise in water tables, 145,600 hectares has turned critical (water table within six meters of land surface). A far more serious problem is anticipated in stage-II of IGNP. Experts believe thousands of hectares of land will be submerged in 25 to 30 years.

6 Water Tariff

Revenue from drinking water supply schemes in the state is about 20 percent of the operating and maintenance (O&M) costs. Power consumed alone costs three times revenue collection. The difference in per unit cost of water compared to user charges has led to a cycle of higher subsidies (estimated at 74 percent) to consumers with higher consumption (and likely higher wastage).

6.1 Price Gap

This study considers the difference between O&M costs and tariffs charged as the price gap for irrigation water supply. For drinking water supply and sanitation, costs include bulk production, treatment and distribution charges. Recoveries are less than 10 percent in the case of major and medium irrigation and rural water supply, while urban water supply and minor irrigation recoveries are higher, though still less than 40 percent.

7 Agriculture-Water Nexus

Around 70 percent of the state's labour force is engaged in agriculture and allied activities. The sector contributes roughly 22 percent to the state domestic produce. Even though agriculture uses 83 per cent of total water resources of the state, only 36.3 percent or 6.66 million hectares net sown area (NSA) is irrigated. Of the irrigated land area, 73 percent is dependent on groundwater, while the remaining is almost entirely dependent on canal irrigation and vulnerable to ill-timed water supply.

7.1 Irrigation

Irrigated agriculture contributes more than 50 percent of agricultural output. In 2005, an expert committee made two important observations: population in the state was expected to almost double to 100 million by 2050, and, due to this population growth, water used for irrigation would need to be reduced from 83 percent to 70 percent by 2050. The only solution is to regulate groundwater demand, especially for agriculture on a priority basis.

8 Policies and Private Sector in Water

To facilitate the role of public private partnerships (PPP) in creating new infrastructure assets and managing existing assets, Government of Rajasthan issued guidelines in May 2012 and has taken several specific steps to set up a framework for private sector participation.

8.1 Water Policy The National Water Policy (NWP) was most recently revised and adopted in December 2012

Section 12.3 of the NWP 2012 states, "Water resources projects and services should be managed with community participation. For improved service delivery on sustainable basis, the state governments/urban local bodies may associate private sector in public private partnership mode with penalties for failure, under regulatory control on prices charged and service standards with full accountability to democratically elected local bodies."

8.2 State Water Policy on Private Sector Role

The State Water Policy (SWP) under its water resources development and management objectives mentions "facilitating private initiative in development, operation and management of water projects." As part of institutional reforms, the SWP seeks to "encourage private initiative in water sector." And finally, as part of legislative and regulatory reforms, the need to "establish rules/regulations for private sector involvement in development and operation of water related projects" finds mention in the SWP.

8.3 Projects under PPP

Contracting has been the main mode of privatization. Given that several water transmission and distribution projects are pending resource allocation and subsequent implementation, the Government of Rajasthan is inclined to explore annuity-based and other appropriate PPP models in the water sector.

8.4 Externally Aided Projects

The projects proposed to the Government of India for external assistance could involve opportunity for private sector participation: Nagaur Lift Project Phase II, Jodhpur Urban Water Supply Scheme, and Chambal-Bhilwara Project.

9 Water Institutions

Rajasthan has its water problems, but it also has its fair share of water actors: non-governmental institutions (NGOs), foundations, research institutions, business associations, international agencies, financial institutions, private companies, and many others who have done, and continue to do phenomenal work in the water sector.

10 Market Dynamics

10.1 Market Failures

Water is a common resource and hence subject to market failures. This leads to several market and system failures, both from the supply and user sides.

10.1.1 Over-exploitation of Groundwater

None of the acts, including the draft groundwater act, addresses the issue of equity. Although cost of water and power is subsidized, due to high capital expenditure only large and medium farmers can afford to extract water. Small and marginal farmers are left out. Ironically, groundwater extraction rights are given away to landowners by the Easement Act of 1882. At the same time, groundwater is also termed as a common pool resource in policy discourse. There are no concrete policies to address problems surrounding groundwater.

10.1.2 The 'Free' Water Mentality

Drinking water is subsidized up to 75 percent. In most towns, bills are raised on the basis of average consumption since 60 percent consumer meters are either not installed or are not working. Bulk metering at source of supply is not available. In this scenario, it is impossible to work out the true cost of water delivery so that appropriate tariff structures can be put in place. This has led to a free water mentality, leading to reckless misuse of water. When it comes to irrigation, current water and energy policies actually subsidize inefficient use of water, since there is no increased cost associated with more usage.

10.1.3 Broken Water Delivery

Leakages in drinking water distribution systems cause a loss of 50 to 60 percent, against a design norm of 15 percent. Tail end consumers are left with little water and low pressure. The gaps in supply are staggering, both in terms of frequency and volume. The same story is repeated in the irrigation system where unlined canals cause water losses and lead to water logging. In areas that are fully dependent on canal water, unscientific, erratic water delivery schedules and inadequate control over volumetric supplies lead to farmers resorting to flood irrigation and short duration varieties at the cost of crop yields.

10.1.4 Lack of Institutional Capacity

Currently, government departments managing water supply systems, such as the Public Health and Engineering Department (PHED) are more suited for creating distribution infrastructure rather than actually operating it. In several capital intensive drinking water schemes, demand outstrips installed capacity even before a project is finished. The traditional top down approach by water related departments has failed to mobilize community involvement in planning water projects.

10.2 Market Needs

While the most obvious market need is access to sustainable water supply, there are other very important between-the-lines issues.

10.2.1 Equitable Water Distribution

The World Bank found that up to 80 percent of subsidies in the country went to medium and large farmers. The first to be affected by falling water tables are the rural poor and marginal farmers who lack the means to deepen their wells and install more powerful pumps. Part of the solution clearly lies in tariff reform, while fixing water rights may be the other part. De linking water rights from land rights would make groundwater a genuinely common resource, and start the process of recharging overexploited aquifers through both natural processes and human effort. In absence of equity, as water resources become increasingly scarce, avoiding water conflicts of the kind already witnessed in the state will become more difficult.

10.2.2 Demand Management and Tariff Reform

Shift from merely meeting the supply-demand gap to managing demand itself is needed. This can be achieved through appropriate pricing of water and adopting technologies backed by legislation and institutional support to ensure adoption. Increased tariffs must go with a water delivery mechanism that consistently works and eliminates inefficiencies such as transmission losses and theft of water. For agriculture, the ideal policy is to promote water-saving crop and irrigation technologies in tube well-irrigated areas with pro-rata pricing of electricity. The price that truly works for domestic, agricultural, and industrial users needs to be discovered.

10.2.3 Delivery Efficiency with Technology

A fully functional and accurate consumer metering system can limit drinking water wastage and enforce a tariff regime. Bulk metering for all water sources should go with consumer metering for domestic, industrial, and agricultural use. In the absence of a well-planned and rigorous framework, despite government's good intentions by way of policy documents, annual plans, and heavy central and state subsidies, (totaling up to 70 to 90 percent), adoption of relevant technologies by farmers will remain poor. Additionally legislation can help streamline equipment supply by discouraging production of inefficient conventional devices.

10.2.4 Groundwater Management

Groundwater mining in the state has surpassed recharge capabilities. In a state with 90 percent dependence on groundwater, this will soon lead to a desperate situation. In many parts of the state physical transportation of water is the only solution to meet drinking water needs, an unsustainable practice even in the medium term. Every effort to help recharge underground aquifers needs to be made, including micro watershed planning and restoration of traditional water bodies that lie scattered in disrepair across the state.

10.2.5 Balancing Agri-Water Nexus

Since 83 percent of water is diverted to agriculture, the need to balance the agri-water nexus cannot be overemphasized. Especially in the context of managing groundwater, which contributes 74 percent of water used in agriculture.

10.2.6 Water Harvesting

In several parts of Rajasthan, especially where rainfall is limited to a few showers during the short monsoon months, groundwater is not an option due to depletion or high total dissolved solids (TDS). With surface water also not available, rainwater harvesting (RWH) is the most viable solution to meet drinking water and household needs, at least for a period of six to eight months. Technical support such as remote sensing data and geographical information systems (GIS) can help. RWH must be a part of micro watershed planning and undertaken in all rural and urban settings to meet demand for drinking, domestic, agriculture, and industrial water.

10.2.7 Industrial Wastewater Management

According to estimates, water demand of industries is 1,000 gallons/acre/day. Overall industrial demand for water in the state currently accounts for the lowest share of 6 percent. But, as demand by this sector grows, it is critical to meet a portion of this with recycled wastewater while minimizing water loss due to industrial pollution.

10.3 Market Barriers

To that end, it is also important to understand limitations and challenges faced by the private sector in delivering water related services.

10.3.1 Water = Government

Unlike all other sectors where the private sector has played a vital role, water as a social sector is unique. As custodian of water resources meant for the public at large, it is the duty and obligation of the state to protect these resources. Added to this is the socialist doctrine long followed by the country where it is understood that government will provide water to people. Further, the role of state governments in this task is well enforced by the Constitution. To conclude, water and government are inseparable. Thus, the role the private sector can play and the efficiency it can exhibit will be governed by the government. Without government blessing, it is likely that the private sector will be viewed with skepticism by user communities, given the widespread notion that private equals profit, which sometimes means exploitation.

10.3.2 Missing Private Eco-System

While Rajasthan has made several attempts in recent times to become more investor friendly and attract business, there are several barriers for private sector participation in the water sector: capital, pricing, policy, institutional framework and awareness.

10.3.3 The Water Business Model

Water is a need, not a want. This need is to be ideally met by simultaneously compensating and conserving finite water resources for coming generations. Secondly, water is a social matter requiring continued community participation. Any water related business model needs to factor this in, which means long periods of handholding, not a standard private company trait.

10.3.4 Uncharted Territory

There are no relevant examples of public private partnership (PPP) or private sector partnerships in the true sense (risk sharing, transferability of assets, and financial structuring) in water related projects. This could change soon with the PPP projects under consideration, however it would be fair to say that water (non-contractual, non-construction projects) is an uncharted territory for the private sector in Rajasthan, as is the case in most of India and the developing world. This automatically leads to lack of trust, both within the government and user communities.

10.4 Market Players

The market players in the state deserve review, as they will be contributing partners in any private initiative in the state. Rajasthan with its arid and semi-arid climate has had an active water player roster-government; NGOs/foundations/volunteers; multilateral agencies/business associations/educational and research institutions; financial institutions including microfinance institutions and self-help groups; private companies; users; and knowledge providers.

11 Potential Participation and Analysis

11.1 Interventions

There is a lot that needs to happen on the government's end, mainly through action-oriented policy intervention, institutional reform, and political will. The private sector is most suited to address many deficiencies, and bring needed efficiencies, both technical and process oriented, while sharing resources and responsibility. It is important to specifically outline possibilities for private sector participation into the following:

11.1.1 Rural Drinking Water – Off Grid

The drinking water solution most applicable to rural areas, especially remote habitations, is off-the-grid water supply, both community and individually owned. Additionally, with no groundwater (due to quality issues or depletion) and limited feasibility to connect with surface schemes (due to low density of population in these areas to justify large infrastructure investment), the most viable source is rainwater harvesting.

11.1.2 Rural/Peri-urban Drinking Water – On Grid

On-grid supply in rural and peri-urban areas, that is in bulk to public stand posts (PSPs) or end users, would present more viability for private involvement. A well-structured PPP model may be the best alternative. The proposed externally funded projects discussed in section 8.5 of this report include peri-urban areas and as such would be an ideal opportunity for private intervention. Additionally, there already may be opportunities to set desalination plants and cater to surrounding communities in an on-grid bulk to PSP or user mode.

11.1.3 Urban Drinking Water – On Grid

In the light of the severely compromised urban drinking water supply in the state the need for an alternative is immediate. Private involvement in urban areas is very relevant as proven by select initiatives within India and abroad. The most important policy thrust in making private sector viable in on-grid schemes is the formal recognition of water pricing and tariff reform as important areas.

11.1.4 Agriculture – Canal Irrigated and 11.1.5 Agriculture – Non-Canal (Groundwater and Rain fed)

Agriculture, which consumes 83 percent of the state's water resources, presents the single biggest opportunity for water reform. A range of water saving interventions by the private sector can be undertaken under an umbrella project in select geographies under canal command and groundwater irrigation.

11.1.6 Industry – Wastewater Recycling (including municipal waste)

While industry is lower priority for government water supply schemes (after agriculture and domestic consumption), the need for solutions is nevertheless significant, given the polluting industrial composition in the state, and growing emphasis on wastewater treatment and recycling in latest plan documents (including water harvesting being made mandatory for both industrial units and industrial areas). In light of the stressed water situation, which threatens the viability of certain industries, support from industry is easy to garner. The key for any private intervention would be to develop the right working model with municipalities where domestic sewage is part of the project. Costs, risks, cross-subsidies, and suitable uses for treated water would be the main areas to tackle.

11.1.7 Industry – Water Efficiency

Water foot printing studies of the kind already executed by IFC will be helpful in the context of water intensive industries such as textile, cement, and marble. Findings could help establish much needed industry best practices in water use, and help influence policy direction and eventually help regulation of industrial water use. Other uses of such an exercise would be tariff reform to penalize wasteful units.

11.2 Analysis

In order to help prioritize efforts, these interventions have been assessed on the basis of:

Degree of positive impact, from high to low, in addressing Rajasthan's overall water problem, compared to the level of effort required to execute each intervention, from easy to difficult (refer to figure below).

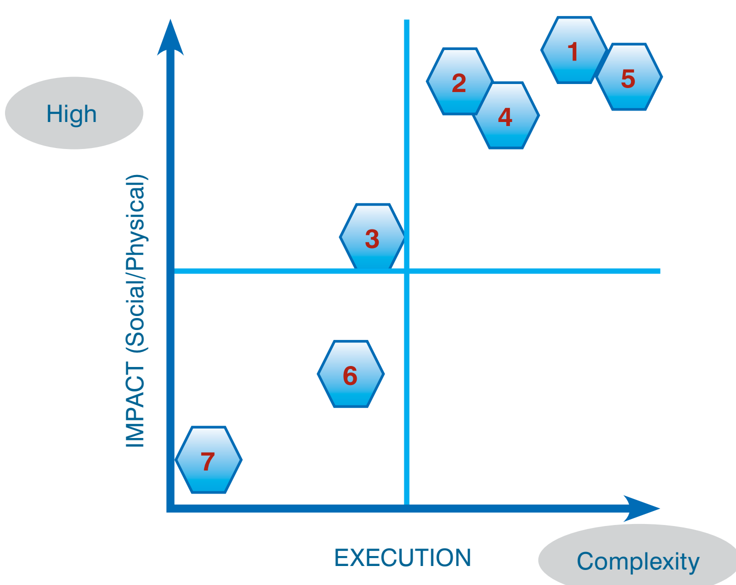
The placement of each intervention in the various gradients is based on the facts and their critical analysis presented in this report. With this background, the top three most effective interventions, numbered in brackets, in order of positive impact are:

1. Rural drinking water – off-grid (1)
2. Tie between rural/peri-urban drinking water on-grid (2) and agriculture – non canal (groundwater and rain fed) (5)
3. Agriculture – canal irrigated (4)

Drinking water needs come before all else and, compared to urban areas, have been neglected in the rural and peri-urban context. On the other hand, the sheer magnitude of water being consumed by rain fed and groundwater-irrigated agriculture in the state and its correlation to food-security explains the tie above.

The three most difficult interventions in terms of time, resource, and effort are:

1. Agriculture – non canal (groundwater and rain fed) (5)
2. Rural drinking water – off-grid (1)
3. Agriculture – canal irrigated (4)



Legend

1. Rural Drinking Water - Off Grid
2. Rural / Peri-Urban Drinking Water - On Grid
3. Urban Drinking Water - On Grid
4. Agriculture - Canal Irrigated
5. Agriculture - Non-Canal (Groundwater & Rainfed)
6. Industry - Waste Water Recycling (Including Municipal Waste)
7. Industry - Water Efficiency

As explained in earlier sections, interventions (6) and (7) relating to industrial water are comparatively lower on both the impact and effort scale, but still important in their own right, with efficiency of water use being the most actionable. Intervention (3) relating to on-grid urban water supply, both in terms of impact and effort, falls somewhat mid-way between industrial interventions as a group on one end, and rural/peri-urban drinking water and agricultural interventions on the other.

11.3 Recommendations

The seven interventions and their analysis presented above, brings us to our concluding section on recommendations, that is, specific answers to the "*Where do we go from here?"* question.

After detailed assessment of all relevant facts, IFC could take up at least one initiative in each of these three sectors, namely, drinking water supply, agri-water nexus, and industrial water use.

Since water is a common resource, each sector is linked to the other. Water efficiency created in one sector, can quickly dwindle if the misuse continues elsewhere. Having an integrated approach that comprehensively addresses all water use in a watershed /geography is most desirable. With current annual trends of deterioration, in a few decades water sustainability itself could become an unachievable goal in Rajasthan. Hence there is a need to approach the problem from all angles while there is time. It is however important to prioritize.

IFC can first take up rural water supply, agricultural water efficiency, and industrial water stewardship. These areas stand to benefit from the right kind of private sector intervention. Further due diligence and involvement of additional parties, both within and outside IFC, is required in order to crystallize recommendations into feasible projects. However effort has been made by the author to influence rapid action with **four** realistic project proposals for IFC to deliberate upon.

11.3.1 Illustrations

Illustration-I Sustainable Agriculture with Water Efficiency in Rajasthan– SAWER (pronounced 'saver')

Illustration-II Rainwater Harvesting Program- Harvest to Drink

Illustration-III IFC supported Drinking Water Intervention under the PURA Scheme

Illustration-IV IFC supported Industrial Water Stewardship Program

CONTENTS

1 Introduction to the State

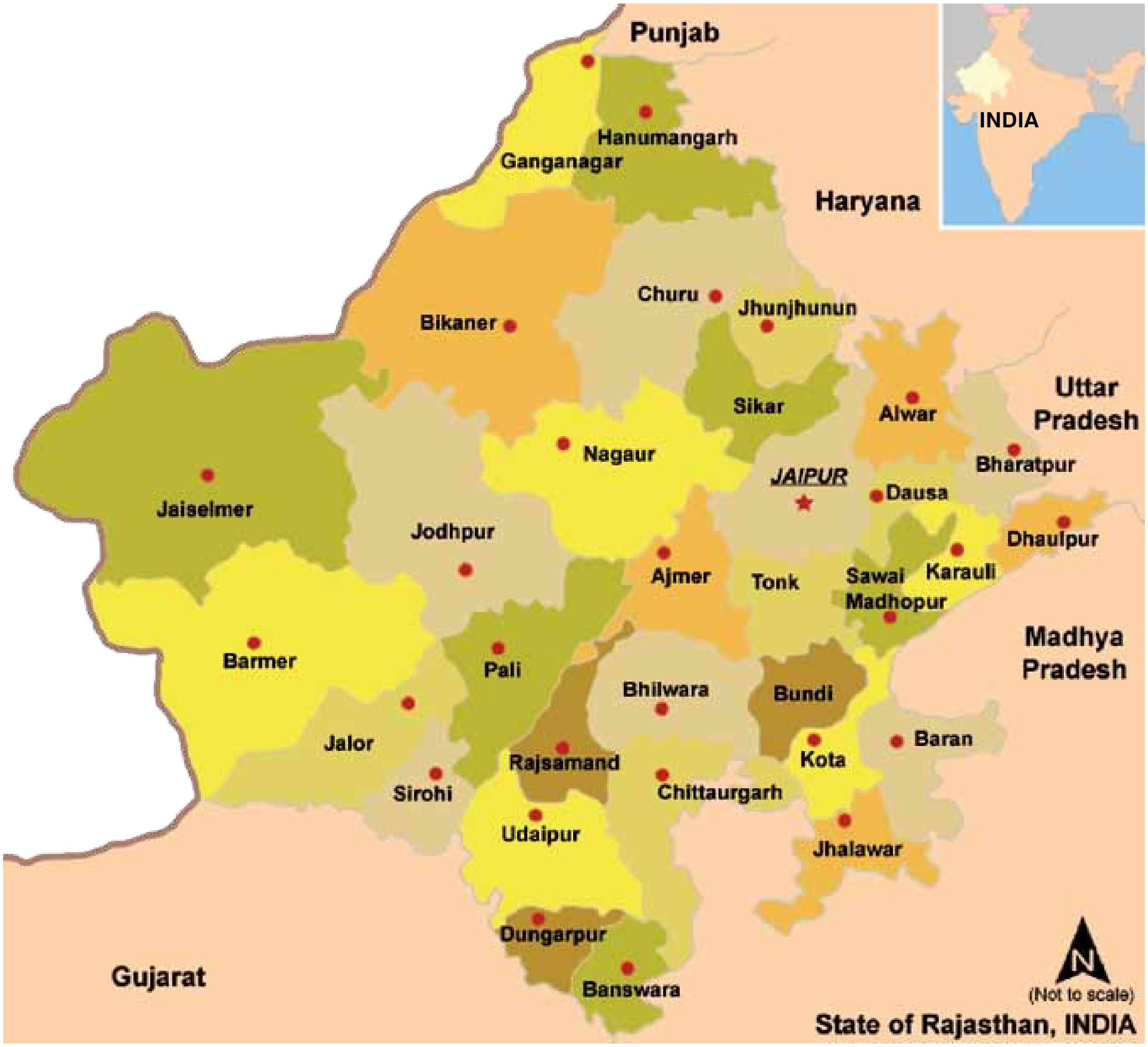


Figure 1 Map of Rajasthan

Source: Wikimedia Commons[9]

[9] Last accessed on May 10, 2013 http://commons.wikimedia.org/wiki/File:Map_rajasthan_dist_all_shaded.png

The northwestern state of Rajasthan, with a land area of 34.3 million hectares or 10.4 percent of India's total area, is the largest Indian state. The state has four main physiographical regions- the Western Desert, the Aravali hills (running southwest to northeast), the Eastern Plain, and the Southeastern Plateau. It is divided into 33 districts, and further sub-divided into 249 blocks[10] and 9,177 gram panchayats.[11]

According to the census of 2011, 5.6 percent of the country's total population or 68.6 million live in the state, of which over 75 percent live in rural areas. The state has experienced a decadal population growth rate of 21.44 percent, which is higher than the 17.64 percent national average and is among the highest in the country. An estimated 24.8 percent of the population lives below poverty line (BPL), compared to 29.8 percent nationally.[12]

The gross state domestic product (GSDP) in 2011-12 was $76.8 billion, with an average annual growth rate of about 15.2 percent in recent times (since 2004-05). Current per capita income is $1,122, which has increased at a compounded annual growth rate of 13.2 percent in the last six years. Tertiary sector contributes 44.6 percent to GSDP, followed by primary sector with 29.2 percent that has been the fastest growing, and secondary sector with 26.2 percent. Agriculture and allied sectors are important, employing two-thirds of the state labor force and contributing roughly 26 percent of the GSDP.

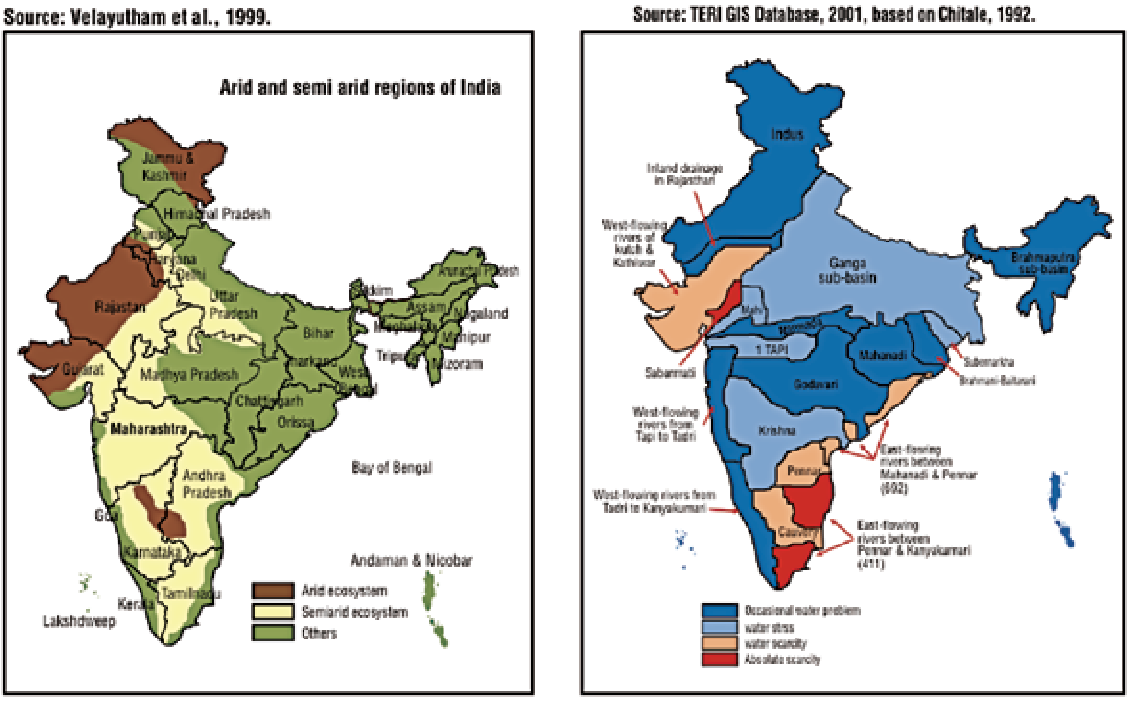
[10] According to state's Twelfth Plan (2013-2017)

[11] Block is an administrative sub-division under district level and is made up of several Gram Panchayats (village council or local self-government over a cluster of villages). The local government body at the block level (tehsil / taluka) is called Panchayat Samiti, and it is the link between Gram Panchayats and Zila Parishad at the district level.

[12] National Health Profile (NHP) of India – 2011, Central Bureau Of Health Intelligence, Government of India. (BPL data for 2009-10, based on Tendulkar methodology, original source Planning Commission)

2 Water Resource Scenario

Figure 2 Rajasthan on Arid / Semi-Arid Map of India



Source: Vulnerability and Adaptation Experiences - Rajasthan and Andhra Pradesh, Swiss Agency for Cooperation and Development, 2010

Figure 2 maps Rajasthan's arid to semi-arid ecosystem with varying degrees of water problems. Two-thirds of the state is the Great Thar Desert, which suffers from recurrent water scarcity. This represents 60 percent of the country's 142 desert blocks. The region is subjected to temperature extremes, from around 0°C during the brief winter to nearly 50°C in summer.

Climate change, and resulting increase in evapotranspiration,[13] has had a key impact on water resources in Rajasthan.[14] The normal average annual evapotranspiration in the state is estimated at 1,701 millimeter, which could increase by 15 millimeter with a slight 1 percent increase in baseline temperature (42°C based on normal maximum temperature for the state). The result would be an additional water requirement of about 313 million cubic meters (MCM) for the entire arid zone of Rajasthan.[15]

The state has just one perennial river, the Chambal, which means almost no dependable surface water. Famine conditions often prevail due to scanty rainfall. There are fourteen defined river basins and an outside basin in Rajasthan. Available

[13] Evapotranspiration is the total loss of water due to evaporation and plant transpiration from the land surface into the atmosphere.

[14] Water resources and climate change: An Indian perspective, 2006, Mall, Gupta, Singh, Singh and Rathore

[15] Sensitivity of evapotranspiration to global warming: a case study of arid zone of Rajasthan (India), 2004, Goyal

surface water is confined mainly to the south and southeastern parts of the state. A large area in the west does not have a defined drainage basin. Thus, the state's water resources are not only disproportionately low when compared to its people, livestock and farmers, but is also distributed unevenly.

Rajasthan has only 1.16 percent of the country's total surface water resources or 21.71 billion cubic meters (BCM). On the basis of a more realistic indication of available surface water at 50 percent dependability (or how planning department looks at this resource), the state has16.05 BCM of economically usable surface water. The state has created capacity to harness and store 11.29 BCM, or around 70 percent of available water. Irrigation potential of 3.4 million hectares has been created, against a potential of 5.1 million hectares. Rajasthan has 1.72 percent of the country's groundwater, translating to around 11.36 BCM. Dependent on inflows into the rivers, 17.88 BCM is allocated through inter-state agreements, although not dependable due to political compulsions of the upper riparian states.

On paper, water use can be expanded by a further 30 percent. However, given the capital-intensive nature of construction projects and budget caps that prevent the irrigation department from sanctioning new projects, the more realistic assessment of additional availability is economically usable water of around 21 percent. This is broken down in figure 3, which accounts for the use of 79 percent of the 45.09 BCM of economically available water.

Figure 3 Water Resource Summary for Rajasthan

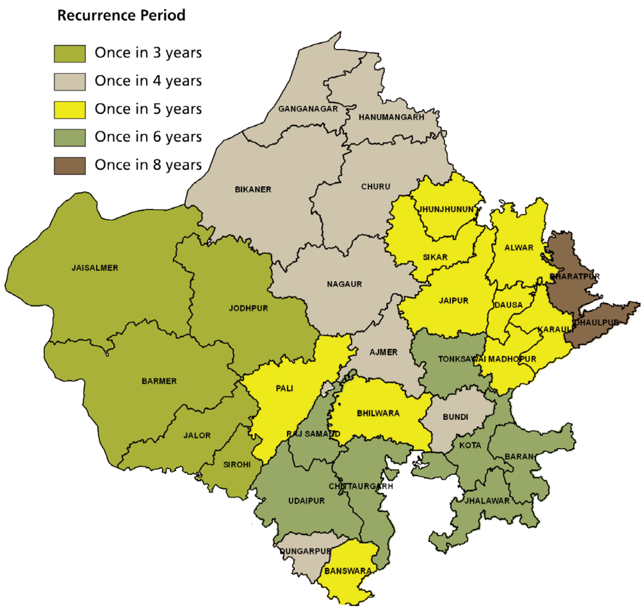
Category	Availability in BCM (as percentage of economically usable water) (1)	Usage in BCM (as percentage of economically usable water) (2)	Percentage Used (2) / (1)
Internal surface water	21.71		
(a) Economically usable	16.05 (35.6)	11.29 (31.6)	70
(b) Economically non-usable	5.66		
Groundwater	11.36 (25.2)	11.77 (39.3)	104
Inter-state/external water	17.88 (39.2)	12.66 (35.4)	71
Total state water resources	50.96		70*
Total economically usable state water resources	**45.09 (100)**	**35.72 (100)**	**79**

*Source[16]: Planning Department (Government of Rajasthan) and Water Sector Performance (Reddy) * Total water usage as percentage of total state water resources*

[16] Unclear from data source if this is annual data. Presentation of data is somewhat altered for ease of understanding.

2.1 Rainfall

Figure 4 Frequency of Drought by District in Rajasthan



Source: Disaster Management and Relief Department, Government of Rajasthan

Studies have shown Rajasthan is among regions with greatest climate sensitivity and lowest adaptive capability.[17] The state's average annual rainfall is 531 mm, with pronounced spatial variations. Rainfall ranges from 100 mm in Jaisalmer in the west to 800 mm in Jhalawar in the east. The 22 eastern districts are better off with 688 mm of average rainfall, compared to the 318 mm average in the 11 western districts. Around 90 percent of total rainfall occurs in the monsoon months of July to September. Most parts of the state receive just a few showers within a band of a few days. The average number of rainy days during southwest monsoon in Jaisalmer and Jhalawar is 10 and 40 days, respectively.

Rajasthan's rainfall pattern is characterized by late onset and early withdrawal of monsoon when compared to other states. Dry spells are common and the state has witnessed frequent drought and famine conditions. The state is hit by drought four out of every five years, the highest incidence in the country.[18] Within the state, the probability of occurrence of droughts is highest in the western parts.[19] Between 1901 and 2002 there have been 48 drought years of varied intensity, which means that the chance of occurrence of a meteorological drought in the state is 47 percent.[20] Further, only in nine out of these years, none of the districts in the state were affected by drought.

[17] Rajasthan State Action Plan on Climate Change (2012), Government of Rajasthan.

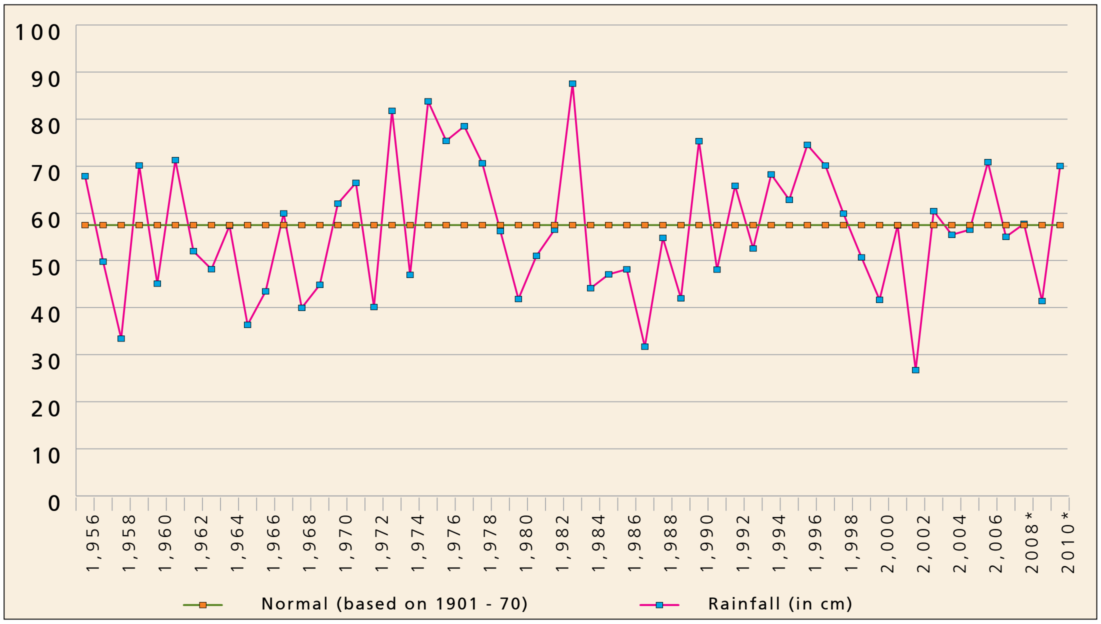
[18] Climate Change Impacts, Mitigation and Adaptation Science for Generating Policy Options in Rajasthan, Rajasthan Pollution Control Board (2010), Government of Rajasthan.

[19] On the basis of percentage area in India affected by moderate to severe drought in the124-year period between 1875-1998, Ray and Shewale et al (2001).

[20] State level analysis of drought policies and impacts in Rajasthan, India, Rathore (2004), International Water Management Institute.

There is a palpable shift in rainfall patterns [21]. The erratic behavior of rains is quite apparent on analysis of rainfall data from 1956 to 2010 (figure 5). Taking 1901 to1971 as baseline, 57.51 cm (575 mm) can be considered as normal rainfall for Rajasthan. However rainfall has remained below normal for about 60 percent of the time during this 55 year period. Data shows frequent periods of lower rainfall that last five or more consecutive years. Hence, uncertain seems to be the new normal for rainfall in the state.

Figure 5 Rainfall Trend Analyses 1956-2010



*Source: Compiled with rainfall data from 50 Years of Agriculture Statistics of Rajasthan (1956-57 to 2005-06), Directorate of Economics and Statistics. *2007-10 data is from Agriculture Statistics of Rajasthan (2010-11 edition)*

2.2 Groundwater

At 210 BCM, the annual extraction of groundwater in India is by far the highest in the world[22]. Heavy and indiscriminate reliance on ground water extraction, possibly to compensate for the lack of surface water, has led to declining ground water availability. In Rajasthan, the annual water table loss is 1 to 3 meters. The gross annual draft of groundwater in the state is 13 BCM against a recharge of only 10.4 BCM.

Around 90 percent of drinking water and 73 percent of water for irrigation is met by groundwater. Underground exploitation of water has shot up from 35 percent in 1984 to 138 percent in 2008, and is likely

[21] The author has conducted several interviews with farmers and residents, in both rural and urban areas of Rajasthan. Widespread concern due to reducing frequency and volume of rainfall, and direct implication on livelihood was noted. These observations are well supported by statistical rainfall data.

[22] In comparison, China's withdrawals are 105 BCM and the United States' are 100 BCM. Source - India's Groundwater Challenge (Shankar 2011), in India in Transition, published by Center for the Advanced Study of India (CASI) of the University of Pennsylvania.

to reach 189.1, 221.4 and 259.1 percent in 2015, 2020 and 2025 respectively[23]. In 16 of the 33 districts, groundwater is over exploited (more than 100 percent), and the rates of exploitation are as high as 165 percent in Jhunjhunu and 153 percent in Jodhpur.

The depth at which wells now hit usable water, if they do, varies widely, but has substantially increased over the past two decades. For instance, in areas around Jaipur, water was found at less than 100 feet depth during the 1980s, now wells are dug to 250 feet and more. Moreover, even at that depth, wells yield less water and re-drilling is required frequently. In parts of central Rajasthan water is extracted from depths of 700 feet or more with submersible pumps. High incidence of salinity in these areas means the probability of finding usable water even at these depths is low, making large areas dependent on transported water for drinking and household use [24].

The groundwater situation is no better even in areas where surface water is used for irrigation due to water logging which renders groundwater saline [25]. To quantify the dismal situation, of the 249 blocks in the state only 12 percent or 32 blocks are in the safe category, and about 80 percent are either over-exploited or critical (figure 6). Around the state capital of Jaipur, almost all blocks are overexploited (12 of the 13, remaining one block is critical).

Figure 6 Groundwater Trend by Block in Rajasthan

Number of blocks in the category (groundwater exploitation rate)	1984	1988	2001	2008
Over-exploited (>100 percent)	12	41	86	168
Critical (90 to 100 percent)	11	26	80	28
Semi-critical (70 to 90 percent)	10	34	21	20
Safe (<70 percent)	203	135	49	32

Source: Groundwater Status of Blocks, PHED, Government of Rajasthan (2008 data excludes Taranagar)

2.2.1 Rajasthan Groundwater Bill

With the groundwater situation as critical as it is, it is important to understand the legislative environment. In India, surface and groundwater regulation is the purview of individual states. Rajasthan does not regulate groundwater, but in 2005 the government drafted the Rajasthan Groundwater Rational Use and Management Act. The draft act was prepared by an appointed expert committee constituted by the Rajasthan High Court Bar Association comprised of technical and policy experts from the state, multiple development agencies such as the World Bank and European Commission, and non-governmental organizations. Inspiration for the act in part came from a

[23] Central Arid Zone Research Institute (CAZRI), 2009.

[24] Author's observations over a period of years, verified during field visit for IFC.

[25] Inland salinity is caused due to practice of surface water irrigation without consideration of ground water status. The gradual rise of ground water levels with time has resulted in water logging and heavy evaporation in semi-arid regions leading to salinity problems in command areas. In some areas of Rajasthan, ground water salinity is so high that the well water is directly used for salt manufacturing by solar evaporation.

World Bank study[26], and from the Government of India's 2005 Model Bill to Regulate and Control the Development and Management of Groundwater.

The objective of the draft bill is to promote conservation, augmentation, equitable distribution, and sustainable use of groundwater resources in Rajasthan. In addition to proposing to regulate future construction of groundwater extraction technologies such as tube wells and to monitor groundwater withdrawal, the draft act attempts to decentralize management by enlisting farmers into conservation monitoring.

The draft bill seeks to address the problem of unchecked water extraction by putting in place well-defined duties and functions for a proposed Rajasthan Groundwater Authority at the state, district and block (panchayat samiti or village body) levels, with specially appointed groundwater officers as executive chairmen. An important function is the registration of existing and new wells, well-digging agencies and rig-owners, and private water supply agencies. The block authority will have powers to take over unregistered existing wells and refuse permission for new wells. Registered well-digging agencies will be required to ensure that permission has been obtained by prospective well-owners and submit completion reports to the block authority, who in turn will test the quality of water and provide an official completion certificate. Electricity distribution companies will provide electricity connections for new wells only on production of the completion certificate by the well owner.

While the draft act envisages different user charges for water based on the nature of commercial activity and groundwater characteristics of the block, it does not provide any specific road map for allocating water in situations of water distress. The draft act provides for the levy of groundwater user charges as prescribed by the state authority. For urban domestic and rural agricultural use of groundwater, the state authority will fix an electricity bill limit per household per month. The amount by which the monthly bill exceeds the prescribed limit will be levied as groundwater user charge. The rationale for using electricity tariffs for computing groundwater user charges is not explained in the draft act. Electricity tariffs are based on the cost of production and distribution of electricity, which is unconnected with groundwater usage. The cost of groundwater management, conservation, and augmentation does not find mention in the draft act.

Groundwater user charges will be collected by electricity distribution companies (Rajasthan has unbundled its power sector into separate generation, transmission and distribution companies), who will hand over collected user charges to block groundwater authorities, who in turn will hand over the charges to the local bodies to be exclusively used for groundwater replenishment.[27] Currently, the fate of the draft act remains unclear.

2.3 Surface Water Resources and River Basins

Rajasthan is divided into fourteen river basins and an outside basin. Surface water resources are scarce and confined to the south and southeast of the state. The central and western parts of the state are devoid of any drainage and have very limited surface water, which too is not replenished due to low and erratic rainfall. High temperatures and low humidity in these parts further add to rainwater loss due to evapotranspiration.

[26] India: Bracing for a Turbulent Water Future, 2005, World Bank study

[27] The involvement of several agencies in collection and distribution of user charges could result in administrative inefficiencies and complexities.

The River Chambal, and according to some sources River Mahi, are considered the perennial rivers of the state; although actual availability of water is questionable. These rivers receive almost all their flow during the short monsoon months (see figure 9[28] for river basin map; appendix A provides basin facts).

The surface water available in all basins is 25,931 million cubic meters (MCM) as shown in figure 7. According to the planning department of this only 60 percent or 16,054 MCM is considered economically usable at 50 percent dependability. For the purpose of planning, an even smaller subset is taken into account.

Figure 7 Economically Usable Water by River Basin (in MCM)

Basin wise Availability of Surface Water (MCM)			
Basin	**Mean Availability (in MCM)**	**Economically Usable Water (at 50 percent dependability)**	**Percentage of Usable Water**
Shekhawati	221	105	47
Ruparail	210	180	85
Banganga	569	449	79
Gambhir	805	353	44
Parwati	226	138	61
Sabi	268	168	63
Banas	4,837	4,039	84
Chambal	11,541	5,203	45
Mahi	3,755	3,149	84
Sabarmati	960	800	83
Luni	1,224	452	37
West Banas	551	406	74
Sukli	190	112	59
Other Nala	91	32	35
Outside Basin	483	468	97
TOTAL	**25,931**	**16,054**	**62**

Source: Water Resources Planning Department, Government of Rajasthan. (1) Total resources in basin/region, (2) Water available for use (excluding non-potable portion) when 50 percent of available resource is being used (3) Percentage of (2) on (1)

Similar to the troubling block-wise groundwater situation explained earlier in this report, almost all river basins are over exploited, except the Mahi, West Banas and Sabarmati basins that are critical / semi-critical (figure 8). Notably, this data also indicates no groundwater is available for further irrigation projects.

[28] Basins shown on the map in figure 7 but not expanded in this section are: 1 - Shekhawati, 6 - Sabi, 12 - West Banas, 13 - Sukli, 14 - Other Nallahs of Jalore, and 15 - Outside Basin

Studies[29] to monitor adverse effects of climate change show the River Luni, along with west-flowing rivers of Kutch and Saurastra that occupy about 60 percent of the area in Rajasthan, face acute water scarcity. River basins of Mahi and Sabarmati are likely to also experience constant water shortage. This scenario calls for urgent efforts to mitigate diminishing water resources in these basins.

Figure 8 Groundwater by River Basin (MCM)

Basinwise Availability of Groundwater (MCM)									
Basin	Potential Zone (Sq Km)	Net Annual Availability	Gross for Irrigation Use (1)	Gross for Domestic/ Industrial Use (2)	Gross for all Use (1)+(2)	Allocation for Domestic/ Industrial Use (as on 2025)	Net Ground Water available for Irrigation	Stage of Ground Water Development (%)	Category
Shekhawati	9,495	504	972	112	1,084	243	(468)	215	Over Exploited
Ruparail	942	347	419	55	474	72	(144)	136	Over Exploited
Banganga	6,593	606	814	90	904	144	(352)	149	Over Exploited
Gambhir	3,616	349	409	47	456	73	(133)	131	Over Exploited
Parwati	4,880	154	186	18	204	29	(79)	133	Over Exploited
Sabi	400	426	644	44	688	64	(282)	161	Over Exploited
Banas	41,090	2,291	2,815	389	3,204	795	(1,319)	140	Over Exploited
Chambal	27,752	1,922	1,966	135	2,102	280	(325)	109	Over Exploited
Mahi	12,062	528	439	37	476	110	(21)	90	Over Exploited
Sabarmati	1,057	80	66	5	71	21	(4)	88	Semi Critical
Luni	24,548	1,040	1,567	119	1,686	235	(762)	162	Over Exploited
West Banas	1,187	76	65	3	68	7	4	90	Critical
Sukli	867	48	53	1	54	2	(4)	113	Over Exploited
Other Nala	1,750	100	250	9	259	16	(165)	258	Over Exploited
Outside Basin	80,330	2,063	2,317	463	2,781	689	(943)	135	Over Exploited

Source: Water Resources Planning Department

[29] Rajasthan State Action Plan on Climate Change (2012), Government of Rajasthan

Figure 9 River Basin Coverage on District Map

Source: Water Resources Department, Government of Rajasthan

- **Ruparail River Basin (2 in figure 9):** River Ruparail, also known as the Barah, has its source in the Udainath hills of Thanagazi Reserved Forest in Alwar District. It traverses these hills northwards, turning towards the east and northeast before flowing into Bharatpur district. The main urban agglomeration in Ruparail basin is Alwar city. Alwar district has a net sown area of 503,000 hectares with a total population of 3.67 million according to the 2011 census.[30] Mustard, pearl millet, and wheat are key crops grown in the district.

- **Banganga River Basin (3 in figure 9):** River Banganga originates in the Aravali hills, near Arnasar and Bairath in Jaipur district. It flows southwards up to the village of Ghat, then east through partly hilly and partly plain terrain. The main urban agglomeration in the basin is Bharatpur city situated at the eastern

[30] Basin wise population and cropping details are unavailable, therefore wherever possible, district details for the main agglomerate falling in the basin have been provided. While not an exact match, it helps in getting a sense of economic dependence in the area.

edge. Bharatpur district has a net sown area of 393,000 hectares with a total population of 2.54 million. Food grain, oilseeds, and pulses are key crops grown in the district. The second largest urban center is Dausa.

- **Gambhir River Basin (4 in figure 7):** River Gambhir originates in the hills near Karauli village in Sawai Madhopur district. It flows from south to north up to Kanjoli village (Toda Bhim), then towards northeast up to village Mertha of Roopbas block, before entering Uttar Pradesh (UP). The river again enters Rajasthan near Catchapaura village in Dholpur district and forms the boundary between UP and Rajasthan. The main urban agglomeration in the basin is Hindaun located in Karauli district, has a net sown area of 1.96 million hectares with a total population of 1.45 million. Mustard, wheat, and pearl millet are key crops in the district. The second largest urban center is Bayana.
- **Parbati River Basin (5 in figure 9):** River Parbati originates in the hills near Chhawar village in Sawai Madhopur district. It flows generally northeast for about 123 km before joining River Gambhir near Kharagpur village in Dhaulpur district.
- **Banas River Basin (7 in figure 9):** River Banas originates in the Khamnor hills of the Aravali range (about 5 km from Kumbhalgarh) and flows along its entire length through Rajasthan. Banas is a major tributary of the River Chambal. The two rivers meet near village Rameshwar in Khandar block in Sawai Madhopur district.
- **Chambal River Basin[31] (8 in figure 9):** River Chambal is a principal tributary of the River Yamuna and originates in the Vindhyan ranges near Mhow in Indore district of Madhya Pradesh (MP). The river flows through the states of Madhya Pradesh (MP), Rajasthan and Uttar Pradesh (UP). The basin is roughly rectangular in shape, with a maximum length of 560 km in a northeast-southwest direction. The river flows for some 320 km in a generally northerly direction before entering a deep gorge in Rajasthan at Chourasigarh, about 96 km upstream of Kota. The deep gorge extends up to Kota and the river then flows for about 226 km in Rajasthan in a northeasterly direction, finally forming the boundary between MP and Rajasthan.
- **Mahi River Basin (9 in figure 9):** River Mahi originates in the Mahi Kanta hills in the Vindhyachal range in the western part of MP and enters Rajasthan in Banswara district near Chandangarh. It leaves the state at Salakari village. On an average the river is about 100 to 130 meters wide and flows mostly through rocky terrain. The main urban agglomeration is Banswara situated at the southeastern end of the basin. Banswara district has a total population of 1.79 million. Food grain, oilseeds, and wheat are key crops in the district. The second largest urban center is Dungarpur.
- **Sabarmati River Basin (10 in figure 9):** River Sabarmati rises in the Aravali hills, which roughly marks the western boundary of Udaipur district and flows in a southwesterly direction.
- **Luni River Basin (11 in figure 9):** River Luni originates on the western slopes of the Aravali range at an elevation of 550 meters near Ajmer. After flowing for about 495 km in a southwesterly direction in Rajasthan, the river disappears in the marshy land of Rann of Kutch in the state of Gujarat. The water of Luni is sweet up to Balotra and becomes increasingly saline further downstream.

[31] Details of Chambal Valley Project can be found in section 7.2.1 of this report

3 Water Demand-Supply Gap

Agricultural use of water accounts for the consumption of 83 percent of available water resources in the state, drinking water for 11 percent, and industry/other uses for 6 percent. Fuelled by rising population and improved awareness of sanitation, non-agricultural demand for water is expected to go up to 8.07 billion cubic meters (BCM) in 2045 (against 3.28 BCM in 1995). Figure 10 shows the rising gap between demand and supply in the state. The current deficit is 8 BCM, and is expected to go up to 9 BCM by 2015.

Figure 10 Rajasthan Water Demand / Supply Gap (in billion cubic meters)

Purpose/Year	2005			2015			2045		
	SW	GW	Total	SW	GW	Total	SW	GW	Total
Demand									
Domestic	0.5	2.1	2.6	1.0	2.2	3.2	2.5	2.2	4.7
Livestock	0.1	0.8	0.9	0.3	0.8	1.1	0.5	0.8	1.3
Irrigation	20.0	15.9	35.9	26.0	14.0	40.0	36.0	13.1	49.1
Others	0.3	0.4	0.7	0.4	0.4	0.8	1.0	1.0	2.0
Total	**20.9**	**19.2**	**40.1**	**27.7**	**17.4**	**45.1**	**40.0**	**17.1**	**57.1**
Availability									
Intrastate	5.8	7.5		8.0	7.5		16.9	7.5	
Inter-State	12.2			13.0			15.0		
Sub Total			25.5			28.5			39.4
Recycled Water									
Domestic	0.8			1.1			1.1		
Irrigation		6.0			6.5			7.2	
Sub Total			6.8			7.6			8.3
Total	**18.8**	**13.6**	**32.4**	**22.1**	**14.0**	**36.1**	**33.0**	**14.7**	**47.7**
Shortage			**7.7**			**9.0**			**9.4**

Source: Vyas Committee report

The average per capita water availability in the state is said to be in the range of 640 to 780 cubic meters on the basis of projected population (as on July 2009). This is against the generally accepted requirement of 1000 cubic meters. The availability is expected to further drop below 450 cubic meters by 2050, which is below the international minimum of 500 cubic meters or absolute water scarcity

In terms of supply, 88.5 percent of villages and habitations in the state receive less than 40 liters per capita per day (lpcd) of water. Of these, 8 percent receive less than 10 lpcd, 33 percent between 10 to 20 lpcd, and 41 percent between 20 to 30 lpcd. The supply-demand gap is also reflected in the proportion of households reporting purchase of water in rural Rajasthan, which is the highest in the country.[32]

[32] Drinking water and sanitation in India: Need for demand management structures, 2003, Reddy and Mahendra

In the urban context, at the aggregate state level, the demand for water (1,803.84 million liters per day or MLD) outstrips installed capacity (1,798.91 MLD), and supply of water (1,475.71 MLD)[33]. The situation is more precarious in towns where shortage could be higher. According to estimates,[34] in 2015 the demand for water in Rajasthan in various sectors will be (in cubic millimeters/year): 3,176 domestic, 71.4 industrial, 1,089 livestock, and 715 for other uses. This adds up to a total demand of 5,051.4 cubic millimeters per year, or a 54 percent jump in the two decades since 1995.

3.1 Industrial Water Demand

Rajasthan is undergoing an industrial transformation. Two important projects, Dedicated Freight Corridor (DFC, being implemented by the Ministry of Railways) and Delhi Mumbai Industrial Corridor (DMIC), could bring rapid industrial development to the state since about 58 percent of the state's area across 22 districts lies in the area of influence of these corridors. Water availability is critical in developing infrastructure resulting from these projects, translating into further pressure on very limited resources.

Industrial water demand in Rajasthan was around 45.5 million cubic meters (MCM) per year in 1995, projected to grow to 138.44 MCM/year in 2045.[35] According to the new industrial promotion policy, 10 percent water in new dams and projects will be reserved for industrial development[36].

Industries that are being encouraged through government policy and present factor advantages include tourism, cement, mining and metals, auto components, information technology/information technology enabled services and electronics, and biotechnology. Other industries where the state enjoys an established reputation are textiles, gems and jewelry, marble, ceramics, and agro-based industries. Among these, water consumption in cement plants, textiles, and marble[37] is particularly high.

The Rajasthan State Industrial Development and Investment Corporation Limited (RIICO) has developed 257 industrial estates including six growth centers and ten industry development centers in the state to provide infrastructure including social and financial amenities to industrial units. RIICO has acquired 20,089.7 hectares of land and has developed an area of 14,087.20 hectares. This boost to industry translates into increased water pollution and demand for water. Figure 11 shows industrial clusters in Rajasthan. Appendix E lists the notified, approved, and operational special economic zones (SEZs) in Rajasthan.

[33] Water Sector Performance, 2010, Reddy. Based on data provided by the Chief Engineer, Urban, PHED (office records, period of data unknown).

[34] Rajasthan Development Report, Planning Commission, 2006. Source: Water Resources Planning for the State of Rajasthan, Tahal and WAPCOS, 1998. Demand from agriculture sector not presented in the source.

[35] Water Resources Planning for the State of Rajasthan, Tahal and WAPCOS, 1998

[36] Draft Annual Plan 2013-14

[37] Rajasthan produces 91 percent of the marble in India, guzzling around 2.75 million liters of water per hour.

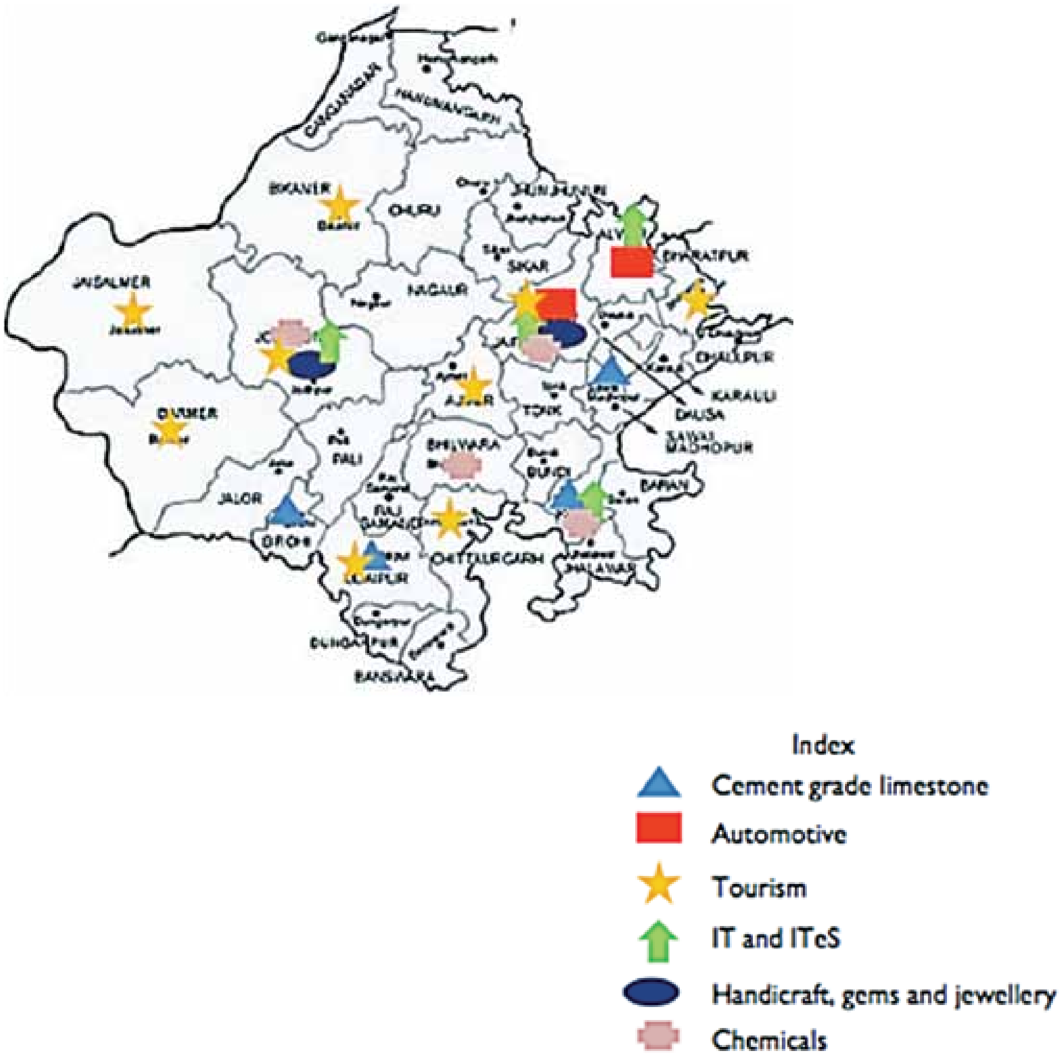


Figure 11 Industrial Clusters in Rajasthan

Source: Rajasthan, April 2010, India Brand Equity Foundation (IBEF)

4 Drinking Water Supply

Rajasthan has severe drinking water supply problems. In the hilly southeastern region, groundwater is available only in some parts of the valleys as the water table fluctuates rapidly due to the rocky geographical formations in the area. Reservoirs in the area dry up and create severe water crisis during years of continuous drought. The western desert area and Aravali region often face drought conditions due to scanty and erratic rainfall. There are only a few reservoirs in these areas. The soil is basically alluvial with limestone and allied sedimentary rocks, which are good aquifers. But increased demand for agriculture, industrial, and domestic use is fast depleting groundwater reserves and affecting water quality. The available water has high total dissolved solids, salinity, fluoride, and nitrates. The Gang-Bhakhra canal system, the Indira Gandhi Nahar Pariyojna (IGNP) in the northwest, and now Narmada canal system in the south are the only reliable drinking water sources in the region.

In addition to geographical problems, the high population growth rate (one of the highest in the country at 21.44 percent decadal growth), and its distribution over sparsely populated pockets has aggravated the problem of providing safe drinking water. The population density in the state has increased from 129 per square kilometer in 1991, to 165 in 2001 and 201 by 2011. Around 70 percent of habitations in the state face problems getting potable drinking water.

During the Eleventh Five-Year Plan (2007-12), 24 major projects amounting to $404.5 million have been completed with an expenditure of $129.6 million and 14 towns, 1,755 villages and 235 hamlets have been covered.[38] Around $2.67 billion has been allocated for water supply in the Twelfth Five-Year Plan (2012-17), of which an outlay of $372.8 million is proposed for urban and rural water supply schemes in the current annual plan (2013-14).[39] These schemes include 21 major water supply schemes and nine new projects to help meet the growing drinking water needs of the state.

4.1 Rural Drinking Water Supply

Currently, 85 percent of all rural water supply schemes are dependent on groundwater. Over the years, severe depletion in groundwater table due to over-extraction for agriculture has led to deterioration in water quality, making a large number of drinking water sources unsustainable. Additionally, large geographical areas have high concentrations of dissolved chemicals such as fluoride and chloride, making water unsafe for drinking.

The poor condition of rural water assets and infrastructure is reflected in the extent of water loss due to leakage in the rural water supply schemes, which is estimated at 40 to 50 percent. Infrastructure, in terms of overhead tanks and distribution lines, was constructed in order to provide piped water supplies to rural areas. Almost all these schemes depend on groundwater. In a majority of the cases, these water supply schemes have become defunct due to depleted groundwater aquifers. Hence, the infrastructure and physical capital is lying unused and dilapidated. A negative effect associated with this is the neglect of traditional water bodies that had once sustained life in rural Rajasthan. In the hope of getting assured piped water, rural communities have neglected the management of these traditional systems, which have degenerated over time.

[38] Twelfth Five-Year Plan (2012-17), Planning Department, Government of Rajasthan

[39] Draft Annual Plan (2013-14), Planning Department, Government of Rajasthan

There are about 122,250[40] rural habitations in the state. Of these, roughly 30 percent or 34,880 habitations have problems with water quality. Of these more than half have multiple quality problems. In terms of service, according to the Public Health and Engineering Department (PHED), a little over half of rural habitations or 65,415 are fully covered[41] while 32 percent have no coverage. The coverage status of rural habitations is given in figure 12.[42]

Figure 12 Rural Drinking Water Coverage in Quality and Non-Quality Affected Areas

Type of Habitation	Level of Service Coverage						
	0 percent	0-25 percent	25-50 percent	50-75 percent	75-100 percent	100 percent	Total
Non-quality affected*	4,618	5,830	4,392	4,212	2,183	65,018	86,253
Quality affected	33,893	243	151	149	47	397	34,880
Total	**38,511**	**6,073**	**4,543**	**4,361**	**2,230**	**65,415**	**121,133**

*Source: PHED, Government of Rajasthan *Assumed to be relatively less impacted with water quality issues*

Another way of looking at drinking water coverage in rural Rajasthan is with data from the planning department as presented in figure 13. Around 14 percent of habitations have slipped out of coverage. Maintaining water supply coverage in rural areas is a constant challenge due to the type of coverage in these areas (see the hand-pump situation described next in this section).

Figure 13 Rural Drinking Water Coverage

Particulars	Total Number (percentage of total)
Not covered due to quality	34,183 (28)
Not covered due to source being > 1.6 km away	31,030 (25)
Slipped back to pre-coverage level (< 40 lpcd)	17,159 (14)
Fully covered	39,878 (33)
Total	**122,250 (100)**

Source: MTR, Eleventh Five-Year Plan, Planning Department, Government of Rajasthan

[40] There are approximately 39,617 main habitations, and 82,633 other habitations in the state. There is a slight variation in total reported by PHED and other sources.

[41] According to the Rajiv Gandhi Drinking Water Mission guidelines, villages and habitations are defined according to the 2001 census definition. The coverage norms are: Not covered = No water source at a distance of 1.6 km in plains or 100 m elevation in hilly areas; non-availability of safe water of at least 10 lpcd, Partially covered = Supply of drinking water is less than 40 lpcd. Fully covered = Entire population in all habitations including the main habitation in provided with good quality of drinking water according to the norms of the mission.

[42] Coverage data dated April 2010. In Figure 13, columns depict level of service, while rows divide habitations on the basis of water quality.

Families in rural areas including those living below the poverty line (BPL) have to pay regularly for water since government supply is limited to extremely dry months. Rajasthan has the highest incidence of rural households purchasing water. Water in rural areas is generally transported by camel carts or tractor tankers and costs about Indian rupees 400 ($8) per load, and this price can more than double in crucial months of water scarcity. This is significant cost for families living in worst affected areas, which earn daily wages of Indian rupees 100 ($2) and are sometimes unable to find employment on all days. Due to lack of resources, groups of families commonly share a storage tank, which needs refilling every two or three days.

Over half the villages in the state are covered by hand-pumps (public stand post model). About 23 percent of these pumps are either unfit or unusable due to their location (areas where there is no water or water is of very poor quality), causing the areas covered under these water supply schemes to often slip out of coverage. Each hand pump (India Mark II) costs about Indian rupees 44,000 ($800), and more than half of them are under repair at any given time of the year. Figure 14 shows coverage in villages by scheme.

Figure 14 Village Rural Drinking Water Supply by Scheme

Type of Scheme	No. of Villages Covered	Percentage
Piped water supply scheme	2075	5.22
Pump and tank water supply scheme	3803	9.57
Regional water supply scheme	11,510	28.96
Hand pump scheme	19,214	48.33
Total sanitation schemes	1,711	4.30
Diggis[43] and others	1,438	3.62
Total	**39,751**	**100**

Source: Draft Annual Plan 2013-14, Planning Department, Government of Rajasthan

Groundwater sources in Rajasthan are no longer dependable due to the limitations of quality and quantity. The state is therefore planning major coverage through surface water resource-based projects that are considered sustainable and reliable. The River Chambal and its tributaries, the IGNP, and Narmada canal are the only dependable perennial surface water sources in the state. These projects involve long transmission systems, making them highly capital and timeline intensive.

The state government has taken up a number of drinking water supply projects based on surface water resources. Under the Bharat Nirman scheme, 77,052 habitations were identified as having drinking water issues as on April 2005. As of March 2012, of these, 50,323 habitations have been identified as problematic habitations; many of these have multiple quality problems. The surface water source-based projects have solved the drinking water problems in 14,314 of these habitations.[44] The remaining habitations are to be covered on completion of the major water supply projects that are currently underway.

[43] Diggis are intermediate water storage structures created in Indira Gandhi Canal Pariyojna (IGCP) to mitigate risks of unreliable and scarce delivery of water through canals.

[44] Draft Annual Plan (2013-14), Planning Department, Government of Rajasthan

4.2 Urban Drinking Water Supply

Pressure on urban centers in the state is growing. Jaipur city, a metropolis with a population of 2.3 million, has grown by 59.37 percent over a decade, one of the highest among metropolitan cities in India. The supply of safe, hygienic drinking water to urban populations is undoubtedly a top priority for the state government. All 222 towns (183 municipal towns) are covered by piped water supply from 124 schemes. Of these schemes, 14 are based on surface water, 54 on both surface and groundwater, and the remaining 156 are entirely dependent on groundwater. However around 30 percent of the peripheral population in urban areas still remain uncovered.

Uncertainty over the availability of groundwater, in terms of quality as well as quantity, makes urban water supply as precarious as supply to rural areas. The levels of service and quality of drinking water are far from satisfactory. Frequency of water supply in urban areas varies; once in 24 hours for 161 towns, once in 48 hours for 49 towns, and once in 72 hours in 12 towns.[45] During summer, when the crisis is at its height, water is often transported to towns in trains and tankers.

According to the 2011 census, only 82.6 percent of urban households in the state had tap supply, and 78.2 percent households had the source of water located within their premises.[46] Forty-two municipal towns located in canal irrigated areas or near big reservoirs had surface water sources, while 141 municipal towns depended on groundwater. Only 10 percent or 23 towns got more than 100 liters per capita per day (lpcd) water against the 135 lpcd standard (figure 15 shows supply for all urban areas).

Figure 15 Water Supply in Urban Areas

Liters per capita daily (lpcd) supply	Number of towns	Percentage of total towns
Below 40	16	7.21
40-60	74	33.33
61-80	79	35.58
81-100	30	13.53
Above 100	23	10.35
Total	**222**	**100**

Source: Mid Term Review, Eleventh Five-year Plan (2007-12), Planning Department, Government of Rajasthan

[45] Chapter 22, Mid-Term Review, Eleventh Five-year Plan (2007-12), Planning Department, Government of Rajasthan

[46] Census 2011, http://www.devinfolive.info/censusinfodashboard/website/index.php/pages/drinking_water/total/Households/IND

4.3 The Role of Public Health and Engineering Department

The Public Health and Engineering Department (PHED) is currently responsible for planning, designing, and building, operating and maintaining urban and rural drinking water supply. Institutional reforms have been proposed to improve delivery by separating roles and responsibilities and increasing accountability. This would also be guided by the 73rd and 74th Constitutional Amendment Act requiring delegation of power and authority relating to drinking water supply to the urban local bodies (ULBs) and panchayat raj institutions (PRIs), or village bodies, with government's role restricted to policy planning, facilitating, and regulating.

The following broad organizational reforms have been proposed to restructure the PHED:

1. Intra-village systems for distribution of drinking water supply to be handed over to PRIs.
2. Drinking water supply in urban towns to be handed over to ULBs. Since not enough capacities exist with ULBs, autonomous companies will be created for the seven divisional headquarters and regional utilities for other major towns. A report by the World Bank[47] has made recommendations for the institutional sector as a medium term vision for 2017. These include:
    - Separate utilities companies, owned by ULBs/state level intermediaries/state government, will be set up for large cities that will be responsible for operation and maintenance of groundwater and sewerage assets, water distribution, and service provision
    - The restructured PHED will be the bulk water provider to corporatized city-based utilities/ regional utilities
    - A few regional utilities serving multiple towns as well as adjoining rural areas will be created
    - A regulatory commission for tariff setting and quality to be set up
    - Water and sewerage policy including financial framework to be prepared and implemented
    - Professional consultants will draft a detailed road map for the creation of companies and modalities to transfer responsibilities to these companies.
3. Bulk transmission of water up to towns/villages to be handled by the Rajasthan Water Supply and Sewage Corporation (RWSSC). In its new role, RWSSC will conduct operation and maintenance of all major water supply projects, supply bulk water to ULBs, PRIs, PHED and other consumers, and collect revenue from the sale of this bulk water. This will be a purely commercial arrangement.
4. PHED in its new role will (a) regulate and allocate water to different utilities, (b) focus on overall planning for the state and related policy matters, and (c) provide interface between Government of India and external funding agencies, among others, on drinking water projects.

[47] Urban Water Supply and Sanitation Sector Strategy and Business Plan, along with specific road map and action plan for Rajasthan, World Bank

5 Water Quality and Water Logging

In the national context, 74 percent of all habitations with multiple quality issues in the country are located in Rajasthan, including 51 percent of all fluoride affected areas, and 42 percent of all saline affected areas. Large areas of the state have such high salinity that the water is unfit for cattle and other domestic use such as washing or cooking. Despite this, people drink saline water during the summer in many parts of the state. Fluoride is the most widespread, while salinity and nitrates are other serious problems. The worst affected districts include Tonk, Churu, Barmer, Pali, Sirohi, Jalore, Rajasmand, Ajmer, Nagaur, Jhunjhunu, Barmer, Bharatpur, Bhilwara, Jodhpur, Baran, and Jaipur. Increasing pollution by industrial units and unregulated mining of water from deep wells is adding to the water quality problem in a number of districts.

Intensive surface water irrigation often causes water logging and increased salinity, which are major environmental threats. In Rajasthan water logging is the other major threat to surface water quality as seen in the canal command areas (CCAs). The primary cause of water logging is an imbalance within the groundwater body underlying the affected area. This imbalance is a result of several factors, most important being more water being available than what can be used, leading to over irrigation in the command areas that were developed initially. Additionally the sandy soils found in more than 60 percent of these command areas have poor water holding capacity,[48] as a result as much as half of the water applied for irrigation percolates down into groundwater. Other contributors to water logging are seepage from canals and inefficient irrigation practices. As the water table rises, it prevents effective drainage due to capillary action. Water rises to the surface with dissolved salts and evaporates, leaving the salt to accumulate on the soil surface and causing secondary salinity in the soil and groundwater. The problem of water logging has become more evident in recent years.

[48] Surface and Groundwater Resources of Arid Zone of India: Assessment and Management (2009), by Goyal, Angchok, Stobdan, Singh, Kumar, for Central Arid Zone Research Institute (CAZRI)

5.1 Groundwater Quality

Rajasthan is over-dependent on groundwater. The major problems associated with groundwater quality are fluoride, nitrate, and salinity. The worst affected districts with 50 percent or more concentrations are[49]:

- **Fluoride > 1.5 mm:** Tonk, Churu, Barmer, Pali, Sirohi, Jalore, Rajasmand
- **Nitrate > 100 ppm:** Churu, Nagaur, Jhunjhunu
- **TDS > 2000 ppm:** Churu, Barmer, Bharatpur
- **Iron > 1ppm:** Bhilwara, Jodhpur, Baran, Jaipur

In addition, many parts of the state encounter high levels of total dissolved solids (TDS) in drinking water, well above 1,000 mg/liter against the WHO standard of 500 mg/liter. Figure 16 compares the magnitude of the problem with the rest of the country, and highlights the worst affected districts in the state.

Figure 16 Groundwater Quality in India and Rajasthan

Particulars	India	Rajasthan	Percentage of Country	Main Affected Districts in Rajasthan*
		Villages / Habitations		
Only Fluoride	17,986	7,130	39.64	Jaipur, Tonk, Nagaur, Ajmer, Bhilwara, Sirohi and Pali
Only Salinity	22,985	18,924	82.42	Churu Bharatpur, Barmer, Jhunjhunu, Nagaur and Ajmer
Only Nitrate	2,758	624	22.62	Jaipur, Nagaur, Barmer, Udaipur, Jodhpur, Churu, Alwar and Tonk
Only Iron	56,144	46	0.08	
Only Arsenic	4,314	5	0.12	
TOTAL	**104,160**	**26,729**	**25.6**	

*Source: Draft Annual Plan (2013-14), Planning Department, Government of Rajasthan. *From Environment Management and Action Plan of SWRPD Report, February 2013*

[49] Environmental Management Guidelines and Action Plan of SWRPD for Water Sector in Rajasthan, Government of Rajasthan

5.2 Surface Water Quality

The two major causes of surface water pollution are sewage water and industrial effluent. None of the towns in the state, except Jaipur, have sewage collection, treatment, and disposal systems. Phase-I of the Rajasthan Urban Infrastructure Development Project (RUIDP) is constructing sewage systems with treatment plants in Jodhpur, Kota, Ajmer, Udaipur and Bikaner. Under Phase-II, RUIDP will cover fifteen towns: Alwar, Baran-Chhabra, Barmer, Bharatpur, Bundi, Churu, Chittorgarh, Dholpur, Jaisalmer, Jhalawar-Jhalarapatan, Karauli, Nagaur, Rajsamand, Sawai Madhopur, and Sikar.

In uncovered towns, sewage and wastewater is carried through open drains running along the roads and is ultimately discharged into a water body (tank or river). The construction of septic tanks is a common practice in towns that do not have sewerage systems.

The Central Pollution Control Board (CPCB) has identified highly polluting industries in Rajasthan: textiles, cement, distilleries, fertilizers, pharmaceuticals, and thermal power plants. Industrial water pollution in the state is mainly confined to Kota, Alwar, Udaipur, Jodhpur, Pali, Balotra, Sanganer, Bhilwara, Jhotwara, and Bagru areas. Large industries have their own effluent treatment plants. Small-scale industries located in and around urban areas do not have treatment facilities. The government has planned common effluent treatment plants (CEPTs) in the following industrial areas: three in in Pali, and one each in Balotra, Jodhpur, Bhiwadi, and Manpura Machhedi in Jaipur.

5.3 Industrial Effluent

In arid western Rajasthan, scarcity of raw material and skilled labor, combined with difficult physiographic conditions, had meant very limited industrial development until the 1970s. Since then, many industries based on local raw materials have sprung up. Many of these discharge high amounts of effluent, adding to the state's water woes. Jodhpur, Pali, and Barmer (Balotra) have numerous dyeing and printing works. Other major water polluting industries are smelters, thermal power plants, major brick/lime kilns, stone crushers, and mines. Industrial water pollution is a problem in several parts of the state such as Bhilwara, Udaipur, Jaipur (Sanganer), Kota, Pali, Barmer (Balotra), Jodhpur, Pali, Kishangarh, Makrana and others. Listed here are some facts that give an idea of the magnitude of the problem:[50]

- In Pali district, 916 textile units have been identified as polluting units, daily discharging more than 36,000 cubic meters high pH domestic and industrial effluents containing high levels of chemical oxygen demand (COD), biochemical oxygen demand (BOD), total dissolved solids (TDS), total suspended solids (TSS), chlorides, sulfate, and sodium into the River Bandi.
- In Jodhpur, 632 industries, including 183 dyeing and printing works and 65 steel rolling units daily discharge about 15,000 to 17,000 cubic meters of polluted wastewater into the River Jojri along with municipal sewage.
- Balotra in Barmer district has 222 water polluting textile units. In Balotra and Jasol, the wastewater from textile units is about 11,000 cubic meters daily, mainly discharged into the River Luni.

[50] Data on number of units, and effluent discharge can be somewhat dated but provides a sense of the issue at hand. If anything, one would expect the numbers to have risen, further intensifying the problem.

- In Sanganer and Bagru districts of Jaipur district, 400 small, medium, and large-scale textile units, blue pottery units, paper and pulp units, and domestic sewage have been identified as responsible for water pollution.
- In Kota, chemicals, alkali, and rayon industries, a thermal power project, 212 textile units, and 101 rolling mills have been identified as polluting industries.
- Pollution in Udaipur is mainly because of the 200 small and large-scale zinc smelters and fertilizer, chemical and pesticide units.
- In Alwar, 400 units such as breweries, chemical factories, and distilleries are polluting the water.
- Bhilwara is famous for its large scale printing, weaving, and dyeing houses, and also has its ground water polluted to a large extent.
- The mining units at Makrana (Nagaur), Rajsamand, Modak, Aandhi (Jaipur), and Dholpur are also responsible for water pollution due to discharge of marble and stone slurry.

Industrial effluents discharged from these industries contain alkalis, residual dyes, starches and cellulose, soluble salts with mainly sodium and calcium, silicates, oils, and other impurities. The effluents are discharged untreated due to the lack of economically viable technologies. As a result, groundwater quality and biophysical resources in several areas such as along the Jojri, Bandi, and Luni rivers are rapidly deteriorating. The continuous use of polluted groundwater for irrigation has sharply reduced cropping intensity, crop production and density, and biomass in terms of trees, shrubs, and grasses. The soils have become compact, impervious and hard, resulting in the formation of a surface crust. Due to the increasing impact of industrial effluents, a large numbers of wells have now been abandoned and a large area of cultivated land has been degraded and turned into wasteland. The use of polluted water for growing food and fodder, and for drinking, has created health hazards for humans and livestock.

As mitigating measures, some units have installed their own treatment plants and recycle water for non-essential purposes such as gardening. The government has set up CETPs at certain industrial locations. In Pali, for example, the Rajasthan high court has ordered the installation of flow meters in April 2008 to check industrial effluents from entering the River Bandi. The court said the effluents should not exceed the capacity of the three CETPs (upgraded at a cost of $2 million in 2008) in the textile town. The industrial units together had spent over $4 million installing 330 meters till May 2009 but the industries claim no one is monitoring them, and that many of the flow meters are non-functional. Some media reports[51] quote officials from RPCB saying there is no court mandate on monitoring the meters and that the trust managing CETPs should monitor them (whereas the trust lays the responsibility with the pollution control board). Separately, the Center for Science and Environment (CSE) has launched a program in Pali to enable the community to monitor water pollution in the local area. About 60 farmers were trained to use testing kits, which test for arsenic, chromium, lead, nickel and zinc.

[51] No check on effluents - Industrial town spent $368 million on flow meters that no one monitors, May 30, 2009, by Ramya Swayamprakasham in Down to Earth

5.4 Water Logging

Water logging is a severe problem in outside basin and Chambal basin. The causes are seepage from canals in the outside basin, and over irrigation in Chambal basin. The mean rate of water table rise is 1.1 meter per year in stage-I of IGNP, 0.81 meters per year in Ghaggar plain, 0.85 meters per year in Bhakra command, and 0.64 meters per year in Gang CCAs.[52] As a result of rise in water tables, 145,600 hectares has turned critical (water table within six meters of land surface). A far more serious problem is anticipated in stage-II of IGNP due to an underground hard substratum of gypsum within 10 meters of the surface, making about 34 percent of the gross command area or 120,500 hectares vulnerable to water logging.[53] Experts believe thousands of hectares of land will be submerged in 25 to 30 years.[54]

Waterlogged areas suffer from drastic reduction in crop yields. Farmers temporarily shift to crops such as paddy; however abandon their lands after a year or two when even these crops are unable to sustain increasing water logging and salinity. The resulting employment loss is a serious socioeconomic challenge, while the degradation of limited water and land resources is an environmental threat.

The problem has been addressed in parts of Chambal CCA by introducing subsurface drainage systems. However the problem still persists in the IGNP areas. Some mitigating efforts are underway, as in the IGNP area, by extending area under irrigation command and reducing quantity of water used, large-scale plantation and conjunctive use of surface and groundwater. These problems have also been observed in some of the medium and minor irrigation projects. As state surface water resources become scarcer due to rising demand and impact of climate change, there is a need to manage these resources more effectively, rather than losing them to water logging.

[52] Surface and Groundwater Resources of Arid Zone of India: Assessment and Management (2009), by Goyal, Angchok, Stobdan, Singh, Kumar, for Central Arid Zone Research Institute (CAZRI)

[53] Rahmanai and Soni, 1997, in Indira Gandhi Nahar Pariyojana—lessons learnt from past management practices in the Indian arid zone, K. D. Sharma, Central Arid Zone Research Institute (CAZRI).

[54] Chouhan,1988. It should be noted in Lune-ki-dhani, Dabli Kalan, Dabli Khurd and Rampur villages in stage I and near Madasar village in stage II, 0.6-3.5 meter water is standing in the cultivated fields. The houses have collapsed and villages are abandoned.

6 Water Tariff

During 1991 to 2000, the Public Health and Engineering Department (PHED) spent three times its revenue to meet the rising demand for drinking water. The revenue-expenditure gap has risen over the years. This has been the story in most Indian cities, and some have taken steps to counter it. The Bangalore Water Supply and Sewage Board (BWSSB) has revised rates by almost 20 percent every year since 1991 to enable operations on a no loss no profit basis. Service agencies that have taken loans from financial institutions like the Housing Urban Development Corporation (HUDCO) have also revised their rates. The Confederation of Indian Industries (CII) has called for rate increases to meet operating and maintenance (O&M) expenses. Several urban infrastructure projects have inbuilt conditions regarding commercialization of urban infrastructure projects to ensure no losses. Rajasthan has also demonstrated some willingness to do this for projects under implementation. Tariff reform is highlighted as an important goal in various planning and policy documents released by the state.

Water distribution today is an open system with no checks in place on withdrawals. Consumers at the tail end of the network are often left with little or no water due to poor pressure, defeating the objective of equitable distribution of water. Metering to discourage excessive consumption of water is a must. This would go hand-in-hand with a tariff structure that covers O&M costs. Figure 17 shows the existing water tariff for domestic consumers. This structure has been in place since 1998, which is not only outdated, but was inadequate even at the time it was first introduced.[55] The result has been that consumers have developed a water is free mindset, resulting in unscrupulous use of drinking water, resulting in water scarcity for populations in low-pressure areas.

[55] Over a 30 year period in Rajasthan, tariff for minimum consumption increased by 300 percent but from a very low base. Average monthly bills for 10 cubic meters have been $3, and $6 for 20 cubic meters. Source - Regulating Water and Sanitation for the Poor: Economic Regulation for Public and Private Partnerships, Franceys and Gerlach, 2012

Figure 17 Existing Water Tariff (Applicable since 1998)[56]

Water consumption per month	Water tariff (Indian rupees*/ kiloliter)	Average per capita per day consumption for five-member household
< 15 kl	1.25	100 liters
< 40 kl	2.40	267 liters
> 40 kl	3.20	> 267 liters

*Source: PHED, Government of Rajasthan (*approximately Indian rupees 55 to $1)*

The recoveries have been far from adequate. Currently O&M costs of drinking water supply schemes are more than $185 million while revenue is about 20 percent of this. The power consumed alone costs three times revenue collection. The difference in per unit cost of water compared to user charges has led to a cycle of higher subsidies (estimated at 74 percent)[57] to consumers with higher consumption (and likely higher wastage).

Lack of proper consumer metering means there is no basis for proper tariff.[58] This fact is clearly highlighted in appendix B which shows the tariff structure for all urban areas of Rajasthan, along with the basis for charges (metered or unmetered), across domestic, non-domestic and industrial use. While the data is dated, it is representative of the tariff structure in place currently. The urban centers of Rajasthan have a block tariff structure for domestic and non-domestic[59] connections.

As part of PHED's reform agenda, the minimum quantity of water required per person per day to meet basic needs, also called lifeline consumption, is being determined to arrive at tariff rationalization. Water will be treated as a social good up to lifeline consumption, and an economic good beyond this. Accordingly, tariffs will vary from affordable tariff up to lifeline (data from other states will be studied to establish this), full O&M costs recovery from this level to the next, recovery of O&M costs plus financing cost for higher consumption, and full cost with different premium rates as consumption increases. Minimum efficiencies will be factored in to determine tariffs under this model, and non-domestic and industrial users will pay a premium. The status of these proposed reforms remains unclear.

[56] Verified tariff structure to be from 1998, as of 26 April 2013. Source: PHED, Government of Rajasthan http://www.rajwater.gov.in/w_tariff.htm

[57] Rajasthan Development Report, Planning Commission, Government of India

[58] Only 3 percent of consumers pay flat rate tariffs. Since 1990 all new connections have been metered, such that 92 percent of customers now have metered supply, but around 50 per cent of the meters do not work. Source: Franceys and Gerlach, 2012

[59] Non-domestic tariffs are of two types: in some cities all non-domestic uses are combined together under one head "non-domestic", while in other cities non-domestic uses are broken up into industrial, commercial and institutional uses. In yet other cities, industrial tariff has been separated while tariff for all the other non-domestic uses have been combined together.

6.1 Price Gap

The price gap is the difference between supply costs and actual price charged. The difference between the O&M costs and the revenue from user charges is also used, since recovering O&M charges alone constitutes an efficiency indicator in most developing countries. This study considers the difference between O&M costs and tariffs charged as the price gap for irrigation water supply. For drinking water supply and sanitation, costs include bulk production, treatment and distribution charges.

Figure 18 Price Gap - Water Supply and Sanitation in Select Cities

City	Supply Cost (Indian rupees**/ kiloliter)	Price (Indian rupees/ kiloliter)	Price Gap percentage*
Jaipur	7.66	1.25 – 3.20	70
Jodhpur	14.5	1.25 – 3.20	84
Kota	5.08	1.25 – 3.20	55
Bikaner	9.65	1.25 – 3.20	76
Udaipur	21.44	1.25 – 3.20	89

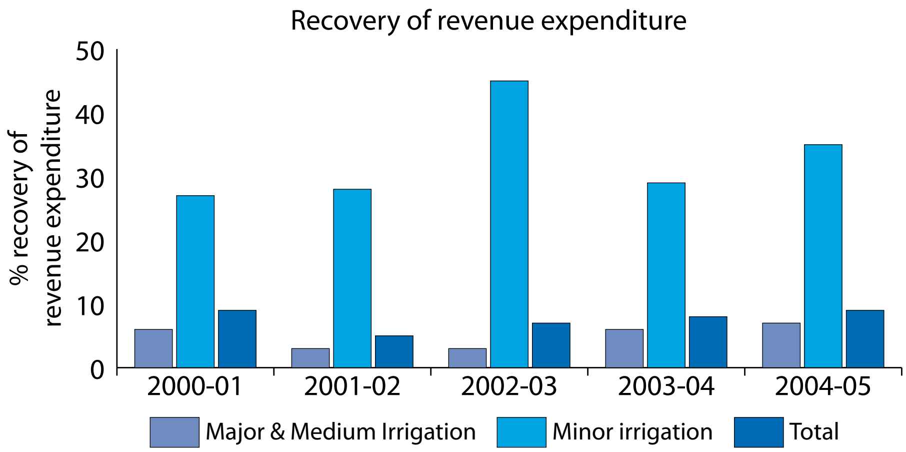
*Source: Water Sector Performance (Reddy). *Estimated by taking average price, gap would be much less for commercial and industrial users (**approximately Indian rupees 55 to $1)*

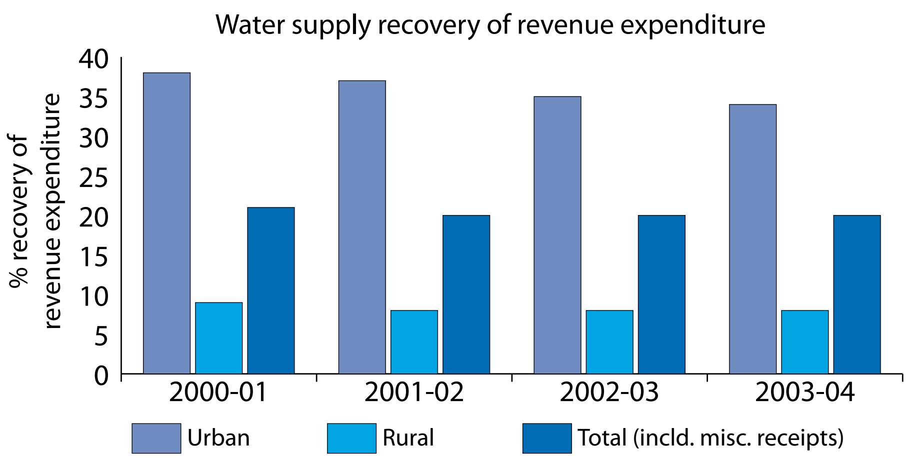
The O&M costs for surface irrigation are about Indian rupees 642 per hectare ($12) while irrigation tariffs range between Indian rupees 75 and 290 per hectare ($1.4 and $5.35) depending on the crop and its water requirement (last revised in 1999). The price gap is more than Indian rupees 400 per hectare ($7.4), considering an average price of Indian rupees 200 per hectare ($3.7).

In the case of drinking water and sanitation, the gap ranges between 55 percent in Kota and 89 percent in Udaipur (see figure 18). Supply costs depend mainly on the source of water supply. Recoveries are less than 10 percent in the case of major and medium irrigation and rural water supply, while urban water supply and minor irrigation recoveries are higher, though still less than 40 percent (figure 19).

Only 1.5 to 2 percent budget is available for O&M costs of water supply schemes, against 6 percent capital costs. Present allocations within O&M are also inadequate, since a substantial share goes towards establishment and power charges. For instance, in the case of irrigation systems only 20 percent of O&M costs are allocated towards maintaining distribution, and another 15 percent towards managing drainage systems in the case of large schemes. In the case of urban water supply, more than 90 percent of O&M goes towards power charges and salaries. Such depressed recoveries are unable to sustain service to users, nor can water assets be maintained to ensure efficient use of the limited water resources.

Figure 19 Cost Recovery in Irrigation and Drinking Water Supply





Source: Water Sector Performance (Reddy)

7 Agriculture-Water Nexus

Rajasthan is a predominantly agrarian state. Around 70 percent of the state's labor force is engaged in agriculture and allied activities, including 13.17 million cultivators, 2.53 million agricultural laborers, and 0.6 million workforce.[60] In economic terms, the sector contributes roughly 22 percent to the state domestic product. According to the land use figures of 2010-11,[61] of the 34.3 million hectares total land area in the state, 53.54 percent was the net sown area (NSA) or cultivable land, 12.35 percent was cultivable waste, 8.65 percent fallow, 8 percent forest, 4.95 percent pastures/grazing, 6.94 percent barren/uncultivable land, 5.51 percent was put to non-agricultural use, and 0.06 percent was land under miscellaneous crops/trees not included in the NSA. The average land holding size in the state is 3.96 hectares, compared to 1.41 hectares nationally.

Even though agriculture currently uses 83 per cent of total water resources of the state, in 2010-11 only 36.3 percent or 6.66 million hectares was irrigated of the 18.34 million hectares of NSA. Thus, around 70 percent of agriculture in the state is primarily rain-fed. Of the irrigated land area, a massive 73 percent is dependent on groundwater (wells and tube-wells), while the remaining is almost entirely dependent on canal irrigation (about 25 percent of all sources), vulnerable to ill-timed water supply based on inflow in rivers, dams and reservoirs, that causes critical gaps in irrigating crop growth stages. Due to rising demand for water for both agriculture and non-agriculture purposes, share of water available for agriculture is set to reduce to 70 percent by 2050[62]. This will have serious implications for agriculture in the state.

With 18.7 percent of the country's livestock population, the state contributes 11 percent of the national milk production, 40 percent of meat, and 42 percent of wool. After agriculture, animal husbandry is the next most important rural activity, contributing 11 percent to the state net gross domestic product. It is noteworthy that small/marginal farmers, agricultural laborers and families living below the poverty line mainly carry out animal husbandry. In western Rajasthan, nearly two-thirds of the population is engaged in livestock rearing and allied activities. In rural areas, income from livestock ranges from 30 to 50 percent of household income.

[60] State Draft Annual Plan (2013-14)

[61] Agriculture Statistics of Rajasthan 2010-11, Directorate of Economics and Statistics. Latest edition when last accessed on May 11, 2013 http://statistics.rajasthan gov.in/Files/Upload/AGST2010.pdf

[62] Rajasthan State Action Plan on Climate Change (2012), Government of Rajasthan

7.1 Agro Climatic Zones and Cropping Pattern

Figure 20 Agro Climatic Zones of Rajasthan

Source: Department of Agriculture, Government of Rajasthan

There are ten agro-climatic zones in the state (figure 20). The gross sown area (GSA) in 2010-11 was 26 million hectares. NSA was 18.34 million hectares. This means 7.65 million hectares or 31.7 percent of NSA was cultivated more than once. Cropping pattern refers to the proportionate area under different crops during an agricultural year. Mono cropping is predominant in almost all zones. About 63 percent of total cultivation is taken up during the *kharif* season[63]. Cereals and pulses constitute food grain crops. Millet (bajra) during *kharif* and wheat during the *rabi*[64] are the major food grain crops grown in the state. Rajasthan produces 5.49 percent of the nation's food grain and 21.31 percent of its oil seeds. Non-food crops constitute oilseeds, fibers, tobacco, dyes, and fodder.

Of the total irrigated area, 35.79 percent is under wheat, 23.65 percent under rape seed and mustard, and 5.8 percent under grams. Rajasthan practices legume-wheat based cropping system. Soybean-wheat cropping pattern is dominant in the southeastern region (Kota, Bundi, Baran, Jhalawar, Chittorgarh, Banswara and others). Other cropping patterns are pearl millet-wheat (Tonk, Banswara), pearl millet-mustard, and maize-wheat (eastern Rajasthan). Yields tend to be low in the state. The average production of wheat in the state (2010-11) is 3,433 kg/hectare, sorghum (jowar) is 700 kg/hectare, and gram is 898 kg/hectare. Figure 21 is a map of the crops grown in various regions of Rajasthan. It is interesting to compare this to appendix C that shows the state's agro climatic zones.

[63] Usually sown in July with the onset of southwest monsoon rains.

[64] Season starts with the onset of northeast monsoon in October. Sowing is done after the rains have withdrawn and harvest begins in April/May.

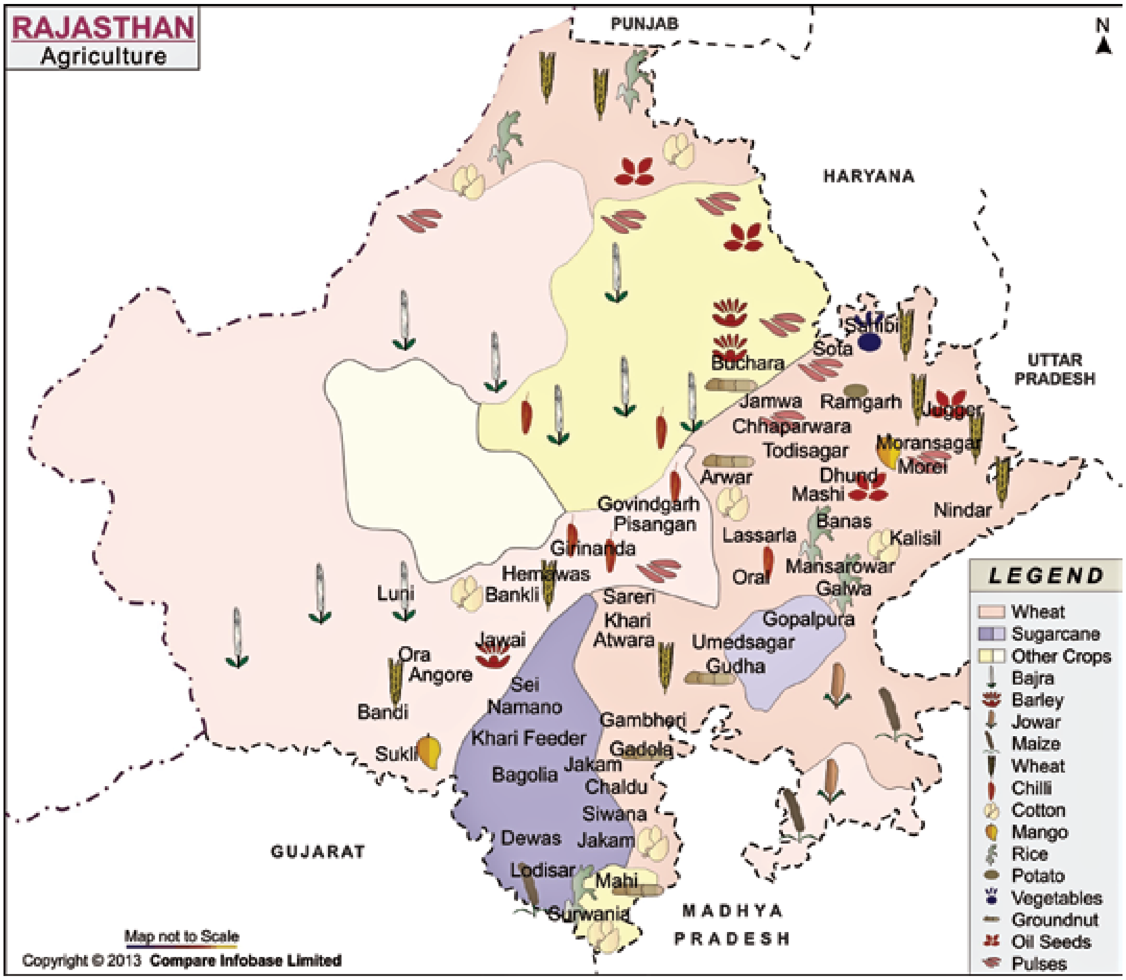


Figure 21 Crops Grown in Rajasthan

Source: Maps of India

The mapping of most suitable crops for an agro climatic zone, compared to current cropping patterns would be an important exercise to work out the 'best crop per drop' and help bridge the supply-demand gap for water in the state. Appendix C charts the climatic, rainfall, and soil conditions in the state prevalent in each of the ten agro climate zones, vis-à-vis the primary kharif and rabi cropping pattern currently followed by the districts that fall under these zones.

Several factors influence a farmer's decision on what to grow. One of the important factors is the availability of irrigation. Non-optimal crops such as sugarcane, which require three times more water than wheat and rice put together, and cotton are grown in areas where there is a sense of water abundance (canal command areas). Other farmers grow crops like sorghum (also fed to livestock) since this is the staple diet in some arid and semi-arid regions. Additional factors include power tariffs, which greatly influences irrigation levels; the guaranteed purchasing scheme through government support prices, which keeps pricing for certain crops artificially high; and agricultural subsidies and protection. Any attempt to change crop patterns will have to consider all these factors to ensure farmer buy in.

In addition to the main crops being grown in various parts of Rajasthan, it is important to understand the overall cropping pattern in the state. Comparing the GSA to the irrigated area is also interesting (figures 22 and 23). Pulses seem to be particularly good 'crop per drop' candidates, supporting a school of thought put forward by some that Rajasthan could become the pulse bowl of the country[65].

Figure 22 Percentage of Gross Area by Crop 2010-11

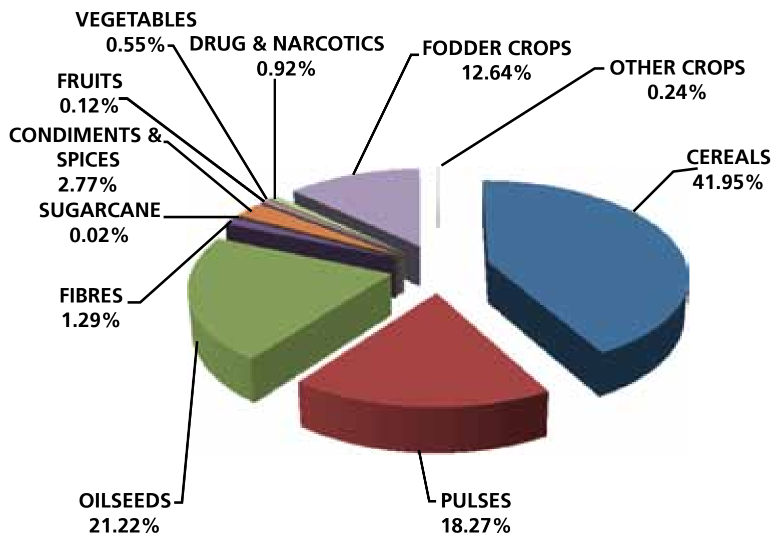
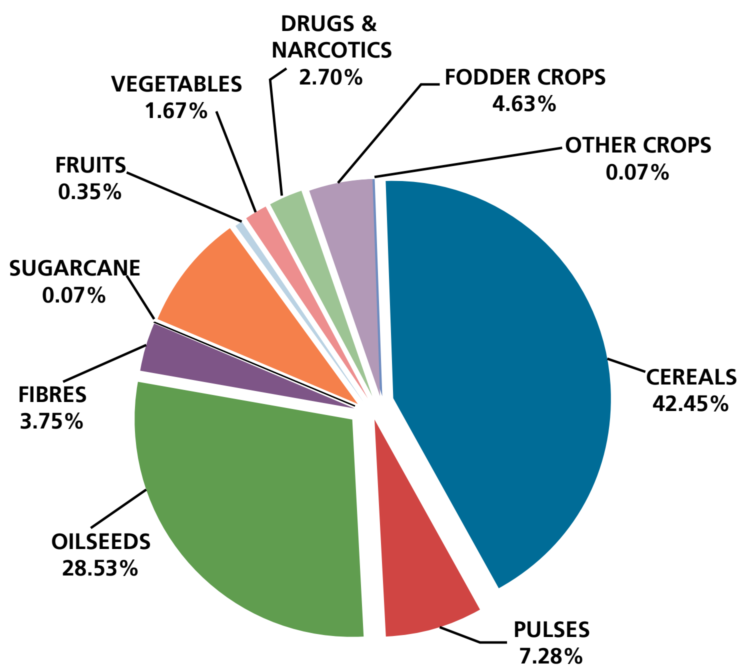


Figure 23 Percentage of Irrigated Area by Crop 2010-11

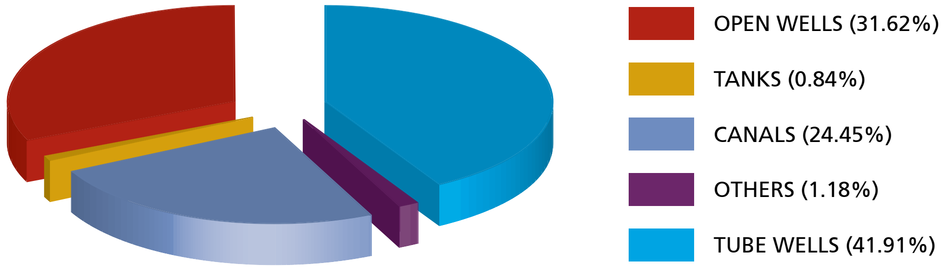


Source: Agricultural Statistics of Rajasthan 2010-11, Directorate of Economics and Agriculture

[65] Wrong Policies behind ajasthan's Water Crisis, 25 May 2010, an article by Devinder Sharma.

7.2 Irrigation

Figure 24 Rajasthan Percentage of Net Irrigated Area by Source 2010-11



Source: Agricultural Statistics of Rajasthan 2010-11, Directorate of Economics and Agriculture

The story of irrigation in India began after independence, from ambitious projects to bring Himalayan waters hundreds of kilometers down to desert plains. Irrigated agriculture contributes more than 50 percent of agricultural output. Understanding where the 83 percent water being used for agriculture in the state is coming from is the beginning of the solution finding process. Unscrupulous over pumping of groundwater for agriculture, faster than it can be replenished, has led to unsustainable irrigation practices. With recurrent droughts on one hand, and current rates of groundwater exploitation on the other, the chances of naturally replenishing the water table are very grim. In 2005, an expert committee[66] made two important observations: population in the state was expected to almost double to 100 million by 2050, and, due to this population growth, water used for irrigation would need to be reduced from 83 percent to 70 percent by 2050. The only solution is to regulate groundwater demand, especially for agriculture on a priority basis[67].

In 1956-57, net irrigated area (NIA) was 1.4 million hectares, with canals providing 20 percent and tube-wells and wells providing 65 percent of water. In 2010-11, NIA had jumped to 6.66 million hectares. The broad breakdown of the four major sources of irrigation in Rajasthan today – canals, tube-wells, open wells and tanks – is given in figure 24. Today, 73 percent of irrigation is through tube-wells and wells placing enormous stress on groundwater. It is particularly alarming that share of tube-wells over the last four decades has shot up from 1 percent in 1967-68 to 39 percent! Although tube wells were first introduced by the British in the late 1800s[68], they did not dominate groundwater supply until after they were promoted in the 1960s-70s green revolution development programs. The numbers of private wells with their owners' 'right' to pump groundwater is significant and continuing to rise. Only 3.3 percent of the 1.4 million irrigation wells accounted for today are government owned. As wells run dry in some parts, new ones are dug elsewhere. In 2010-11, 12,480 irrigation wells went dry, 7,609 were added while 22,889 were repaired. Figure 25 provides additional details of NIA by source, while figure 26 shows irrigation sources in absolute number terms.

[66] Integrated Development of Water Resources chaired by Professor VS Vyas with the input of the European Commission, the World Bank, Asian Development Bank, Groundwater Board engineers, and other experts.

[67] Rajasthan - The Quest For Sustainable Development, edited by Vijay Shankar Vyas, 2007.

[68] Indian Irrigation Commission 1903; Birkenholtz 2008.

Canals provide around 25 percent of irrigation in the state. Rajasthan's canal systems, their distribution network, history, ongoing irrigation projects, maintenance of existing assets, and programs to bring more areas under canal command areas (CCA) is detailed in the section 7.2.1 of this report. Canals are being used for drinking water supply, and in some cases are the only perennial sources of water. Canal irrigation divides the state into pockets of relatively higher agricultural viability compared to groundwater-irrigated areas, which face rapid depletion of water tables and water quality issues. Water-surplus command areas with unregulated water supply leads to a commonly seen phenomenon where farmers generally grow water-intensive crops such as sugarcane. Sriganganagar district, which is at the top of the NIA list with 0.57 million hectares, is a good example. A general analysis of crop-area based irrigation water prices prevailing in other parts of the country (pricing in various parts of Rajasthan needs to be evaluated further), showed that the area-based prices do not reflect the irrigation water requirement of the crop. This could mean that the irrigation water charge per unit volume of water is lowest for water-intensive crops[69].

[69] IRMA/UNICEF, 2001. Listed in Water saving and yield enhancing technologies (D Kumar).

Figure 25

Net Irrigated Area (in Ha.) by SOURCE (2010-11)								
	Canal	% of Canal Total	Tube-Wells	% of Tube-Well Total	Irrigation Wells	% of Well Total	Tank	Other Sources
Indira Gandhi (Rajasthan)	517,260	32%	-		-		-	-
Bhankhara	331,470	20%	-		-		-	-
Chambal	257,754	16%	-		-		-	-
Gang / Bikaner	287,537	18%	-		-		-	-
Others	234,725	14%	-		-		-	-
Electricity-run	-		2,194,185	79%	-		-	-
Oil Engine-run	-		597,392	21%	-		-	-
Pumpsets Electricity-run	-		-		1,421,459	68%	-	-
Pumpsets Oil Engine-run	-		-		646,272	31%	-	-
Other (Rehat etc)	-		-		38,119	2%	-	-
Total NIA by Source	**1,628,746**	**100%**	**2,791,577**	**100%**	**2,105,850**	**100%**	**55,676**	**78,876**
Total NIA	**6,660,725**							
Percent of NIA by Source	**24.5%**		**41.9%**		**31.6%**		**0.8%**	**1.2%**

Source: Table compiled using 2010-11 data from Directorate of Economics and Statistics, Rajasthan

Irrigation in Rajasthan is plagued by quality problems, not only because of greater dependence on groundwater but also due to improper maintenance of surface systems. In most regions, groundwater is saline and farmers use it for irrigation. This practice can sometime lead to long-term damage to cultivable land and reversing this is tedious and time consuming. Large tracts of land under surface irrigation are water logged and saline. This is mainly because flood irrigation is not suitable for sandy and sandy-loam soils. Another reason is seepage from the canal systems. The quality of irrigation infrastructure, especially the distribution system, is poor and losses are in the range of 60 percent. Often these canals are either not fully lined or have poor quality lining. Systems are not maintained resulting in wastage and water logging in head reach areas and water scarcity at the tail ends.

There is growing concern about conflicts between upstream and downstream water users, or between users of existing irrigation systems and new water harvesting structures in upstream catchment areas. This is resulting in downstream regions receiving lower flows and well recharge due to the construction of water harvesting structures in the upstream regions[70]. There is concern that these structures may reduce the reservoir inflows of large irrigation systems. There are no institutional mechanisms in place to address or resolve these conflicts.

The most important canal system, Indira Gandhi Nehar Pariyojna (IGNP), has had its share of issues due to water shortages. According to the 1981 agreement signed between Rajasthan, Punjab, and Haryana, Rajasthan is supposed to receive about 10.61 BCM (the state receives its water from the Pong Dam in Punjab), but receives only about 9.87 BCM. Rajasthan irrigation officials argue[71] that farmers in phase I region (Sriganganagar, Hanumangarh, and Bikaner) are accustomed to a constant supply of water. Now, with phase II in place, they get comparatively less. Additionally, Punjab is releasing less water. The farmers in phase I claim that they need 5.23 cusecs of water for around 400 hectares (about 12,795 cubic meters per day). However, meeting these demands would mean that the phase II area (Jaisalmer and Barmer districts) is left out. The state government has decreased water release from the Indira Gandhi Canal to 3.25 cusecs (7,951 cubic meters per 400 hectares), which has not been well received by farmers in phase I. This has caused repeated agitations by farmers.

The state's estimated irrigation potential is 5.1 million hectares, of which 3.1 million hectares is already achieved. This gap of two million hectares cannot be further addressed by groundwater, which is fully exploited. Most canal water is available only for drinking water use. Hence it is clear the key to feeding an ever increasing population is to adopt better cropping practices and increase irrigation efficiency.

[70] Upstream vs. Downstream: Groundwater Augmentation Through Rainwater Harvesting and its Implications for Agriculture Development, 2005, Ray and Mahendra

[71] Rajasthan farmers revive agitation over irrigation water by Kirtiman Awasthi, Down to Earth, November 15, 2006.

Figure 26

Sources of Irrigation by Number (2010-11)					
	No. of Tanks	No. of Tube-Wells	%	# of Wells	%
For Irrigation- Ayacut <100 Acre	5,810	-		-	
For Irrigation -Ayacut >100 Acre	1,590	-		-	
For Bed Cultivation Only	3,064	-		-	
Electricity-run	-	253,441	68%	-	
Oil Engine-run	-	121,070	32%	-	
Irrigation Wells- Pumpsets Electric	-	-		644,447	43%
Irrigation Wells- Pumpsets Oil Engine	-	-		514,929	35%
Irrigation Wells- Other (Rehat etc)	-	-		297,328	20%
Drinking Water Wells	-	-		28,932	2%
Source Total	**10,464**	**374,511**	**100%**	**1,485,636**	**100%**

Source: Table compiled using 2010-11 data from Directorate of Economics and Statistics, Rajasthan

While specific data for Rajasthan needs to be collected, institutions that have evolved elsewhere in the country around the use of groundwater, such as tube well companies and groundwater irrigation cooperatives, provide significant future opportunities for large-scale adoption of new water-saving technologies (WSTs) through joint ventures. This is due to the socioeconomic benefits found in such shared situations[72]. Costs could be significantly brought down as additional cost of new equipment can be shared among the large number of farmers who will benefit from it.

The factors that increase the socioeconomic feasibility of new WSTs in these joint ventures are:[73]

- **T**he operational rules of these irrigation organizations are based on principles of equity, and all farmer members strictly follow these rules.

[72] Although the technical feasibility of conventional WSTs is very low in such situations because, as members of the venture that jointly owns the water source, or as individual farmers who purchase water from these joint ventures, members are supplied water through underground pipes with very low pressure (head). This poses a limitation since conventional drip and sprinkler systems require considerable pressure to run.

[73] Water Saving and Yield Enhancing Technologies: How far can they contribute to water productivity enhancement in Indian Agriculture, Kumar, Samad, Amarasinghe and Singh

- There is a great deal of transparency and accountability in the transactions, including water allocation, payment and collection of water charges, operation and maintenance works, and account keeping.
- The groups are already conversant with the operation of well systems, so the confidence to run advanced water saving irrigation systems is likely to be very high.
- These groups can invest in overhead tanks and distribution systems, from which water can be directly taken to the irrigation devices. Such interventions could also help expand area under irrigation, even under restricted power supply.

According to some national surveys[74], the basins where water-saving technologies (WSTs) could result in enhanced basin level water productivity include west flowing rivers north of Tapi (the river basins of Saurashtra, Kutch and Luni in Rajasthan). The enhancement in water productivity due to use of WSTs would come from two factors: one, reduction in the amount of water depletion (since these regions have many crops with high non-beneficial evaporation and also face deep percolation), and, two, rising yield of crops grown in these basins. The semi-arid, hard rock areas provide a favorable environment for adoption of micro irrigation systems owing to limited groundwater potential, the dominance of well irrigation, and dominance of responsive crops. At the same time, there would be real saving in water due to depleting groundwater tables.

7.2.1 Major Irrigation Canal Systems in Rajasthan

There are three main canal systems in the state: the Indira Gandhi, Bhakra, and Bikaner/Gang canals. A fourth, the Chambal system is also briefly explained below. Figure 27 gives an idea of the command areas of these systems.

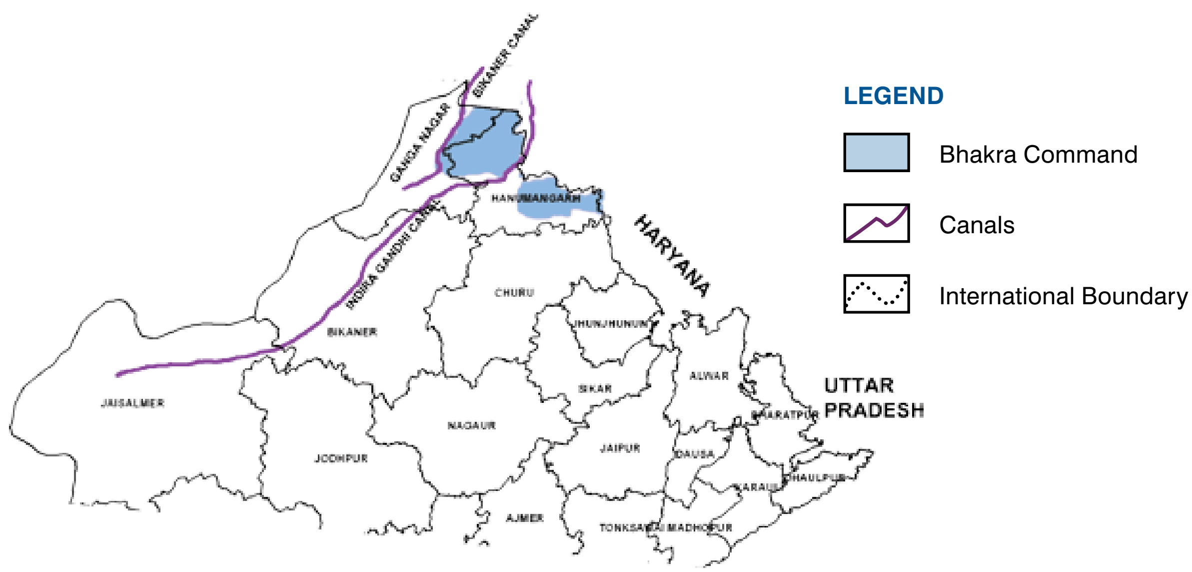


Figure 27

Source: unraveling Bhakra - assessing the temple of resurgent India by Sripad Dharmadhikary

[74] Water Saving Technologies, (D Kumar et al).

7.2.1.1 Indira Gandhi Canal Project

The Indira Gandhi Canal Project (IGNP) is one of the biggest canal projects in India. It is also regarded as one of the world's biggest projects of its kind in a desert ecosystem. This herculean task of bringing water from the Himalayas to the Thar Desert aims at transforming vast stretches of the western desert terrain into cropland, and was originally conceived in 1948. The project started a decade later in 1958 but irrigation in part of the area was initiated only in October 1961. Earlier known as Rajasthan Canal, the name was changed in 1984.

IGNP was designed to use 9,367 MCM/year of the total 10,608 MCM/year allocated to Rajasthan from the surplus waters of the Ravi and Beas rivers. The canal starts from the Harike Barrage at Sultanpur, a few kilometers below the confluence of the Sutlej and Beas rivers in Punjab state. The canal runs south by southwest in Punjab and Haryana but mainly in Rajasthan for a total of 650 km and ends at Ramgarh near Jaisalmer in Rajasthan (see figure 27). It uses water released from the Pong dam (located at Pong across the River Beas in Kangra district of Himachal Pradesh) and provides irrigation to the northwestern region of Rajasthan. The IGNP traverses seven districts of Rajasthan: Barmer, Bikaner, Churu, Hanumangarh, Jaisalmer, Jodhpur, and Sriganganagar.

For administrative construction convenience, the project was taken up in two stages:

Stage I: The entire system in this stage consists of the 204 km long Rajasthan feeder canal, 189 km long main canal and distribution system, it is concrete lined, and serves 553,000 hectares command area through four pumping stations. The feeder canal has a head works discharge capacity of 460 cubic meters per second. The first 167 km of the feeder canal lies in Punjab and Haryana, and the remaining 37 km in Rajasthan.

Stage II: This consists of the downstream part of the main canal from the 189th kilometer till the tail, and distribution systems. Work on lift schemes of Bikaner zone and flow area of Jaisalmer zone is in progress.

According to the original plans, about 11 percent of the Thar Desert was to be irrigated after completion of IGNP. Total CCA of the project as per estimates approved by the central water commission (CWC) in 1996 was 1.96 million hectares; 0.55 million hectares under stage I, and 1.4 million under stage II. The Eleventh Five-Year Plan targeted 1.96 million hectares of CCA for IGNP, but this was later reduced to 1.6 million hectares as less water was available. Canal construction works were completed for 1.59 million hectares up to March 2012. An outlay of $42.5 million is proposed for the current plan period of 2013-14, and 9,000 hectares of CCA will be added by completing work on pumping stations of lift schemes.

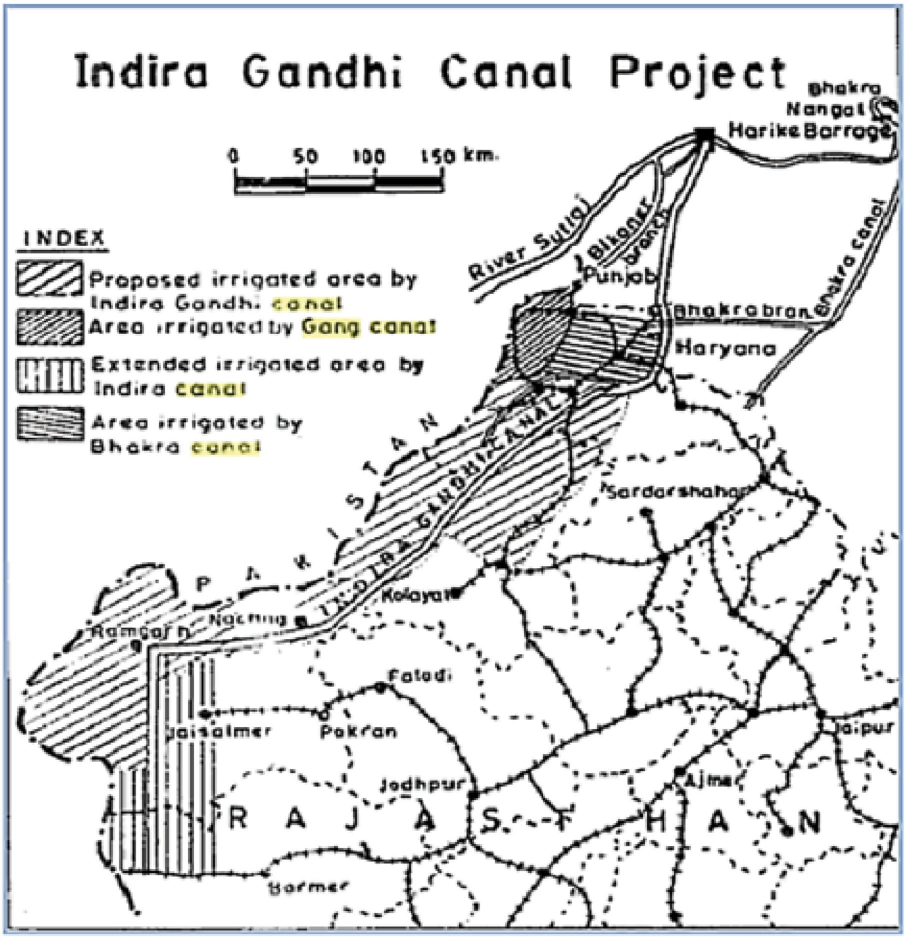


Figure 28

Source: Dryland Farming, Perspectives and Prospects by Bhanwar Lal Sharma

7.2.1.2 Bhakra Nangal System

According to the Indus Water Treaty concluded between India and Pakistan in 1960, three eastern rivers namely Sutlej, Beas and Ravi came to the exclusive share of India. The Bhakra Nangal and Beas projects were originally the joint ventures of the erstwhile states of Punjab and Rajasthan. Project construction was taken up in 1948 for uplifting the northern region, and was completed in 1963. Sutlej waters were distributed between Punjab and Rajasthan as per the Bhakra Nangal Agreement 1959 with Rajasthan's entitlement at 15.22 percent.

The Bhakra Nangal system is a complex system of several dams, reservoirs, inter-basin transfer linkages, powerhouses and a vast canal network. The Bhakra Dam is a majestic achievement constructed across the Sutlej and controls its water for irrigation and power. It is 740 feet high, the highest concrete gravity dam in Asia and second highest in the world. Forty-nine percent of the project's canal command area (CCA) is in Haryana, 35 percent in Punjab, and 16 percent Rajasthan.

In Rajasthan, this translates to 372,000 hectares or 1.45 percent of state's cultivable area, served by the 1,219 km long Bhakra-Sirhind canal distribution system. Only two districts of Sriganganagar and Hanumangar are covered by the project (figures 27 and 28). The Bhakra channels of Rajasthan are perennial and are supplied 2,562 cusecs water through five contact points (the flows vary every year and so does the actual irrigated area). Of these points, one contact point is via Punjab, while all others are via Haryana (together contributing a discharge of 950 cusecs).

7.2.1.3 Bikaner / Gang Canal

The 114 km-long Gang Canal was the first to come into existence and became fully operational in 1928, with a 1,251 km long distribution system to serve Sri Ganganagar district. Along with the Bikaner feeder, it provides water to a command area of 300,000 hectares with 65 percent intensity (figure 29).

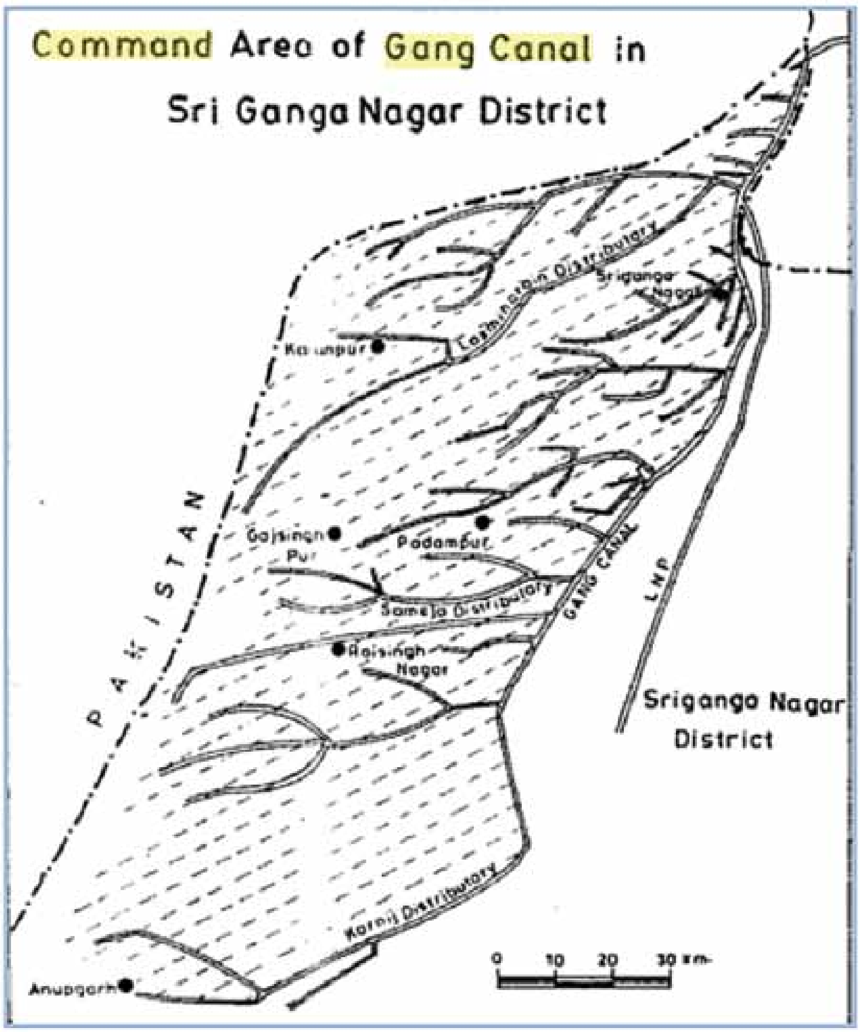


Figure 29

Source: Dryland Farming, Perspectives and Prospects by Bhanwar Lal Sharma

The Gang Canal was constructed as a part of the Sutlej Valley Project that was undertaken jointly by the Government of Punjab, the State of Bhawalpur and the State of Bikaner. The authorized full supply discharge of the Gang Canal was kept to 2,144 cusecs. Soon after construction of the canal was started, it was felt that additional water would be available during the *kharif* season and so two non-perennial channels were added. The authorized full supply discharge of the canal was increased to 2,720 cusecs. In 1960, the Indo-Pakistan treaty came into force according to which, Pakistan's share to be delivered below Ferozepur included the Sutlej component. The Gang Canal was therefore reduced to its pre-partition allocation.

The canal's pre-partition share is 1.11 million acre-feet (MAF) annually. As per the 1981 agreement, Rajasthan is entitled to use 8.0 MAF of surplus Ravi-Beas waters, against its full share of 8.60 MAF. Now Rajasthan is in a position to use its full share, the matter has been taken up with the authorities[75].

The canal system has deteriorated over the years. A modernization project was started in 2011-12 for the lining of the Bikaner Canal in Punjab and the portion of the canal system running in Rajasthan. The current annual plan (2013-14) has allocated $9.5 million for the construction of lined water courses in 35,000 hectares.

[75] In 1966, state of Haryana was formed out of Punjab. To redistribute the share of Ravi-Beas waters allocated to erstwhile state of Punjab (originally shared under the 1955 agreement), an agreement was signed by the states of Rajasthan, Punjab and Haryana on 31 December 1981. Accordingly Rajasthan's share was fixed as 8.6 MAF or 52.7 percent of the surplus flows. However at the time, IGNP was in its initial stages and Rajasthan was not in a position to use more than 8 MAF. It was agreed for Punjab to use the surplus until such time when Rajasthan could use its full share. Rajasthan is in a position since past many years to utilize its entire share due to extensive development of IGNP. Despite this, Bhakra Beas Management Board (BBMB) is still giving Rajasthan an allocation of 8 MAF or 49 percent. Rajasthan has repeatedly submitted its representation to the central government, and BBMB and Punjab to restore its remaining share of 0.60 MAF. Source - Compendium of Issues Pending with Government of India, Government of Rajasthan, Planning Department, February 2013

7.2.1.4 Chambal Valley Project

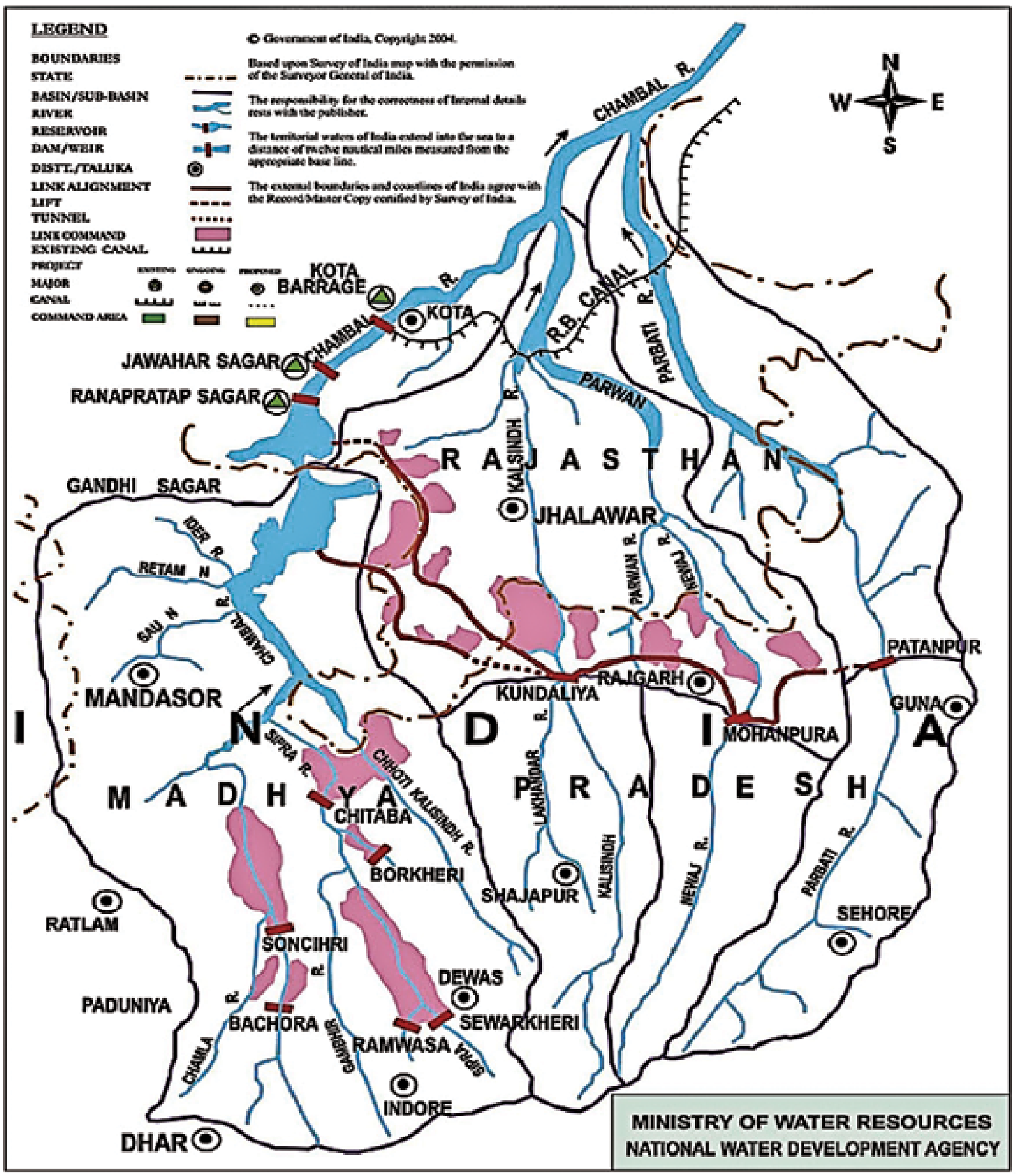


Figure 30

Source: Ministry of Water resources

The Chambal Valley Development Scheme is a joint venture between the governments of Madhya Pradesh and Rajasthan. The purpose of the scheme was to generate hydroelectric power and to supply water for irrigation. Project construction began in 1953 and water for irrigation by canals was made available in 1960, although the construction of stage III was completed in 1971.

Waters of the River Chambal has been harnessed in three phases:

- Gandhi Sagar Dam, Kota Barrage, Chambal right main canal (RMC) and Chambal left main canal (LMC)
- Rana Pratap Sagar Dam between Gandhi Sagar and Kota Barrage
- Jawahar Sagar Dam

Chambal command area in Rajasthan is spread over six panchayat samitis (groups of villages) in Kota, Bundi and Baran districts, and is centered at Kota city (figure 30). The net command area in the state is 230,000 hectares. There are two main canals starting from the Kota Barrage:

- The RMC is 372 km long, with 124 km in Rajasthan (Kota and Baran districts). The water carrying capacity of the RMC is 6,656 cusecs, and the distribution system covers 1,376 km. The RMC consists of seven branches, 27 distributaries and minors.
- The LMC is 2.59 km before dividing into the Bundi and Kapren Branch Canals. Three branches, 27 distributaries and 180 minors of the LMC irrigate 102,000 hectares in Kota and Bundi districts. LMC is designed to carry water at the rate of 1,500 cusecs.

A project costing $235 million to renovate the entire irrigation system for the benefit of tail users is underway. The current annual plan (2013-14) has an outlay of $22 million for this.

8 Policies and Private Sector in Water

In the decade starting 1990, India witnessed significant economic policy reform – liberalization. The states as administrative entities need to develop a competitive edge to attract investments for sustainable development, and reduce dependence on the national exchequer. Apart from key focus areas such as roads, power, tourism, and infrastructure, Rajasthan has also opened social sectors such as health, education, drinking water, and housing for private sector investment.

A number of initiatives have been taken up in India to accelerate the pace of investment in infrastructure, including inviting investment through public-private partnerships (PPP). The investment sought from the private sector has steadily increased from 21.76 percent during the Tenth Five-Year Plan, to 37.20 percent during the Eleventh Plan, to 48.19 percent or $498.69 billion in the Twelfth Plan. The Government of India has started a viability gap funding (VGF) scheme that enables PPP projects in the states to get central assistance of up to 20 percent of project costs. The India Infrastructure Finance Company Limited (IIFCL) was set up to provide these long-term loans. The IIFCL raises funds against sovereign guarantees. The India Infrastructure Project Development Fund (IIPDF) has been created to support the development of bankable PPP projects. The Government of India has also issued model request for proposal documents for the selection of technical consultants, financial consultants, legal and transaction advisers.

To facilitate the role of PPP in creating new infrastructure assets and managing existing assets, Government of Rajasthan issued guidelines for PPPs in May 2012. The guidelines define PPP as an "arrangement between a government or statutory entity or government owned entity on one side and a private sector entity on the other, for the provision of public assets and/or related services for public benefit, through investments being made by and/ or management undertaken by the private sector entity for a specified period of time, where there is a substantial risk sharing with the private sector and the private sector receives performance linked payments that conform (or are benchmarked) to specified, pre-determined and measurable performance standards."[76]

The state government has taken several specific steps to set up a framework for private sector participation, the most important steps, and other enabling developments are:

- Three-tier institutional arrangement comprising empowered committee on infrastructure development (ECID) as the approving committee; PPP cell as the nodal agency; and the concerned administrative department/agency as the implementing agency. All PPP projects require approval of the ECID, constituted under the chairmanship of the chief secretary. The PPP cell, with principal secretary (planning) as its nodal officer, coordinates efforts of the government in pursuing PPPs, and it is supported by technical assistance from the Asian Development Bank (ADB).
- The Rajasthan Infrastructure Project Development Fund (RIPDF), with a corpus of $4.59 million managed by the planning department, is set up to meet expenses related to feasibility studies for developing identified projects. This is interest free financial assistance, to be recovered along with a success fee of up to 40 percent of funding. In case of revenue generating PPP projects, the advance plus 40 percent of advance is to be recovered from the successful private partner on award of the project.

[76] Annual Plan 2013-14, Planning Department, Government of Rajasthan

- The Rajasthan Social Sector VGF Scheme promotes PPP in the social infrastructure sector. All administrative departments and autonomous organizations under the state government and local bodies are eligible for social sector infrastructure and services supported under the scheme.
- A dedicated project development company, PDCOR Limited, has been set up as an equally owned joint venture between Infrastructure Leasing and Financial Services Limited (IL&FS) and the Government of Rajasthan. PDCOR's primary mandate is to structure and attract private sector investment to various infrastructure projects in the state.
- Rajasthan is one of the states selected under the National PPP Capacity Building Program (NPCBP) launched by Department of Economic Affairs (DEA) in 2010 with support of KfW (German Development Bank) and World Bank. A memorandum of understanding (MoU) has been signed with the India PPP Capacity Building Trust (I-Cap), appointed by the DEA as the project executing agency for the program. Eight officers from the state have completed the training of trainers (ToT) under the program to help government staff at various levels conceptualize, structure, award, implement, and monitor PPP projects.
- An Infrastructure Development Act has been drafted. The draft act provides a legislative framework for private participation in the state's infrastructure development by defining the legal basis for grant of concessions to private parties. The draft is under consideration and subsequently will be placed before the state assembly for approval[77]. Meanwhile, draft public-private partnership guidelines have also been prepared.

8.1 Water Policy

The National Water Policy (NWP) was first adopted in September 1987, then revised in April 2002, and most recently revised and adopted in December 2012 at the sixth meeting of the National Water Resources Council. Recently the NWP 2012 document was formally released at the India Water Week[78].

Section 12.3 of the NWP 2012 states, "Water resources projects and services should be managed with community participation. For improved service delivery on sustainable basis, the state governments/ urban local bodies may associate private sector in public private partnership mode with penalties for failure, under regulatory control on prices charged and service standards with full accountability to democratically elected local bodies."

More directly encouraging language on private sector participation in the water sector from section 13 of the previous (2002) version of the draft states, "Private sector participation should be encouraged in planning, development, and management of water resources projects for diverse uses, wherever feasible. Private sector participation may help in introducing innovative ideas, generating financial resources and introducing corporate management and improving service efficiency and accountability to users. Depending upon specific situations, various combinations of private sector participation, in building, owning, operating, leasing, and transferring of water resources facilities, may be considered."

[77] According to Annual Plan 2013-14, Planning Department, Government of Rajasthan

[78] Efficient water management: Challenges and opportunities, five-day event held in New Delhi starting April 8, 2013

While the policy is a set of guidelines that the states are not obligated to follow, many states have expressed concern over the overarching nature of the proposed National Water Framework Law, and the law on river basin management as drafted in the policy. Other reservations on the policy include water tariff system, statutory empowerment of water users associations, pricing of electricity, and establishment of a water regulatory authority.

In the past, Rajasthan has brought out water policy documents after NWP documents were released, and most of these simply mirrored the NWP. This started to change in 2003 when the state made an effort to include state specific issues. The current state water policy (SWP) draft issued in February 2009 goes further in outlining policy direction on the basis of integrated water resource management (IWRM) principles to address mounting pressure on the state's rapidly deteriorating water resources. This draft was subsequently adopted by the government as the SWP in February 2010.

8.2 State Water Policy on Private Sector Role

The SWP[79] under its water resources development and management objectives speaks of "facilitating private initiative in development, operation and management of water projects." As part of institutional reforms, the SWP seeks to "encourage private initiative in water sector." And finally, as part of legislative and regulatory reforms, the need to "establish rules/regulations for private sector involvement in development and operation of water related projects" finds mention in the SWP.

Separately, there is a proposal under review by PHED for introduction of PPP in the drinking water sector. This is in conjunction with a reform agenda for PHED itself (section 4.3). In introducing this proposal, PHED acknowledges the current inefficiencies in the construction and management of water supply schemes, and highlights potential benefits from private sector involvement especially in distribution systems to end users in urban areas.

8.3 PHED Proposal for PPP in Water Sector

As part of its reform agenda, the state government intends to involve private sector through PPP. The PHED website states the reason for this as, "To utilize new technology, professionalism, share risks and gain, access to private capital, to improve operating efficiency, and, ultimately, make the sector more responsive to consumer needs[80]." The proposal has been under consideration, although latest status is unclear. A sample performance parameter sheet, put together by PHED that could be adopted for PPP projects for urban distribution systems can be viewed in appendix D of this report.

8.4 Projects under PPP

Involvement of the private sector in water supply is not very common across India. The private sector has been involved mainly in the operation and maintenance of pipelines, treatment plants, tube-wells, and pumping stations. In certain cases, the sector is also involved in billing and revenue collection.

[79] SWP document accessed on April 28, 2013 on Planning Department, Government of Rajasthan website, link: http://waterresources.rajasthan.gov.in/docs/swp.pdf.

[80] PHED website as accessed on April 28, 2013, link: http://www.rajwater.gov.in/ppp-projects.htm.

Contracting has been the main mode of privatization. According to one national study[81], most cities in India have been able to compute the cost of an outsourced activity only after privatization, which is the actual payment made to the contractor. Very few have calculated the cost of an activity before that activity was privatized. This could indicate that privatization in these cities was undertaken, not as a measure of economy and efficiency, but for other reasons. In the study, covering 300 metropolitan and class I cities across India, only 24 urban centers had used the private sector for activities related to water supply. One-third, that is, eight of these urban centers were in Rajasthan. The report found that private sector participation in the water supply sector had been going on since 1989, although most cities introduced it in 1992 or later.

Given that several water transmission and distribution projects are pending resource allocation and subsequent implementation, the Government of Rajasthan is inclined to explore annuity-based and other appropriate PPP models in the water sector. No live examples of water supply projects involving true PPP in Rajasthan were found in the course of research and interviews for this report. The only project in the water sector said to be operational under PPP[82] in the state is a desalination plant of 20 million liters per day capacity commissioned at Nagaur on DBOOT (design, build, own, operate and transfer) basis with an investment of $55 million to supply 14 million liters of potable water per day to the state. The plant processes water with high TDS content coming out of a brackish aquifer at the lignite mines of Kasau and Matasukh in Nagaur district. The Bhavnagar-based Central Salt and Marine Chemical Research Institute (CSMCRI) has used membrane technology in this reverse osmosis (RO) desalination plant.

While improving efficiencies are sometimes stated as reasons, most discussions to involve private players currently stem from a need to augment government funding. Given that these are only early stages, we can expect such ambiguity. Pilot projects/studies are being undertaken to justify private participation and investment in the water sector[83]. Project development and structuring for certain water supply projects have been initiated: water supply to the towns of Ajmer and Udaipur at the cost of $275 million and $145 million, respectively; and two pilot projects with focus on reducing non-revenue water supply in Jaipur (Mansarovar) and Kota at the cost of $4.6 million and $2.75 million, respectively. These four projects seek assistance under the India Infrastructure Project Development Fund (IIPDF) scheme of the Government of India. Partial cost of project development is proposed to be met by the Asian Development Bank (ADB). Technical consultants have already been engaged to prepare feasibility reports for the Ajmer and Udaipur projects.

[81] Status of Water Supply, Sanitation and Solid Waste Management in Urban Areas, June 2005, CPHEEO, Ministry of Urban Development, Government of India.

[82] As of update in Draft Annual Plan 2013-14. The author has visited this plant. However, details of the arrangement between parties are unclear and therefore it is difficult to assess the nature of the project as a true PPP project.

[83] Updated per Draft Annual Plan 2013-14.

8.5 Externally Aided Projects

Apart from the above, the following projects[84] that have been proposed for external assistance to the Government of India could involve the private sector (although there is no official indication that any of these will involve PPP):

- **Nagaur Lift Project, Phase II:** A loan agreement has been signed with Japan International Cooperation Agency (JICA) on September 28, 2012 to provide a loan for Nagaur Lift Project Phase II costing $540 million.
- **Jodhpur Urban Water Supply Scheme:** Jodhpur town receives water from the Rajeev Gandhi Lift Canal. Raw water to meet demand till 2016 is available. A project is planned to augment and reorganize water supply. The estimated cost of the project is $101 million. A loan agreement for the project has been signed in February 2012 with a French funding agency.
- **Chambal-Bhilwara Project:** A $187 million proposal has been forwarded for assistance to the World Bank. The state government has approved design of system components that will supply 55 lpcd to rural areas, and plans to submit the revised proposal, incorporating cluster/village distribution work and sewerage system work for Bhilwara town.

Two other projects have also been proposed to the Government of India for external assistance: the Aapni Yojana Phase II to cover 6 towns and 444 villages of Churu and Jhunjhunu districts, and the Barmer Lift Project Phase II to cover 691 villages of Barmer District.

[84] Per Draft Annual Plan 2013-14.

9 Water Institutions

Rajasthan has its water problems, but it also has its fair share of water actors: non-governmental institutions (NGOs), foundations, research institutions, business associations, international agencies, financial institutions, private companies, and many others who have done, and continue to do phenomenal work in the water sector. While this list is by no means exhaustive, this chapter introduces readers to some of the most active and impact oriented water players and their work in Rajasthan. The listed stakeholders may or may not be based in the state, but the idea is to include those who contribute positively to the water crisis here[85]. Care has been taken to highlight players who could be potential partners for private sector driven initiatives in the state's water sector.

9.1 NGOs, Foundations, Organizations and Institutions

The NGOs listed below have water as their primary focus. The trend is to focus on traditional rainwater harvesting (RWH) techniques and structures as a sustainable solution in rural areas of Rajasthan. The challenge in adopting these solutions is the fractured nature of communities, a result of decades of overdependence on government promises of water. The work that is being done involves re-imparting best practices to the current generation, and building capacities so it can once again manage these off-grid drinking water and irrigation methods. The other highlight is the NGOs' roles in renewing community interest in water policies, so that advocacy can help bring much needed water sector reform.

9.1.1 Jal Bhagirathi Foundation

The Jal Bhagirathi Foundation (JBF) works in more than 200 villages, in the Marwar region (Thar Desert) of western Rajasthan. Its focus is on construction and restoration of traditional water harvesting structures and capacity building with 'jal sabhas' or water committees. It has initiated an advocacy campaign to reform water sector policies. JBF regularly works with United Nations bodies and other international agencies as partners.

Among other key initiatives[86], JBF is implementing a project named 'Poverty Reduction of Desert Communities in the Dry Lands of Western Rajasthan through Integrated Community-based Water Resource Management'. This will focus on reducing vulnerability of the poor in water-scarce Marwar region. The initiative is co-financed by the European Union (EU). It will benefit 80 villages of Barmer, Jalore and Jaisalmer districts in the Marwar region, reaching a population of 100,000. Its overall budget is $1.4 million, 90 percent is EU's contribution.

JBF helped implement an important public private community partnership (PPCP) project, named *Paniharan Pariyojna,* to provide safe drinking water to a community suffering from high incidence of water-borne diseases in Pachpadra in Barmer district and, as part of the project, also provided livelihood in water-scarce desert communities. A private company, M/s Environze Global Ltd, helped

[85] It must be noted, while many international/multilateral agencies are very active in the water space in Rajasthan (as also evident by the various references to these as partners in following sections of this chapter, and throughout this report), all these have not been separately outlined in this chapter. This is because the list would not only be too long to serve much purpose in the context of this report, but also because it is assumed their work is generally known by IFC (due to their association with the World Bank, and others worldwide). If not, information on these can be easily looked up.

[86] The EU Ambassador to India, Ms. Danièle Smadja visited Rajasthan on March 8, 2011 to make the announcement. Separately, EU has also given a €450 million grant to Government of Rajasthan.

set up a community-owned reverse osmosis (RO) plant to filter raw water of 4,500 ppm TDS to less than 300 ppm. Other partners were the local gram panchayat (village body) and Government of Rajasthan. UNDP, Italian Development Cooperation, Acumen Fund and IDEO supported the program. Household outlets were owned/managed by women from self-help groups (SHG). Four women entrepreneurs earn up to Indian rupees 4,000 per month ($75), spending three to four hours a day working, translating into a potential of generating annual income of $147,000 for women in the poor region of Marwar (extrapolated for 10 percent of villages in the region).

9.1.2 Tarun Bharat Sangh

Tarun Bharat Sangh (TBS) is a voluntary organization based in Alwar District in Rajasthan. Established in Jaipur in 1975 by a group of professors and students from the University of Rajasthan, it works in villages of the semi-arid region along the foothills and main ranges of the Aravalis, including the Sariska National Park. TBS has built 4,500 *johads* (earthen check dams) in 1,050 villages, regenerating 6,500 square kilometers of land. It has restored over 10,000 rainwater harvesting structures in 25 years, recharging wells/aquifers and revived five rivulets (Ruparel, Aravari, Sarsa, Bhagani and Jhajwali) in Alwar, Dosa and Jaipur districts that had been dry for years. The benefits to communities are increased agriculture production, reversal of migration, reduction in women's drudgery, and high fodder availability, which has helped milk production/sale through informal cooperative arrangements. TBS has formed Rashtriya Jal Biradari (National Water Community), a network of farmer groups, NGOs, research institutions, and water experts. Other activities include the National Water Awareness Campaign (Rashtriya Jal Chetna Yatra) to help reform NWP and Tarun Jal Vidyapeeth (Water School) to build capacities within organizations and individuals in the field of water conservation. TBS is supported by the United Nations, USAID, and the World Bank.

9.1.3 Gramin Vikas Vigyan Samiti (GRAVIS)

Based in Jodhpur, the Gramin Vikas Vigyan Samiti (GRAVIS), or the Center for People's Science for Rural Development, was created in 1983 by a group of social activists. It works in six districts with over 50,000 desert families across 850 villages, reaching a population of over 1 million. It has established over 1,100 community-based organizations (CBOs) and focuses on community-based interventions to restore traditional water harvesting structures. GRAVIS is an implementation partner for an important poverty mitigation project of the Government of Rajasthan, funded by International Fund for Agricultural Development (IFAD) and Sir Ratan Tata Trust (SRTT), named Mitigating Poverty in Western Rajasthan (MPOWER) for Jodhpur and Jaisalmer districts. GRAVIS has worked with a long list of national and international agencies including UNDP, and WHO.

9.1.4 Arghyam

Based in Bangalore, Karnataka, Arghyam is a public charitable foundation working in the water and sanitation sector since 2005. As a funding agency, Arghyam works primarily through partnerships with government, NGOs and others. Its emphasis is on access to domestic water in communities across 18 states. Key initiatives include project grants, the India Water Portal and the Urban Water Initiative. Its research and development and technology teams provide specialized support to core efforts. In Rajasthan, Arghyam supports Seva Mandir NGO to improve drinking water in 12 villages of Udaipur and Rajsamand districts. Arghyam also supports Sambhaav Trust to restore traditional water harvesting structures in western Rajasthan, with reach in more than 120 villages, with the aim to transfer management to communities after five to seven years.

9.1.5 Centre for Community Economics and Developments Consultants Society

CECOEDECON is a Jaipur based NGO working in 750 villages of rural Rajasthan. It has worked in the districts of Jaipur, Jodhpur, Sikar, Barmer, Sawai Madhopur, Jaisalmer, Nagaur, Tonk, Jhalawar, and Baran. It focuses on institutional development, natural resource management, health, and child development programs. Its project activities address water quality, groundwater, rainwater harvesting, wastewater management, microfinance, and agriculture. Interventions are characterized by creation of village level institutions such as village development committees and farmer groups. In 1998, it launched Jal Prahri (Water Guards) to carry out networking and advocacy, and to ensure protection and augmentation of water resources. It is one of the few NGOs accredited by the United Nations Framework Convention on Climate Change (UNFCCC).

9.1.6 Indian Institute of Health Management Research

The Indian Institute of Health Management Research (IIHMR), Jaipur was founded by the Transport Corporation of India (TCI)-Bhoruka Industrial Group. It has been recognized by the Ministry of Science and Technology, Government of India, as a scientific and industrial research organization (SIRO) since its inception in 1984. It is engaged in policy issues, program planning/management, and capacity building mainly in the health sector. It undertakes research, training and consulting activities, including NGO management and networking to implement projects. IIHMR works with several international agencies including UNICEF, WHO, World Bank, and USAID. In Rajasthan, it is involved with several important water related projects: the promotion of rooftop rainwater harvesting structure in 40 villages in Churu district (with Safe Water Network, USA); the Akash Ganga Rooftop Rainwater Harvesting program in three villages (with World Bank's Development Marketplace); project follow-up and sustainability of integrated water supply, sanitation and health education program for Aapni Yojna Scheme implemented in 370 villages in Rajasthan (supported by the German development bank Kreditanstalt für Wiederaufbau (KfW) meaning Reconstruction Credit Institute; and village water security plan in Tonk and Rajsamand districts (supported by UNICEF). Many IIHMR projects are implemented on the ground with the help of its sister entity, Bhoruka Charitable Trust.

9.1.7 Bhoruka Charitable Trust (BCT)

Bhoruka Charitable Trust (BCT)[87] was founded in 1962 by the founder-chairman of the TCI-Bhoruka group of companies. It works in three states including 350 villages of Churu district (Rajgarh, Taranagar, Ratangarh, and Churu blocks) in Rajasthan and has implemented community-based watershed development and rainwater harvesting programs in the area. BCT is the sister entity of IIHMR, and works closely with the Institute.

9.1.8 Association For Rural Advancement Through Voluntary Action and Local Involvement

ARAVALI is registered as a society under the Rajasthan Societies Act, 1958. This member-based organization includes representatives from voluntary agencies, research institutions, and the government. It was initiated as joint effort between the state government and select leading voluntary agencies in 1994 to act as an interface between both parties. It currently works intensively with around 20 organizations around the state and has a network of 70 organizations through its information exchange programs. It facilitates promotion of development innovations and scaling up, networking and liaison between government, NGOs, research bodies and the private sector. Its donors include Aga Khan Foundation, European Commission, Sir Ratan Tata Trust, Paul Hamlyn Foundation, UNICEF, UNDP, and Jamshedji Tata Trust.

9.1.9 Centre for Microfinance

CMF is an autonomous organization registered under the Rajasthan Societies Act, 1958. It came into existence in 2005 as an agency to guide growth of community-based microfinance in Rajasthan on the recommendation of Prof. VS Vyas, an eminent economist. It is a nodal agency for the Sakh Se Vikas (SSV) program supported by the Sir Ratan Tata Trust and provides technical support to SSV partner NGOs who have a combined reach of more than 50,000 poor households in Rajasthan.

[87] During field visits, RWH structures implemented by BCT for SWN were surveyed with their local team. They were also part of the discussions in Jaipur on work being done by BCT and IIHMR.

9.1.10 The Barefoot College

Founded in 1972, Barefoot College known as Social Work and Research Centre is an NGO based in Tilonia in Ajmer district. Around 300 barefoot water engineers provide drinking water and sanitation to 2.65 million rural children. It has built 1,513 RWH structures in rural schools and community centers with total capacity of 96.65 million liters. It has launched Neerjaal, a water resource management system allowing communities to monitor water quality and facts. Barefoot activities include solar energy, water, wasteland development, rural handicrafts, and women's empowerment.

9.1.11 Center for Science and Environment

CSE is a public interest research and advocacy organization based in New Delhi. CSE is active in water harvesting and rural water. The Department of Drinking Water Supply (DDWS), Ministry of Rural Development, has set for itself the goal of providing safe and adequate water for drinking, cooking, and other domestic needs on a sustainable basis to every rural person. CSE has been nominated as a key resource center by DDWS to undertake activities of research, training, and awareness creation. CSE publishes important knowledge material including the fortnightly magazine *Down to Earth* and is the developer/manager of the *India Environment Portal*, widely followed for environment and development issues.

9.1.12 Sadguru Water Development Foundation (SADGURU)

Established in 1974, Navinchandra Mafatlal Sadguru Water Development Foundation is an NGO based in Dahod, Gujarat. In Rajasthan, SADGURU works in Banswara and Jhalawar districts. Activities include community water resource development, participatory micro watershed development, environment and forestry, and community based support services. Working in the Mahi river basin, the strategy is to work on micro watersheds with the help of community managed lift irrigation systems, water harvesting structures, and masonry check dams.

9.1.13 Sambhaav Trust

Sambhaav is working with communities in Barmer and Jaisalmer districts in Rajasthan. It aims to revive community supported traditional water management methods in desert and semi-arid areas. It is supported by Arghyam to work on a traditional water harvesting restoration program covering villages in Barmer, Jaisalmer, Alwar, Dausa, Nagaur and Jaipur districts, with an overall reach of more than 120 villages, and aims to transfer management to communities after five to seven years.

9.1.14 Wells for India

Wells for India is a U.K.-based registered charity with its India office in Udaipur working in partnership with local voluntary organizations in Rajasthan and North West India since 1987. Its focus is on three geographical areas of the Aravali Hills, Thar Desert and Sambhar lakes, each representing a different agro-climatic environment. It has worked in Jodhpur, Bikaner, Barmer, Jalore, Udaipur, Dungarpur, Banswara, and Jaipur with a focus on water, strong emphasis on RWH for drinking water, food, and fodder. It encourages revival of traditional water management wisdom, combined with scientific and technological innovation. Its activities have led to 3,000 acres of desert yielding two crops a year from more than 40 wells. It has financed more wells with the Government of Rajasthan, providing pipes while villagers provide labor free. Around 50 miles of pipe were laid linking 15 sources of water to some 45 villages. Other projects include Pabupura drought mitigation project in Jodhpur, clean water and sanitation in 15 village schools of Udaipur benefitting 1,500 students, water harvesting structures in schools of Jharol in Udaipur, and rural livelihood and nutrition in Barmer and Jodhpur.

9.1.15 Confederation of Indian Industry–Triveni Water Institute

CII-TWI is a joint initiative of the CII and the state government focusing on detailed water audits for industry, facilitating zero water discharge, rainwater harvesting, wastewater treatment and desalination. The state government has formed the Rajasthan Business Community Alliance on Water (RBCAW) with the World Economic Forum, CII and the United Nations Development Program (UNDP) to implement statewide water and watershed management programs incorporating public private community partnership (PPCP) models. CII-TWI has conducted detailed water management studies and water audits in different sectors of industries such as cement, pulp and paper[88].

9.1.16 The IWMI-Tata Water Policy Program

IWMI is a non-profit research organization with headquarters in Colombo, Sri Lanka, working across Africa and Asia. The IWMI-Tata Water Policy Program was launched in 2000 with the support of Sir Ratan Tata Trust, Mumbai. Its objective is to help policy makers at the central, state, and local levels address 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 through IWMI-Tata publications[89]. IWMI's research team includes 100 scientists from sixteen countries.

9.1.17 Aga Khan Rural Support Program India

The Aga Khan Foundation (AKF) is an internationally recognized, community-based, NGO based in Gujarat. The Aga Khan Rural Support Program India (AKRSP) is the rural development partner of AKF. Since the early 1980s, it has focused on enhancing rural livelihoods through sustainable management and use of natural resources in degraded and resource poor regions of western and central India, often characterized by limited economic opportunities as well. Over 400,000 beneficiaries across 900 villages in four states (Gujarat, MP, Maharashtra and Rajasthan) have organized themselves into more than 1,400 village-level institutions. AKRSP works in close partnership with local communities and governments to implement strategies that lead to income growth, mobilization of local capital, technical innovations that help halt environmental degradation, and reduce drudgery of poor people. It has achieved success in improving management of micro watersheds and creating a variety of water harvesting structures in different agro-climatic regions. In Rajasthan, AKRSP works with ARAVALI.

[88] Complete list of clients at http://www.greenbusinesscentre.com/site/ciigbc/greenbuild.jsp?servid=198881.

[89] See examples under the References section of this report.

9.1.18 International Development Enterprises (India)

IDEI is an Indian NGO working in cooperation with the global family of IDE organizations. IDEI has operations in selected districts of 15 states, including Jaipur, Hanumangarh, and Sriganganagar in Rajasthan. It is engaged in development of small-scale irrigation and rural mass marketing of simple, affordable and environmentally sustainable technologies to small and marginal farm families through private marketing channels. In semi-arid areas, IDEI has adopted, developed and introduced drip irrigation technologies in the form of packaged and ready-to-use kits such as bucket kit, drum kit, and customized systems that are used by farmers for growing both horticulture crops and cash crops. Since 1997, the low cost drip systems have benefited numerous small holders by providing them with an opportunity to grow off-season crops. Till now, these systems have been successfully adopted by 295,000 small farmers.

9.2 Private Companies

The role of private companies in the Rajasthan water sector has mostly been limited to certain contractual arrangements with the government. Additionally, there are also, very isolated examples of social enterprises. An attempt has been made in this section to list those companies that work in water related projects in Rajasthan[90].

9.2.1 Infrastructure Leasing and Financial Services Ltd.

IL&FS was originally promoted by the Central Bank of India, Housing Development Finance Corporation (HDFC) and Unit Trust of India (UTI). The company promoted the first PPP water project in India in Tirupur. IL&FS Water Limited (IWL) is a wholly owned subsidiary of IL&FS. It is mandated to develop, finance, operate and maintain water and wastewater projects. In Rajasthan, IL&FS Infrastructure Development Corporation Limited (IIDC) is an empanelled organization for the preparation of city development plans (CDP). It supports PDCOR, a joint venture between the Government of Rajasthan and IL&FS, to facilitate private sector investment in infrastructure sector in the state. IL&FS is selected to execute both Jaipur and Rajsamand clusters for PURA in Rajasthan, discussed in section 11.3.1 of this report.

9.2.2 Doshion Veolia Water Solutions

Headquartered in Ahmedabad in Gujarat, Doshion Veolia Water Solutions (DVWS) is an equal partnership between Doshion Ltd and Veolia Water Solutions, the technical subsidiary of Veolia Water. DVWS aims to execute engineering, procurement, and construction (EPC) projects for water and wastewater management facilities in municipal, infrastructure, and industrial projects.

[90] Please note, micro irrigation manufacturers are listed in section 11.3.1 under illustration-I of this report, these are the well-known names. Also, certain wastewater and rainwater harvesting projects being executed by companies such as Shree Cement, Hindustan Zinc Limited, Chambal Fertilizers and Chemicals Ltd. and others were noted during the course of research. These have been excluded from this chapter due to various reasons, including that these projects are not a core part of what these companies do (instead done as CSR, and for other reasons).

9.2.3 Sarvajal

Based in Ahmedabad in Gujarat, Sarvajal is the brand name of Piramal Water Private Limited. It is a for-profit venture offering water filtration services in which Piramal Water provides the technical know-how, and local franchisees manage sales and distribution. Sarvajal has operations in Gujarat, Rajasthan, Madhya Pradesh, and Uttar Pradesh. Sarvajal launched the first Water ATM where customers get 24/7 access to clean water using their pre-paid cards (or coins) and can recharge their cards using their mobile phones. Sarvajal has 117 rural franchises, with 64,467 people covered at last check. Refer to section 11.1.1 of this report for observations from field visits to Sarvajal franchise locations.

9.2.4 Environze Global Limited

Based in New Delhi, Environze Global Limited offers a range of water and effluent treatment mechanisms for pharmaceuticals, electronics and cosmetics, turnkey mineral water plants, sea water desalination, sewage treatment, effluent treatment, water reuse and zero discharge system, and project services. It was the first company in the country to install a rural water desalination plant on a build, operate, own (BOO) basis in partnership with a local NGO and the state government to supply pure water to the villagers (refer to section 9.1.1 and 11.1.1 of this report).

9.2.5 SPML Infra Limited (formerly Subhash Projects and Marketing Limited)

SPML is involved in integrated water management solutions (IWMS) which includes water distribution, performance assessments, asset management, operation and maintenance of water supply schemes, and augmentation of water supply schemes. It has executed India's first source to tap water supply project for Latur Municipal Corporation. Projects in Rajasthan include integrated bulk water supply/water management for Bhiwandi Nizampur city municipal corporation, 24/7 water supply under JNNURM scheme, Jawai-Pali water supply project valued at $67 million, Jaipur Bisalpur-II water supply project valued at $25 million, and Rajeev Gandhi Lift Canal water supply project phase II valued at $26 million.

9.2.6 Aakash Ganga

Aakash Ganga (AG)[91] describes itself as social enterprise or public private community partnership (PPCP) model for domestic rainwater harvesting. It is floated by Sustainable Innovations (SI), an NGO based in Fairfax, Virginia, USA. AG has implemented rooftop rainwater harvesting structures in Churu and Jhunjhunu districts of Rajasthan.

[91] Aakash Ganga RWH structures in Churu and Jhunjhunu districts of Rajasthan were surveyed during the author's field visit with Mr. Bastiaan Mohrmann of IFC to Rajasthan. AG is a social enterprise, set up by Sustainable Innovations of USA, and has won the WB Marketplace Award for 2006. It was observed that AG model was not scalable at the time.

9.3 Financial Institutions

Financial institutions - non-banking financial companies (NBFCs), microfinance institutions (MFIs), and banks[92] - that support sustainable development activities in the water and/or agriculture sectors are the subject of this section. Self-help groups (SHGs) are effective vehicles for microfinance. In Rajasthan, there are an estimated 280,000 SHGs with an average membership of twelve, translating into 3.4 million members, or 40 percent rural families in the state, in effect representing 75 percent of total rural population living below the poverty line here[93]. NGOs too have supported a substantial number of SHG groups in the state and some of these have large microfinance programs.

9.3.1 Microfinance institutions[94]

MFIs started operating in the state around 2007 and by March 2010 MFIs had reached 800,000 clients with an outstanding credit of $97 million. The most noteworthy MFIs in the state are:

- **SKS Microfinance:** Launched in 1998, SKS Microfinance is one of the fastest growing MFIs with 2,379 branches. In Rajasthan, it serves about 231,401 clients with a loan portfolio of $18 million making it the biggest in the state. It operates at a 24.55 percent reducing rate of interest per annum.
- **Pustikar:** This is the second largest MFI in Rajasthan with a loan outstanding of $16.4 million. Interest rate per annum is 15 percent for SHG loans and 17 percent for individuals, both on reducing basis.
- **BASIX Social Enterprise Group:** Third largest in the state with a loan outstanding of $9.2 million and 62,155 clients. Interest rate per annum is 24 percent on reducing basis.
- **Ujjivan:** Another large MFI in the state with loan outstanding at $7.25 million and 54,663 clients.
- **Arth:** Loan outstanding at $2.15 million and 15,028 clients. Interest rate per annum is 25.93 percent on reducing basis.
- **Share Microfin (SHARE)/Asmitha Microfin:** SHARE had 914 branches across 19 states and a loan outstanding of $389 million as of March 2012.

[92] While certain banks like Punjab National Bank and State Bank of India have agricultural credit related programs, direct interaction with the banks will be needed to obtain specific agriculture and water sector program information for Rajasthan.

[93] Rajasthan Microfinance Report 2011, CMF

[94] Rajasthan Microfinance Report 2011, CMF (MFI data for March, 2011 unless otherwise stated).

9.3.2 National Bank for Agriculture and Rural Development (NABARD)

NABARD is India's apex development bank based in Mumbai. The bank is responsible for matters concerning policy, planning and operations in agriculture credit and other economic activities in rural areas. It has linked a total of 8.2 million SHGs with savings accounts/banks. NABARD's total commitment under watershed development program in 2011-12 was $295 million, covering an area of 1.78 million hectares where it focuses on livelihood/agriculture productivity enhancement measures, and increasing water use efficiency through water budgeting and micro-irrigation. Watershed initiatives include Indo-German Watershed Development Program (IGWDP) supported by KfW, and the Planning Commission-funded Integrated Watershed Development Program. Rajasthan is a beneficiary of these programs. Additionally, NABARD has helped construct new rainwater harvesting structures for $7.7 million.

10 Market Dynamics

10.1 Market Failures

Water is a common resource and hence subject to market failures. Except groundwater, all other water resources are developed and provided by the state. Even then, groundwater is still a state subject. This is because harnessing this resource for public consumption is the state's responsibility, since around 90 percent of drinking water is from groundwater. This leads to several market and system failures, both from the supply and user sides as elaborated below.

10.1.1 Overexploitation of Groundwater

The draft act for groundwater legislation is in circulation (see section 2.2.1) and has been referred to a legislative committee. While this seeks to regulate use of groundwater, the ability of the executive and judicial system to actually enforce it remains to be seen. Other states - such as West Bengal, Maharashtra and Andhra Pradesh - that have sought to regulate groundwater have not met with much success[95].

None of the acts, including the draft act in Rajasthan, address the issue of equity. Although cost of water and power is subsidized, due to high capital expenditure only large and medium farmers can afford to extract water. Small and marginal farmers are left out. Ironically, groundwater extraction rights are given away to landowners by the Easement Act of 1882. At the same time, groundwater is also termed as a common pool resource in policy discourse. The indiscriminate extraction of groundwater has resulted in degradation of a resource beyond its regeneration capacity. If not addressed, the looming water crisis can easily translate into a food crisis.

[95] Groundwater socio-ecology and governance: a review of institutions and policies in selected countries, 2005, Mukherji and Shah.

Except for certain regulations linked to institutional credit and groundwater, there are no concrete policies to address problems surrounding groundwater, which supplies 90 percent of the state's drinking water and 74 percent of its irrigation water. Interestingly, the state seems willing to regulate groundwater use by large private developers in peri-urban areas. Section 9.1.3 of the state water policy (SWP)[96] says, "A legal framework will be developed for the regulation and management of groundwater extraction in general and in 'critical and overexploited' zones in particular. Such legislation will also address the need for compensatory water conservation and recharge measures to be taken by bulk water consumers." The actual implementation of the policy and its effectiveness needs to be watched closely with current average groundwater utilization rates already over 100 percent, in other words beyond recharge capacity.

10.1.2 The 'Free' Water Mentality

The present tariff structure needs to be looked at. Drinking water is subsidized up to 75 percent. This barely covers 20 percent of operating and maintenance costs. This has led to a price gap of 90 percent in rural drinking water and medium/major irrigation, and 60 percent in urban drinking water and minor irrigation. In most towns, bills are raised on the basis of average consumption since an estimated 60 percent consumer meters are either not installed or are not working. This leads to the ironic situation where the consumer who uses the most water receives maximum subsidy. Bulk metering at source of supply is not available, so there is no foolproof method to trace the supply channel from production to end-user. In this scenario, it is impossible to work out the true cost of water delivery so that appropriate tariff structures can be put in place. Meanwhile, paying for water, in the true sense, is a foreign idea for most[97]. This has led to a free water mentality, leading to reckless misuse of water.

When it comes to irrigation, current water and energy policies actually subsidize inefficient use of water, since there is no increased cost associated with more usage. This hinders adoption of water saving technologies (WST). Pricing that is based on cropping area and not on type of crop planted or volume of water consumed, does not provide incentive to adopt crop varieties that require less water and give higher yield. Additionally, the flat rate system of pricing of electricity or actually giving it away free for the farm sector does not provide incentive to use energy and water-efficient irrigation technologies. Further, power supply restrictions for the farm sector limit expansion of area under pressurized, energy-intensive micro irrigation (MI) systems.

[96] State Water Policy (February 2010) version as accessed on April 30, 2013 at http://waterresources.rajasthan.gov.in/WaterPolicy/Rajya%20Jal%20Neti_English.pdf.

[97] According to Reddy (1996), the affordability and willingness to pay for water in Rajasthan is estimated to be 3 percent of a family's budget, less than elsewhere in the country.

10.1.3 Broken Water Delivery

The inability to recover even operating and maintenance costs has placed a lot of pressure on the state's water infrastructure. Leakages in drinking water distribution systems cause a loss of 50 to 60 percent, against a design norm of 15 percent. Tail end consumers are left with little water and low pressure. Consumers use online boosters to draw more water, which does not improve the situation. The gaps in supply are staggering, both in terms of frequency and volume. The same story is repeated in the irrigation system where unlined canals cause water losses and lead to water logging, which further aggravates the state's salinity problem. In areas that are fully dependent on canal water, unscientific, erratic water delivery schedules and inadequate control over volumetric supplies lead to farmers resorting to flood irrigation and short duration varieties at the cost of crop yields.

10.1.4 Lack of Institutional Capacity

Currently, government departments managing water supply systems, such as the PHED, are more suited for creating distribution infrastructure rather than actually operating it. The State Water Policy (SWP) acknowledges this limitation by proposing a shift away from an engineering-driven approach in favor of a service-driven approach. Most water supply schemes are understaffed, sometimes by as much as 50 percent, and many do not have required skillsets. In several capital intensive drinking water schemes, demand outstrips installed capacity even before a project is finished. The traditional top down approach by water related departments has failed to mobilize community involvement in planning water projects. Hence poor public buy-in, especially in rural drinking water schemes, results in lack of cooperation by the public in helping to maintain water assets or pay for services. Policies around constructing rainwater and storm water harvesting structures in certain types of building and road projects have largely remained on paper. There is evidence of intent. The Twelfth Plan document, for instance, does talk about measures such as better cropping practices in CCAs and adoption of micro irrigation. But, without the institutional capability to enforce these measures, there is little chance they will be adopted. The overall scenario has led to misuse of the state's very limited water resources, lack of trust, and little credibility for government run water supply schemes.

10.2 Market Needs

While the most obvious market need is access to sustainable water supply, there are other very important between-the-lines issues that need urgent attention to make this possible while keeping in mind long-term sustainability of water resources and the communities impacted.

10.2.1 Equitable Water Distribution

Subsidies towards irrigated water in India are not well targeted to the rural poor. The World Bank found that up to 80 percent of subsidies in the country went to medium and large farmers[98]. Electric supply is not metered and a flat tariff is charged, depending on the horsepower of the pump. This means farmers can use as much power as they like with zero incremental costs, giving them little incentive to use power or water more efficiently. The first to be affected by falling water tables are the rural poor and marginal

[98] In 2003, South Asia Rural Development Unit of the World Bank looked at subsidies to surface irrigation in Andhra Pradesh, Karnataka, Maharashtra, and Uttar Pradesh.

farmers who lack the means to deepen their wells and install more powerful pumps. A report[99] by the planning commission suggests that it will be difficult for states to raise power tariffs for agricultural users due to political reasons. While withdrawing subsidized power altogether may be politically untenable, a potential compromise could see farmers receive an up front entitlement to a fixed amount of power at an administered price, from which consumption charges would be deducted. The report also points out that government support for micro irrigation techniques will help make water use more sustainable. The situation with unjustified subsidies in drinking water has already been discussed in various sections of this report. Part of the solution clearly lies in tariff reform, while fixing water rights may be the other part.

Water resources - surface, groundwater, river basin or sub-surface aquifer- need to be treated as a common pool resource, meaning effective abolition of riparian rights. Delinking water rights from land rights would make groundwater a genuinely common resource, and start the process of recharging overexploited aquifers through both natural processes and human effort. Institutional arrangements need to be evolved to reduce conflicts in resource sharing. Regulation is not always the best answer to ensure equity in distribution, or the cheapest. Communities need to be mobilized, awareness needs to be created, and efforts made towards equitable distribution of water resources. This is a long process and time is of essence, hence the need for a start from the policy end. As daunting as the task seems, there have been examples within India (Pani Panchayat[100] in Maharashtra) and abroad (South Africa and Mexico). In absence of equity, sooner or later, as water resources become increasingly scarce, avoiding water conflicts of the kind already witnessed in the state[101] will become more difficult. Left unchecked, such a situation can reach critical magnitude, surpassing communities and spiral into regional and national chaos.

10.2.2 Demand Management and Tariff Reform

Users just need access to safe, dependable water supply. To achieve this, our approach needs to shift from merely meeting the supply-demand gap to managing demand itself. This should be reflected in planning for all water related projects by the government. This can be achieved through appropriate pricing of water and adopting technologies backed by legislation and institutional support to ensure adoption. Often pricing policies are thwarted by lack of willingness to pay for basic amenities. Contrary to general belief, there is evidence from Rajasthan that domestic and irrigation water consumers are willing to pay substantially higher prices (double the present price) for improved

[99] Report of the Expert Group on Ground Water Management and Ownership, Planning Commission, Government of India.

[100] Pani Panchayats are water councils set up for management and equitable distribution of water resources in the drought prone state of Maharashtra. The councils use technological and social innovations to restore degraded watersheds to enable water harvesting. Each family within the community is guaranteed an equal share of the water harvested for cultivation, typically at the rate of half an acre per head, subject to a maximum of 2.5 acres per family. This translates into 1,000 cubic meters per head per year, subject to a maximum allowance of 5,000 cubic meters per family per year.

[101] Six farmers in 2004, five in 2005, and six in 2006, were killed in Rajasthan while protesting lack of access to adequate irrigation water. This prompted a series of protest marches in Jaipur that began in 2005, and again took place in 2006 and 2007 (Birkenholtz 2009). Context: farmers demanding water from the IGNP, protested in Sriganganagar, Hanumangarh and Bikaner (IGNP phase-I), demanding 58 percent water from IGCP, as was promised by the government. An agreement to that effect was signed between the government and the Kisan Sangharsh Samiti (KSS). The farmers allege that the government has not kept its word.

water supplies[102]. This is also highlighted by a World Bank survey[103], undertaken as part of the Karnataka 24x7 Water Supply Project appraisal process, which indicated that people were willing to pay more for a more dependable supply. However, there are bottlenecks to charging higher prices. The government's unwillingness to raise tariffs due to fear of a public backlash and due to lack of confidence in being able to consistently deliver quality service is clearly an obstacle. Currently, due to inadequate metering, consumers are not even aware of their consumption levels. Therefore public resistance could be a temporary reaction while consumers first adjust to their usage and start adopting better water conservation practices. However, increased tariffs must go with a water delivery mechanism that consistently works and eliminates inefficiencies such as transmission losses and theft of water, one of the main reasons for higher provision costs. In order to be viable and long term, efficiency of any service needs to be supported by an adequate and just pricing mechanism.

For agriculture, the ideal policy is to promote water-saving crop and irrigation technologies in tube well-irrigated areas with pro-rata pricing of electricity. Many states face serious problems in introducing consumption-based charges for power use. The government needs to start with metering agricultural consumption. Cash incentives or subsidies can be given to farmers who adopt water saving technologies and reduce electricity consumption. Subsidies can be linked to connected electricity load or average energy consumed and area under water-saving irrigation technology so that farmers who save more water and power per unit of area will get higher subsidies. The price that truly works for domestic, agricultural, and industrial users needs to be discovered. Till now, there has been no credible effort towards setting of tariffs, although it finds increasing mention in various policy and other documents.

10.2.3 Delivery Efficiency with Technology

Technology needs to be injected into the water supply systems. A fully functional and accurate consumer metering system can limit drinking water wastage and enforce a tariff regime. Bulk metering for all water sources such as reservoirs, canals, tube wells, and pumping stations should go with consumer metering for domestic, industrial, and agricultural use. There is willingness in the government to outsource supply, installation, and operation and maintenance of consumer meters to achieve near complete coverage. Cost of meters and their maintenance can be recovered by increasing meter rents, which are too is low and unsustainable at present. PHED has proposed to outsource bulk metering project to an experienced firm with in-built operation and maintenance, data capturing, storage, and reporting capabilities. An example of technological revamp undertaken by the PHED is outsourcing of its project to phase out old submersible pumps used in tube wells in favor of energy efficient new models.

[102] Urban Water Crisis: Rationale for Pricing, 1996, V.R. Reddy. Aapni Yojna Scheme in Rajasthan.

[103] The Karnataka Urban Water Sector Improvement Project- 24x7 Water Supply is Achievable, September 2010, WSP. The survey found that a household's willingness to pay for a 24x7 water service, on average, was an extra Indian rupees 125 ($2.80) per connection per month (even though very few people believed such a service to be possible). With the system in place and working, the higher-income groups, who were taken by surprise at the high amount of water they were using and therefore by their monthly bills, successfully lobbied for a reduction in the new tariff structure.

On the irrigation front, the use of micro irrigation needs to be supported with capacity building to include:

- Spreading awareness about the scope of micro irrigation since currently its role is misunderstood to be limited to growing vegetables.
- Financial support to help farmers buy equipment.
- Power tariff reforms to incentivize farmers to use less water by using water saving technologies.
- Timely and adequate surface water delivery in canal irrigated areas to make micro irrigation devices effective.
- Manufacturing best practices so that only equipment suited for a given land holding size is sold at a fair price.
- Efficient subsidy payouts by building capacity within relevant state departments.

In the absence of a well-planned and rigorous framework, despite government's good intentions by way of policy documents, annual plans, and heavy central and state subsidies (totaling to 70 to 90 percent), adoption of relevant technologies by farmers will remain poor. Additionally legislation can help streamline equipment supply by discouraging production of inefficient conventional devices.

10.2.4 Groundwater Management

Groundwater mining in the state has surpassed recharge capabilities. In a state with 90 percent dependence on groundwater, this will soon lead to a desperate situation. In many parts of the state physical transportation of water is the only solution to meet drinking water needs, an unsustainable practice even in the medium term. While there may be a gradual shift towards surface resources such as canal systems to make drinking water schemes more dependable, this alone cannot be a solution. Just the capital outlay and timelines required to execute surface water projects could mean continued dependence on groundwater, at least in the medium term. Every effort to help recharge underground aquifers needs to be made, including micro watershed planning and restoration of traditional water bodies that lie scattered in disrepair all around the state. These bodies once sustained life in this harsh terrain, but over-dependence on state-supported water schemes and the gradual decay of communities that once supported these structures has created a desperate water situation in areas such as most of western Rajasthan.

Analyzing the factors behind the exponential increase in groundwater use, a World Bank report[104] points out that groundwater allows users more control over quantity and timing of supply. Thus, it is linked to higher productivity. The crop to water productivity of groundwater-irrigated farms is almost twice that of surface-water irrigated farms. Also, use of groundwater is a response to poor service delivery of

[104] Deep wells and Prudence: Towards pragmatic action for addressing groundwater overexploitation, March 2010, World Bank.

surface water systems, as in urban water supply. The need to promote surface water schemes to help groundwater conservation is clear. The need to educate farmers to voluntarily reduce groundwater use and still safeguard their drinking water supply and crops is also clear. This is being done in Andhra Pradesh where people who never went to school are today successful barefoot hydro-geologists[105].

To restrict use of groundwater for irrigation, electricity to farmers should be metered and charged appropriately instead of the heavily subsidized power tariff regime currently in place. Other suggestions include giving upfront entitlements to farmers and allowing them to cash in unused electricity[106], rationing electricity through separate lines for agricultural pumps, and restricting supply to specific hours as is being done in Gujarat.

10.2.5 Balancing Agri-Water Nexus

Since 83 percent of water is diverted to agriculture, the need to balance the agri-water nexus cannot be overemphasized. Especially in the context of managing groundwater, which contributes 74 percent of water used in agriculture. While sustenance agriculture is a fact of life in many parts of the state, and a necessity in the absence of economic alternatives, efforts to ensure that scarce groundwater is not wasted are needed. Several initiatives such as farm plans, contract farming, installation of micro irrigation equipment per well/tube well, and crop diversification under the Eleventh Plan[107] can help address this. Current cropping patterns just do not suit this arid/semi-arid state. With surface irrigation schemes not meeting demand, enormous pressure is put on groundwater resources.

10.2.6 Water Harvesting

In several parts of Rajasthan, especially where rainfall is limited to a few showers during the short monsoon months, groundwater is not an option due to depletion or high total dissolved solids (TDS). With surface water also not available, rainwater harvesting (RWH) is the most viable solution to meet drinking water and household needs, at least for a period of six to eight months. Rajasthan has a tradition of building, and maintaining RWH structures such as *johad, kuis*, and *kund*s. Traditionally, these structures supported life in this water stressed region, and were well supported in turn by a system of community ownership. Excessive reliance on government run systems has led to the gradual neglect of these structures and disintegration of the entire support mechanism. Attempts are being made by non-governmental organizations (NGOs) such as the Jal Bhagirathi Foundation in

[105] Droughts are common in the western arid parts of the state of Andhra Pradesh. Here a group of NGOs have come together to run a first of its kind project in India to monitor, decode and thus manage groundwater. This is done by first mapping the locality to define its hydrological units and drainage; each unit is drained by a single stream with one inlet and one outlet (region consists of 11 hydrological units, one containing 41 villages while others are much smaller). Subsequently farmers voluntarily collaborate in projects to measure/record rainfall, water table, withdrawals and other data for their land. They calculate water availability if water tables remain steady, decide which crops to grow and estimate how much water they will use given that about half will go in evapo-transpiration. They then form groups within each hydrological unit, and each group draws up a water budget, details of which (showing who should grow what/how) are displayed on a wall in the village and updated over the year with information about rain, harvests and even revenues. As a result a large number of farmers (more than 650 villages or 1 million people) are starting to reduce their demand for water. Local diet has become more varied, chemical fertilizers have been replaced by compost, and relentless drilling of wells has abated. The state water department has been trained in the basic principles, and other states have adopted the project.

[106] An Integrated Approach to Management of Water – by Dr. Kirit Parikh.

[107] MTR, State Eleventh Five Year Plan, chapter 7, Agriculture Production, sections 7.5 and 7.7

the western Marwar region, Tarun Bharat Sangh and others to repair these RWH structures and re-engage communities in their preservation. Attempts to encourage individual household RWH tanks are being made by agencies (such as Safe Water Networks), social enterprises (such as Aakash Ganga), NGOs such as (Bhoruka Charitable Trust), foundations, governments and others. The relevance of RWH in addressing today's water crisis is unquestionable; however implementation models, design norms, and funding vary. The lack of financial models and capital limitations at the user end pose challenges in the rural individual context. In the urban setting, enforcement of RWH norms for large buildings has been a challenge.

Technical support such as remote sensing data and geographical information systems (GIS) can help as in Madhya Pradesh which has outsourced this function to experts. In Chennai, RWH has been made a requirement for support by the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) for water supply schemes. RWH must be a part of micro watershed planning and undertaken in all rural and urban settings to meet demand for drinking, domestic, agriculture, and industrial water.

10.2.7 Industrial Wastewater Management

As highlighted in section 5.3 of this report, contamination of water due to industrial effluents is a significant problem in many parts of the state. According to estimates, water demand of industries is 1,000 gallons/acre/day[108]. Overall industrial demand for water in the state currently accounts for the lowest share of 6 percent. But, as demand by this sector grows, it is critical to meet a portion of this with recycled wastewater while minimizing water loss due to industrial pollution.

Groundwater extraction for industrial use has to be especially regulated through increased charges and by providing alternative and reliable supply. Groundwater for industry should be limited to sustainable use and should attract a cess to finance measures such as groundwater recharging.

Industry associations should be encouraged to regulate themselves to keep pollution under control. While there are individual examples of water stewardship initiatives by socially responsible companies, what is really needed to make a quantifiable difference is industry-wide involvement through water foot printing studies and follow up dialogue. Industries can be made to publish their effluent quality data regularly, which will help empower affected communities and citizens at large.

[108] Initial Screening Report, Integrated Utility Management of Bhiwadi, PricewaterhouseCoopers (PwC).

10.3 Market Barriers

The question is who will help make things right and deliver what is needed? While it is clear that a consistent, constructive, and collective effort by several entities, supported by an overall enabling environment, is required, the purpose of this report is to specifically explore the contribution that the private sector can make in the water endeavor. To that end, it is also important to understand limitations and challenges faced by the private sector in delivering water related services. This section highlights the key market barriers to private sector involvement.

10.3.1 Water = Government

Unlike all other sectors where the private sector has played a vital role, water as a social sector is unique. As also acknowledged by various legal verdicts[109], access to clean water constitutes the Right to Life under Article 21 of the Indian Constitution. As the custodian of water resources meant for the public at large, it is the duty and obligation of the state to protect these resources. Added to this is the socialist doctrine long followed by the country where it is understood that government will provide water to people. Further, the role of state governments in this task is well enforced by the Constitution in which water is included in Entry 17 of List II in the Seventh Schedule, which is the State List, however subject to Entry 56 of List I in the Seventh Schedule, which is the Central List. To conclude, water and government are inseparable.

People have come to expect government's role in providing water for all purposes. However, many governments provide inefficient and inadequate services at highly subsidized rates. Attempts by the private sector to engage in water, will at a minimum, involve interaction with the government, and more likely, involve dialogue with, buy in from, and partnership with the government. Thus, the role the private sector can play and the efficiency it can exhibit will be governed by the government. Without government blessing, it is likely that the private sector will be viewed with skepticism by user communities, given the widespread notion that private equals profit, which sometimes means exploitation.

10.3.2 Missing Private Eco-System

While Rajasthan has made several attempts in recent times to become more investor friendly and attract business, several barriers prevail for private sector participation in the water sector. Broadly, these are:

- **Capital:** In Rajasthan, the communities that are most vulnerable to absent or inadequate water supply are marginal farmers, landless laborers, the rural poor, and inhabitants of remote/tribal areas. They do not even meet soft finance/micro finance requirements.
- **Pricing:** The lopsided tariff structure, in some cases altogether missing, has set a very dangerous precedent in the minds of the users that water is free. This an unsustainable practice, but corrective measures can lead to resistance and mistrust.

[109] Honorable High Court of Kerala in the matter of Perumatty Grama Panchayat vs. State of Kerala, also known as the landmark "Coca-Cola Case."

- **Policy:** While the private sector is increasingly being viewed as an option for the water sector, the policy framework to safeguard private interests and regulate private performance is missing.
- **Institutional Framework:** The institutional framework to support private participation in the water sector is limited, from both financial and legislative sides. While many banks and financial institutions support infrastructure projects for water and provide agriculture finance, their role in supporting projects for drinking water supply, efficient water use in agriculture and similar interventions has been limited.
- **Awareness:** Knowledge of the wide range of efficiencies that the private sector can bring into the water space is limited. This is true not only at user level, but also at government and institutional levels. In part, this may be attributed to limited exposure to technological solutions that the private sector can provide. There is lack of information sharing between various states working on various water related projects, not to mention limited exposure to private sector achievement in water sectors outside India. Also, employees of water related government departments are not involved in exploring and understanding solutions. The private sector is mostly seen as a means to augment funding and as an outsourced service provider.

10.3.3 The Water Business Model

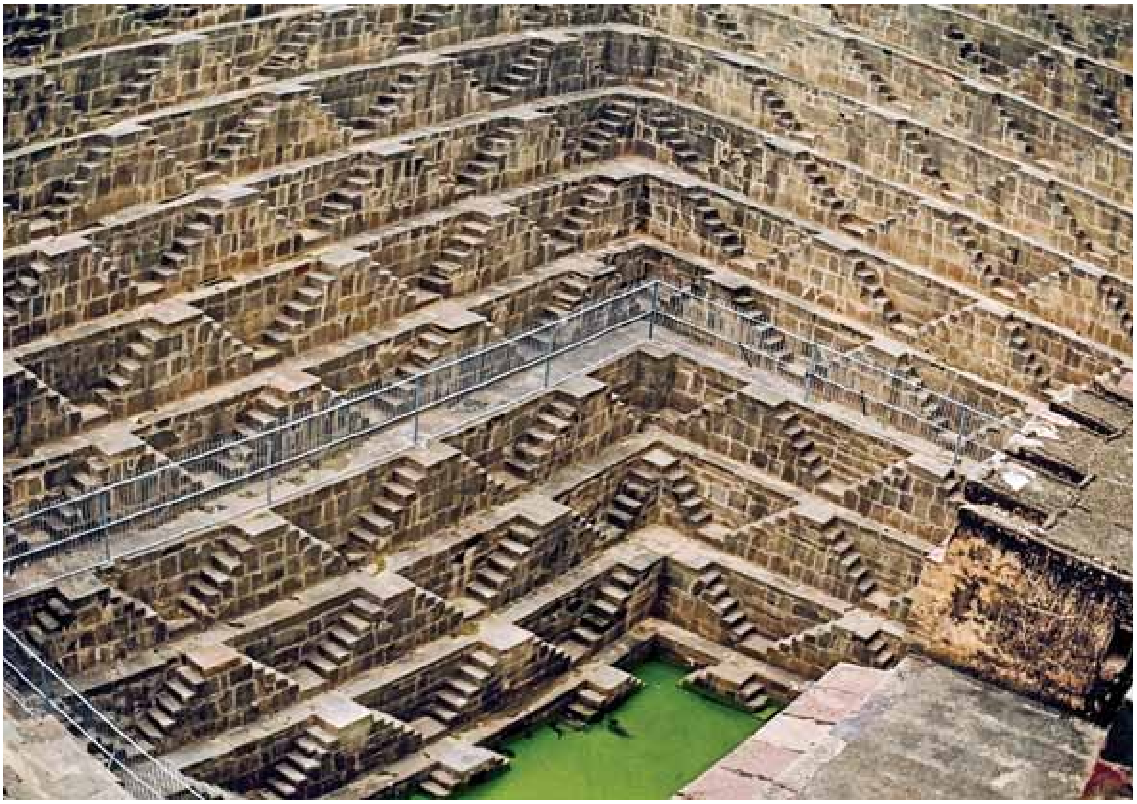
Focus on the development/inclusive index, does not always translate into viable business models for the private sector. Water is a need, not a want, this fact supersedes all else. This need is to be ideally met by simultaneously compensating and conserving finite water resources for coming generations.

Secondly, water is a social matter requiring continued community participation. Any water related business model needs to factor this in, which means long periods of hand-holding, not a standard private company trait, although a given with NGO and volunteer work. More business models need to evolve for the private sector to fine-tune its water value proposition.

10.3.4 Uncharted Territory

As seen in chapter eight, the role of the private sector in water in Rajasthan has been limited to standard contractual work. There are no relevant examples of public private partnership (PPP) or private sector partnerships in the true sense (risk sharing, transferability of assets, and financial structuring) in water related projects. This could change soon with the PPP projects under consideration, however it would be fair to say that water (non-contractual, non-construction projects) is an uncharted territory for the private sector in Rajasthan, as is the case in most of India and the developing world. This automatically leads to lack of trust, both within the government and user communities. While better awareness and stakeholder dialogue can gradually help create trust, the ultimate solution will be successful delivery by the private sector. However, this may be somewhat of a chicken and egg situation. For now, there seems to be a mindset within the state government that may on occasion act as a block, discouraging private role. The need for professional guidance, expert transaction structuring, and transparent processes to unleash the true potential of private sector in water is the need of the hour.

Figure 31



Chand baori (step well), Abhaneri near Jaipur. Built in the 19th century, it has 3,500 narrow steps, 13 stories, and is 100 feet deep. Baoris or bers are community wells found in Rajasthan used mainly for drinking. Most are very old and were built by banjaras (mobile trading communities) for their drinking water needs. They can hold water for a long time because of almost negligible water evaporation.

Rajasthan as a state has a long, proud history of water stewardship and an entire tradition[110] around it where water was a community resource, used and managed as such. Though neglected, the superior examples of different types of water structures all across the state bear testimony to this. These structures are of various types and different names: *kunds/kundis, kuis/beris, baoris/bers, jhalaras, nadi, tobas, tankas, khadins, vav/vavdi/baoli/bavadi, virdas,* and *paar* (see figure 31). The Paliwal Brahmins discovered the relevance of gypsum in preventing water seepage in parts of western Rajasthan some five hundred years ago, where they built *kuis*[111] (shallow wells) to access water. Private companies need to understand and support traditional wisdom to be most effective.

[110] Johad (a crescent-shaped earthen check-dam) found in many parts of the state, was a place of special significance. Villagers would engage in community work like building a temple or start work on a new johad. The practice is being revived again, as in Bhaonta-Kolyala village in Alwar district of Rajasthan that also walked away with the Down To Earth - Joseph C John Award, for its work on RWH.

[111] Found in western Rajasthan, these are 10 to12 meter deep pits dug near tanks to collect the seepage. Kuis can also be used to harvest rainwater in areas with meager rainfall. The mouth of the pit is usually made very narrow. This prevents the collected water from evaporating. The pit gets wider as it goes deeper into the ground, so that water can seep in into a large surface area. The openings of these entirely earthen structures are generally covered with planks of wood, or put under lock and key. The water is used sparingly, as a last resource in crisis situations.

10.4 Market Players

The market players in the state deserve review, as they will be contributing partners in any private initiative in the state. Rajasthan with its arid and semi-arid climate has had an active water player roster. Chapter nine of this report provides insight into the most active members specific to Rajasthan. They fall into the following groups:

- **Government:** Ministry of Water Resources, PHED, agricultural and horticulture directorates, Planning and Irrigation Department, and others such as urban local bodies (ULBs) and panchayat raj (elected village bodies) institutions (PRIs)
- **NGOs/foundations/volunteers:** They play a significant role in community mobilization and rejuvenation of traditional water structures
- Multilateral agencies/business associations/educational and research institutions
- **Financial institutions:** Including micro finance institutions and self-help groups that give loans
- **Private companies:** Technology providers, water related services/products, water infrastructure and service delivery
- **Users:** Domestic, non-domestic, agricultural, and industrial
- **Knowledge providers:** professional consultants and research houses.

11 Potential Participation and Analysis

11.1 Interventions

The perspective on what has gone most wrong, and what is needed most urgently, offered in chapter 10, helps establish an important fact – that there is a lot that needs to happen on the government's end, mainly through action-oriented policy intervention, institutional reform, and political will. What also emerges is that the private sector is most suited to address many deficiencies, and that it must play its part in bringing needed efficiencies, both technical and process oriented, while sharing resources and responsibility. Given the barriers to private sector participation as discussed in section 10.3, it is important to specifically outline possibilities for private sector intervention, and further, narrow these interventions down to those that the IFC can or will support, depending on resource availability and internal priorities.

This chapter specifically explores how private sector can contribute to Rajasthan's water sector. In the context of our goal, and on the basis of Rajasthan specific facts presented thus far in this document, it makes most sense to assign the state's water sector into the following seven intervention possibilities.

11.1.1 Rural Drinking Water – Off Grid

Around 75 percent of Rajasthan's population, more than 51 million people, live in rural areas. Add to this the large livestock population, animal husbandry being the second most important livelihood activity in this agrarian state. The state has experienced more than 40 droughts in the past 52 years. Nearly 75 percent of its villages have had a 50 percent deficit in crop yield, jeopardizing the lives of nearly 32 million people. This recurring situation is especially hard on women, who often must walk for miles to collect water. In the dry regions of Rajasthan for example, women spend as much

as four hours a day and walk an average six kilometers for water[112]. By some estimates, the Rajasthan government spends millions of dollars in transporting water to rural villages[113]. The state government has made rainwater harvesting (RWH) mandatory for all public establishments and for properties on plots measuring more than 500 square meters in urban areas. If an RWH completion certificate is not submitted to the Public Health and Engineering Department (PHED), water supply connection can be terminated, although this hardly happens in reality.

There are roughly 122,000 rural habitations in Rajasthan. These areas are to be covered under the Rajiv Gandhi Drinking Water Mission (RGDWM). The definition of drinking water related coverage (including number of villages or habitations) and corresponding statistics tend to vary within government departments. The accuracy of some of this data is questionable for a variety of reasons. Based on Planning Commission estimates, roughly 30 percent of habitations are covered and have access to 40 liters per capita per day (lpcd) of water. The remaining 70 percent are not covered for various reasons: the quality of water is not good, they are located too far away from the nearest water source (beyond the government's definition of feasible distance to supply), or have slipped back to pre-coverage levels of less than the minimum targeted water supply. Even by PHED estimates that are more optimistic, about 30 percent of the habitations have no coverage at all, little over 50 percent are covered fully, and the rest are partially covered, the definition of coverage being ambiguous.

The vulnerability of source of coverage (based on reliability of supply) and the burden associated with the source (such as using hand pumps in sweltering temperatures and long lines) are other dimensions. These are significant when one considers that women and, sometimes, children are entrusted with the task of fetching water for the household. Only 5 percent of rural village drinking water supply is covered by piped schemes (deemed most reliable), while more than 50 percent of villages are covered under hand-pump schemes, which are wide open to failures due to maintenance issues and falling water tables.

Despite being a low-income state, Rajasthan has the highest percentage of rural households where water is purchased. Options for potable water are limited, while water quality issues are numerous and very common. Conveying water over vast distances and difficult terrain compounds this problem. In many severely affected parts, there are negligible employment alternatives to agriculture and animal husbandry. It is normal for people in Rajasthan to consume water with twice the level of acceptable total dissolved solids (TDS) for the country (refer to chapter 5 of this report on water quality).

The drinking water solution most applicable to rural areas, especially remote habitations, is off-the-grid water supply, both community and individually owned. Additionally, with no groundwater (due to quality issues or depletion) and limited feasibility to connect with surface schemes (due to low density of population in these areas to justify large infrastructure investment), the most viable source is rainwater harvesting.

RWH as a concept has been around in the state for hundreds of years, and traditional structures such as community tanks, reservoirs, and step wells can be seen all over Rajasthan. Several non-governmental organizations (NGOs) have taken on the task of repairing such structures, and rejuvenating the concept

[112] Aga Khan Development Network

[113] World Bank estimates

of community managed water supply. More recently, newer structures have been built with philanthropic, government, and institutional support, testimony to the continued faith in traditional practices in the absence of alternative means. Innovative solutions built on traditional methods are being promoted by institutions such as the National Geophysical Research Institute and Indian Institute of Chemical Technology. For instance, efforts to enhance runoff in kundis by 60 to70 percent depending on intensity of rainfall rely on new techniques involving polymers. Formal policy recognition is evident in section 5.1.3 of the state water policy (SWP)[114], which specifically states that roof top rainwater harvesting will be promoted both in rural and urban areas.

Several institutions have promoted individual, household RWH tanks with typical capacities of 15,000 to 25,000 liters at an average cost of Indian rupees22,000 ($450), where the material to labor cost ratio tends to be about 60:40. The catchment area comprises of rooftops where available, or specially built concrete structures around these tanks. The designs of tanks vary, in some cases these are connected to larger community tanks to collect overflows, although not successful given the limited amount of rainfall received in these areas. The funding models for such household tanks vary as well, but the user component is generally found to be less than 30 percent, which is typically contributed in kind; that is labor (basic training is given) and material (mostly bricks, since these are locally available). The ability to contribute even this much varies from one household to another.

In parts of western Rajasthan personally surveyed by the author, households are unable to contribute at all. Here, families earn as little as Indian rupees100 or less than $2 a day as daily laborers manually breaking stones; an opportunity they claim is limited to 15 to 20 days a month. These areas, however, also happen to be the most needy (hence highest on the developmental impact scale). Unlike household RWH structures surveyed by the author in northern and eastern parts of the state (where groundwater is still available, there are canals within a few kilometers of the villages, and marginal farming is being done), in central and western Rajasthan none of these apply. In these areas, hamlets consisting of a few households lie scattered in the desert, collectively paying about Indian rupees 400 ($8) for a camel cart to supply water that lasts about two days. In addition to being a financial burden, there are associated health risks to this practice since supplied water is saline and has dissolved solids beyond levels considered safe for human consumption[115]. Households do not have the means to build larger tanks; they store water in a community tank built by the government, if any, or in small tanks in their home.

While the above scenario of limited or no user capital poses a challenge for private involvement, it is worth exploring possibilities with the right private partners such as microfinance institutions (MFIs) in cases where the user is able to contribute and the government, which should ideally support very poor users, is unable to. As an example of professional institutions involved in the RWH space, Safe Water Networks (SWN) has been active with BASIX Social Enterprise Group as its MFI partner, along with local NGOs to support the initiative on the ground.

The argument for the state to subsidize would be that these areas are likely to remain uncovered while the state machinery is occupied with other priorities relating to urban water supply. These areas also fall outside the prescribed distance (between source of water and end user) for coverage under the RGDWM,

[114] State Water Policy (February 2010) version as accessed on April 30, 2013 at http://waterresources.rajasthan.gov.in/WaterPolicy/Rajya%20Jal%20Neti_English.pdf.

[115] During interviews with families in these areas, the author observed frequent reports of water borne diseases in young children.

and it is highly probable that they will slip back from coverage, as is the case for areas dependent on hand pump schemes. Additionally, around 66 percent of the state is desert (Jodhpur, Barmer, Jaisalmer, Pali, Jalore, Churu and Nagaur districts) with a lower density of population. The costs of government schemes increase substantially, a disincentive for the fund strapped state. The hidden costs of not providing access to water in these areas are high for the state. Therefore, money can be channeled by the state towards private initiatives to subsidize very poor users. RWH will help reduce dependence on unreliable groundwater sources, something the government is struggling with. In areas where part of the cost can be borne by the user, the private model can anyway be explored through microfinance.

In addition to better planning and execution, the value add that private intervention will bring over a PHED run program could be integrated sanitation solutions, scalability and community involvement (water user groups (WUGs) or existing government projects such as Village Water Security Planning), and health (WHO and other UN agencies).

In areas of really high TDS, off-grid filtered water supply through kiosks or other distribution channels could be explored. However field visits by the author[116] to survey one such initiative by Sarvajal, a private water filtering company based in Gujarat, that uses reverse osmosis (RO) technology in the villages of Sikar and Jhunjhunu districts in Rajasthan, showed mixed results. The bulk water being treated was typically in the TDS range of 400 to 800 ppm[117], and filtration brought it down to 100 ppm (WHO generally recommends 500 ppm for India). Interestingly, even pre-filtration levels of TDS in these locations were already lower than TDS levels of filtered water supplied by PHED run piped schemes in some of the worst quality affected areas in Rajasthan. One such location surveyed during the field visit was Nagaur district, where PHED supplies water at 1,000 TDS.

In certain parts of Barmer district, TDS as high as 4,500 has been recorded, while it is common to find 2,000 TDS in the other affected areas of the state. Sarvajal franchisees reported that customers who did not always buy filtered water did not report major health problems due to poor water quality when they switched to other cheaper sources. This is not the case in the worst affected parts of the state where incidence of fluorosis and associated diseases is high. Additionally, certain areas where the company operates are facing acute groundwater depletion. Some franchises even reported having dug new tube wells (Samota Ka Baas, near Palsana village), or deepened existing tube wells (Rolsabsar village) to qualify for business with the company. In the absence of clear health benefits, the need to put additional pressure on an already critical groundwater situation is debatable[118].

In contrast, in western Rajasthan where people suffer from serious health issues due to water quality, a public private community partnership (PPCP) with the private company Environze has demonstrated the benefits of off-grid solutions where communities own/manage operations and generate income through self-help groups (SHGs). These would be good examples for IFC to study (refer to Jal Panihari program under 9.1 of this report). Bulk desalination plants are also worth looking at in these areas with very high TDS (see section 11.1.2 next).

[116] Bastiaan Mohrmann of IFC was with the author on this particular visit.

[117] With one exception of 2,200 TDS in Rolsabsar village.

[118] Further due diligence on companies such as Sarvajal is needed with a larger sample size of their operations to draw final conclusions on their true relevance as social enterprises that promote better health where it is needed the most, especially in the context of groundwater stressed areas such as Rajasthan.

11.1.2 Rural/Peri-urban Drinking Water – On Grid

On-grid supply in rural and peri-urban areas, that is in bulk to public stand posts (PSPs) or end users, would present more viability for private involvement. At present, about 27 percent of village drinking water supply is supported by regional schemes. However with the PHED looking to move away from groundwater to surface schemes linked to IGNP, rural and peri-urban areas in the canal distribution network can benefit. For reasons discussed at length in chapter 10 of this report around market failures and market needs, these schemes would be best implemented under private partnerships, ably supported with metering, pricing, system efficiencies, community involvement, and sustainable operations and maintenance (O&M).

In the state draft annual plan document for 2013-14, section 19.5 says, "State's medium term plan is to shift toward surface water sources through building an extensive network of multi-town and multi-habitation schemes, each with long distance conveyance systems simultaneously supplying bulk water to a large number of villages, towns and cities, for maximizing benefits. The main surface sources are Indira Gandhi Main Canal, Banas, Chambal and Narmada rivers based dams. Yamuna water shall also be utilized for nearby rural areas."

As detailed in chapter 8, a number of such surface based regional schemes are in the project planning stage. The failure of government run schemes, where demand has outstripped supply even before completion of projects, or where distribution has serious lags with no community buy in (hence no cost recovery), would suggest that without major institutional reform, future schemes could meet similar fates. Besides, priority on urban schemes combined with paucity of state funds, by the government's own admission[119] could mean delayed launch and implementation of these rural and peri-urban projects, if at all these are sanctioned in the near term.

A well-structured PPP transaction may be the best alternative. The proposed externally funded projects discussed in section 8.5 of this report include peri-urban areas and as such would be an ideal opportunity for private intervention.

Additionally, there already may be opportunities to set desalination plants and cater to surrounding communities in an on-grid bulk to PSP or user mode. An example is the Kasnau-Matasukh Desalination Project in the Nagaur lignite belt (refer to chapter 8 of this report), which is a unique project. The accidental discovery of a vast brackish water aquifer in a lignite-mining zone is being used to the advantage of thirsty habitations in the area. Rajasthan has more than 4,000 million tons of lignite reserves in the districts of Barmer, Bikaner, and Nagaur and, in recent years, some lignite blocks in three districts have been allotted to thermal power plant projects. With such vast lignite deposits in the state, the possibility of additional aquifers could be proactively explored. Along with community buy in, a private partnership model in such a case could work well. IFC could explore desalination projects under various proposals (see details in illustration IV under 11.3.1, and appendix F[120] of this report).

[119] Section 19.13 of the draft annual plan 2013-14 states "Due to the limitations of quality and quantity, the ground water sources can no longer be considered dependable in Rajasthan. Major coverage, therefore, shall be from surface water source-based projects. River Chambal and its tributaries, Indira Gandhi Canal System and Narmada Canal are the only dependable perennial surface water sources in the state. Due to a limited number of reliable surface sources, these projects involve long transmission systems that are highly capital intensive, require substantial funds and long time for completion. Surface sources are being adopted as the most sustainable and reliable source to avoid slipping back after achieving coverage."

[120] While current status of these projects is unclear, the list demonstrates the kind of projects that are feasible in the state. Last accessed on May 1, 2013 at http://www.ibaw-india.com/site/ibw/read.jsp?reqpage=Projects.

11.1.3 Urban Drinking Water – On Grid

In the light of the severely compromised urban drinking water supply in the state (refer to section 4.2 of this report), the need for an alternative is immediate. Private involvement in urban areas is very relevant as proven by select initiatives within India and abroad.

The government's intent to involve the private sector is known. PHED, under its reform agenda (refer to section 10.2.3 of this report), talks of the likelihood of outsourcing implementation and O&M for several technical upgrades, including bulk and consumer metering. This would be relevant especially in the urban context. Such opportunities can be explored further by the private sector by taking a holistic view and addressing the overall supply system under a partnership, rather than the traditional contractual model.

The most important policy thrust in making private sector viable in on-grid schemes is the formal recognition of water pricing and tariff reform as important areas. Section 8 of the SWP[121] reflects on this. With the broad objective of conveying the scarcity value of water through water pricing, the draft states, "Water tariffs will be set for progressively moving towards full cost of operation and maintenance...this will be matched by a rigorous program of improvement in the efficiency of operation and maintenance...for all water supplies a three or four stepped water tariff will be charged…a program of water metering for water management purposes will apply to all significant water users irrespective of source and water ownership."

11.1.4 Agriculture: Canal Irrigated and 11.1.5 Agriculture – Non-Canal (Groundwater and Rain fed)[122]

Agriculture, which consumes 83 percent of the state's water resources, presents the single biggest opportunity for water reform. Importantly, due to rising demand for water for non-agricultural use, experts predict serious implications for agriculture in the state as the share of water available to the sector reduces to 70 percent by 2050[123]. There is almost no alternative, but to switch from the inefficient practices currently in use towards more water efficient irrigation and cropping practices.

While one would ideally like long-term food security to result from better water management, this arguably also cannot be expected from present day cropping and irrigation practices in the state. Despite agriculture being the most important sector in the state, Rajasthan is not a significant contributor to the food bowl, for itself or the nation.

Rajasthan is under the grip of severe food insecurity with 22 of its 32 districts[124] being labeled as 'most food insecure' in a study.

[121] State Water Policy (February 2010) version as accessed on April 30, 2013 at http://waterresources.rajasthan.gov.in/WaterPolicy/Rajya%20Jal%20Neti_English.pdf.

[122] Since many facts are common to irrigated agriculture, whether through canal or groundwater, the two have been combined to avoid repetition.

[123] Rajasthan State Action Plan on Climate Change (2012), Government of Rajasthan.

[124] There are 33 districts in Rajasthan (including Pratapgarh formed in 2008), likely omitted by the study titled Food Security Atlas of Rural Rajasthan, released in September 2010 by Institute for Human Development and World Food Program.

Food security situation of the state was arrived at based on the three axes of availability, access, and absorption. A food security index (FSI) was calculated with agricultural production, irrigation, agricultural laborers, and access to safe drinking water among other indicators. Districts were ranked on the basis of performance in food security outcome (FSO), which included under-five mortality and number of underweight children. Improving irrigation and agricultural productivity were among the five areas highlighted by the study that could positively impact the current situation[125]. Among newer areas of policy focus, the study also identified agricultural diversification and development of non-farm enterprises.

It is important to examine the current cropping pattern. Cereals and pulses constitute food grain crops. The state produces 5.49 percent of the nation's food grain. Millet (bajra) in the kharif season and wheat in the rabi season are the major food grains grown here. In 2010-11, 42 percent of Rajasthan's gross sown area (GSA) was under cereals, 21 percent under oilseeds, and 18.2 percent under pulses. In contrast, in terms of irrigated area, 42 percent was under cereals, 7 percent under pulses and 29 percent under oilseeds. Wheat alone typically accounts for about 29 percent of total irrigated area, rapeseed and mustard together are about the same, and grams 6 percent. The top wheat producers in India are Uttar Pradesh, Punjab, and Haryana; for coarse cereals Rajasthan, Karnataka, and Maharashtra; and for pulses Madhya Pradesh, Uttar Pradesh, and Rajasthan. If we compare average yield for food grains across two five-year periods (1999-2004 and 2004-09), we find yields dropped in Punjab (the food bowl of India along with Haryana) by close to 400 kg/hectare, while the state with the highest improvement of more than 600 kg/hectare was Rajasthan[126].

The point established is that despite mismatched cropping practices, Rajasthan still figures well in the national scene for coarse cereals and pulses. These are good examples of hardy crops suited to semi-arid soil and climatic conditions requiring little water.

With focus on weaning away from crops unsuited to the state's agri-zones, and adoption of micro irrigation technologies to increase irrigation productivity of water efficient crops such as millets and pulses, the yield of these crops could improve, while water use would further reduce (depending on the crop, drip is shown to reduce water requirement by up to one-third per acre compared to conventional irrigation, and energy consumption to almost half).

Rajasthan could become an important agricultural contributor. The state may have the potential to become the pulse bowl for the country and further enhance India's position in the world. In 2008, India ranked first in pulses production, while in cereals it was third after China and the US. India has a need for pulses as well. Despite imports, growing demand from a burgeoning population has led to per capita net availability of pulses to steadily decline since the 1950s and prices to skyrocket. Increasing food grain yield is key to ensuring food sufficiency in the long term.

Misconceptions and lack of awareness about emerging micro irrigation (MI) possibilities are rampant. Drip is mostly thought to be limited to vegetables and fruit, and is stated thus in policy documents. Failure to promote better water use in agriculture has resulted in crops like sugarcane and cotton to

[125] Other three being rural connectivity, rural wages, and distribution of land to scheduled castes and particularly women.

[126] Indicus Analytics: The great Indian food challenge, January 20, 2011

be grown in the state. Sugarcane needs three times the amount of water required by wheat and rice put together. To highlight some of the lesser-known developments around MI, Jain Irrigation (JISL), the largest player in the Indian market, is working with scientists to determine optimal irrigation and fertigation systems for irrigated rice and wheat[127]. The company is propagating use of drip irrigation in pulses and oilseeds – both important crops for Rajasthan. Traditionally, pulses are a rain fed crop and most farmers use minimal irrigation. Trials on pulses conducted in Maharashtra have shown water saving through drip irrigation, and substantial increase in yields with limited use of fertilizers and other nutrients[128]. The normal yield for pigeon pea or tur in Maharashtra under standard conditions of sowing is four quintals an acre, but went up to ten quintals an acre with drip irrigation. Tests on oilseeds using drip are also being conducted.

In addition to technology and cropping practices, there is a need to concurrently work with the government on overall policy direction. An example is support prices for crops. Mustard is one of the most suitable crops for Rajasthan's environmental conditions. However, prices can go very low due to palm oil imports (a substitute for mustard oil). Enhanced marketing opportunities for millet, another important *kharif* crop, are required since it is sometimes difficult to even cover costs of cultivation at prevailing prices. Power tariff practices in case of groundwater irrigation and unsuitable distribution systems in case of surface irrigation create an adverse environment for adopting water saving technologies (WSTs) and changing cropping patterns to water efficient crops.

Studies indicate that the most scope for water saving exists in those areas where groundwater levels are deep, as in Rajasthan. Low groundwater tables, and arid/semi-arid climatic conditions reduce non-beneficial evaporation from soils, hence actual water saving could be high through MI devices. Many crops grown in the state are conducive to MI devices: mustard, rapeseed, wheat, oil seeds, and chilies. Limited areas under cotton and sugarcane are also good candidates for MI. In areas with very poor yields, such as rocky land, well owners leave a part of their land fallow due to shortage of water or discontinue pumping after some time to allow wells to recuperate. Farmers in these areas will have strong incentive to adopt pressurized irrigation systems. When pressurized irrigation systems are used, the rate at which water is pumped will reduce, giving enough time for pumps to recuperate. Since pumps will eventually run for more hours while pumping out the same quantity of water, command areas can be expanded.

The above facts clearly indicate the need and scope for private intervention in the sector. There are two distinct areas of intervention: groundwater irrigated areas and surface irrigated areas or cultivable command areas (CCAs).

Roughly 36 percent of agriculture in the state or 6.6 million hectares is irrigated, and accounts for little over half the agricultural output from the state. Around 25 percent of this area is under canal command and is plagued with distribution mismanagement, ill-timed supply at critical crop growth stages, and unfit cropping practices (refer to sections 7.2 and 7.2.1 of this report). This presents a real opportunity for water management.

[127] IRRI, Jain Irrigation sign MoU on water efficient irrigation, Economic Times Bureau, February 20, 2010

[128] Drip irrigation developed for pulses, oilseeds- Jain Irrigation conducts trials in AP, Maharashtra, Suresh P. Iyengar, September 2, 2010

A range of water saving interventions by the private sector can be undertaken under an umbrella project in select geographies under canal command and groundwater irrigation.

The state aims to encourage optimum use of water through installation of sprinklers on every operational well/tube well. Large subsidies on MI equipment are supposed to help achieve this objective. Currently, combined central and state subsidies are about 70 percent[129]. However actual adoption of these technologies has remained low so far due to several reasons: inefficiencies in subsidy payout, MI equipment ill-suited for sizes of land holdings (hence high per acre costs), lack of institutional framework for gap funding, lack of awareness about MI, and current farm sector power tariffs.

The mid-term review document of the Eleventh Plan, under sections 7.5 (Harnessing the Potentials of Crop Productivity), and 7.7 (Enhance Water Use Efficiency) contains several important references to private intervention. Select examples are[130]:

- Sprinklers, drip and pipelines along with efficient water management practices for crop production to be emphasized with adequate financial support during the plan...area specific/crop specific models of micro-irrigation (MI) systems including sprinkler/drip be developed and popularized...popularization of irrigation on volumetric basis and use of water saving devices.
- Pressurized irrigation systems to be promoted for rational use of irrigation water particularly in orchards and vegetables...promote drip irrigation in vegetables and fruit plants for higher yields and quality produce.
- **PPP Model:** Looking to the high cost of investment and technical specialization in laying out of water saving devices particularly drip systems, there is need to involve manufacturers/companies of drips in lay out of systems on farmers field...such private participation may also be in popularizing water saving devices and imparting training on efficient water management issues.
- Crop and plant varieties to be developed that have higher water use efficiency...diversification from cereals crops to high value crops like pulses/oilseeds/vegetables/fruits/ spices...promote short duration and less water consuming crops especially in rain fed areas...marketing support for introduction of new crops – declaration of minimum support price and ensuring buy-back guarantee
- Take up programs on rainwater harvesting and other water harvesting systems for recharging of groundwater...construction of diggis[131] and storage tanks to enable operation of MIS in CCAs...construction of water storage tanks/farm pond to be encouraged in rain fed areas with adequate financial support.
- Need to develop appropriate technologies for treatment of brackish water, treatment of sewage water, and recycling of sewage water for irrigation purpose.
- **Policy Issues:** Incentive/disincentive for efficient cropping pattern in the CCAs to be given to WUGs/ farmers' organizations.

[129] Combined central and state subsidies can go up to 90 percent in the case of certain microirrigation devices.

[130] Rearranged to eliminate redundancy, however wherever possible, presented verbatim to reflect the original intent.

[131] Diggis are intermediate water storage structures created in IGCP to mitigate risks of unreliable and scarce delivery of water through canals.

- There is a need to promote contract farming - large area (1,000 acre) in each agro climatic zone/agro ecological zone with monetary incentives and buy back guarantee. Contract farming model to be encouraged with government as facilitator.

The state's depleting groundwater tables are now finding mention in policy documents. Section 3.1.1 of the SWP[132] states, "In the case of irrigation with groundwater the primary objective will be to farm as much land as can be irrigated without a long-term decline in the water table...the current ethos of uncontrolled groundwater extraction as an 'individual right', will be discouraged...it will be replaced by an ethos of community responsibility for the long-term sustainability of the aquifer as a community resource." Further, section 1.3.12 of the SWP promotes pressure irrigation methods including MI to help achieve groundwater management.

More than 70 percent of irrigation is dependent on rapidly deteriorating groundwater resources. Wells and tube wells are preferred sources over canals, given these are deemed more reliable and under direct individual control. Once thought to be the key to unlock the green revolution, the very same resource is now near exhaustion, and has pushed the state to the brink of a crisis. Outside of canals and ground water, the remaining 70 percent of agriculture in the state is rain fed. While significant, this sector is most difficult to influence.

Among measures being discussed to reduce inequality between irrigated and rain fed areas, are in-situ moisture conservation to ensure availability of water, watershed approach, water harvesting, use of short duration varieties to overcome biotic/abiotic stresses, research support for development of drought resistant/photo sensitive varieties, promotion of agro forestry particularly silvi-pastoral models in low rainfall areas, and adoption of soil moisture conservation practices. Among the state government's successful innovations in rain fed agriculture is the concept of elected user committees to manage common property resources and inform the government about farmers' needs. Around 15,000 such committees are functioning in Rajasthan with bank accounts to handle community funds.

Groundwater is the biggest area of concern in the state and cries out for intervention. Private intervention around MI and cropping reform is needed to optimize output from wells and tube wells. In rain fed areas, promoting pulses could be an intervention.

Model private intervention could take the following shape: IFC initiates dialogue with the state government for the selected CCA and groundwater irrigated geography. As broad deliverables, the project can seek to achieve certain MI implementation targets (with one or more MI providers as partners) with a scientifically planned cropping plan, with agriculture universities or research institutions as partners. The intervention will seek community participation, as well as from NGOs to support involvement with water user groups. Features will include an efficient subsidy payout mechanism, minimum support pricing and irrigation tariff reform, and gap funding for technology implementation and irrigation tank/reservoir construction. Other value additions could be post-harvest marketing and warehousing support and agri-based livelihood generation with self-help groups. Please refer to illustration I under section 11.3.1 for a detailed program proposal.

[132] State Water Policy (February 2010) version as accessed on April 30, 2013 at http://waterresources.rajasthan.gov.in/WaterPolicy/Rajya%20Jal%20Neti_English.pdf.

11.1.6 Industry – Wastewater Recycling (including municipal waste)

Industry in Rajasthan consumes 6 percent of water in the state. According to estimates[133], annual industrial demand for water is expected to grow to 139 MCM/year by 2045. The actual acceleration in demand from industry could be much more rapid given the development of Dedicated Freight Corridor (DFC) and Delhi Mumbai Industrial Corridor (DMIC) that are underway, and requirements of the new industrial promotion policy which sets aside 10 percent water in new dams/projects for industrial development[134]. Industrial water demand and industrial effluent treatment in the state has already been broadly discussed (refer to sections 3.1 and 5.3).

While industry is a lower priority for government water supply schemes (after agriculture and domestic consumption), the need for solutions is nevertheless significant, given the polluting industrial composition in the state, and growing emphasis on wastewater treatment and recycling in latest plan documents (including water harvesting being made mandatory for both industrial units and industrial areas).

Rajasthan produces 91 percent of the total marble in India, an industry that consumes up 2.75 million liters of water per hour. Textile units on an average require 17 liters of water per meter of fabric produced. In Bhilwara town, the average fabric processing capacity for 22 units at the time of data collection was one million meters per day, which translated into 17 million liters per day (MLD) water requirement for one town. Textile is a flourishing industry in several parts of the state, importantly Jodhpur, Pali, Barmer (Balotra), and Jaipur (Sanganer) where numerous dyeing and printing works are located.

Rajasthan has vast reserves of cement grade and steel melting shop (SMS) grade limestone. At least 14 major, and two medium cement plants, with a total installed capacity of about 20.3 million tons per annum (MTPA), are operational in the state. Cement is a water intensive industry; among other uses, water is used for cooling. A 1.4 MTPA plant can consume more than 300 cubic meters of water per hour. Thus, more than 4,350 cubic meters of water is consumed by the cement industry every hour in Rajasthan. A portion of this may be recycled depending on individual plant practices.

In terms of water polluting industries, textiles, smelters, thermal power plants, major brick/lime kilns, stone crushers, and mines are the biggest culprits in the state. Industrial water pollution is a problem in Bhilwara, Udaipur, Jaipur (Sanganer), Kota, Pali, Barmer (Balotra), Jodhpur, Kishangarh, and Makrana. Industrial effluent discharged from textile industries contains alkalis, residual dyes, starches and cellulose, soluble salts (mainly sodium and calcium), silicate, oils, and other impurities.

[133] Source: Tahal Report. The figure for 1995 was 45.5 MCM/year. The projected figure for 2045 could be conservative given the study was undertaken several years ago, and industrial growth has accelerated in recent years. That said, it provides a good reference point.

[134] Draft Annual Plan 2013-14

In the absence of economically viable technologies for treatment, mindless dumping of these pollutants into open drains and catchment areas of river basins has had serious repercussions on ground and surface water used for irrigation. Wells have been abandoned and cultivable land has turned into wasteland. Soil productivity has suffered due to crust formation.

Compared to domestic and agricultural water supply, interventions in industrial water supply will involve a lesser degree of interaction with the government. Faster action will result by working directly with industrial units and industry associations. The objectives should be to promote water reuse and efficiency, augment industrial water supply, improve service delivery, and achieve cleaner affluent footprint. Government involvement will be required through policy reform (as well as legislative reform in some cases) in order to achieve these objectives on a larger sector-wide scale. Any project involving municipal waste will have a government component built into it. To summarize, there is clear scope for private intervention, both with and around the state government.

The existing policy framework both assists and deters private involvement in the sector. The SWP[135], under section 5.3, which is dedicated to municipal and industrial water conservation, lists the following: reuse of treated sewage effluent treated at different levels according to use (municipal, industrial, horticultural, beneficial surface discharge, and groundwater recharge); water intensive industries required to recycle water; beneficial use of groundwater extracted in mining operations (with remediation of chemical pollution where appropriate); and water auditing for all industries (which covers quantified usage, potential for recycling and conservation, and actual/potential pollution associated with each site).

To appreciate the acute water shortage faced by industrial units in Rajasthan, take a look at two key industrial clusters in the state. Jaipur industrial region has been divided into four broad areas by the Rajasthan State Industrial Development and Investment Corporation Limited (RIICO): South, North, Rural, and Sitapura. Each in turn consists of several industrial areas with over 50 medium and large scale units, and 20,000 small-scale units involved in textiles and related products, gems and jewelry, agro-based industries, handicrafts, and basic metals and related products. With all 13 blocks in Jaipur falling under exploited or over exploited categories, and groundwater development rates of 270 percent or more (groundwater recharge versus draft), certain areas have reported a drop of more than 22 meters in water levels in recent years. The total water demand of the city was estimated at 319 MLD (as of 2001), projected to increase to 598 MLD in 2011, and 897 MLD in 2021[136]. Industrial demand-supply gap in Jaipur was already 55 percent at the time of data compilation. The total industrial demand for water was estimated at 26.85 MLD, against supply of 12.07 MLD.

[135] State Water Policy (February 2010) document

[136] Rajasthan Infrastructure Agenda 2025 – Initial Screening Report, March 2003, PwC. The data may hence be dated, but still presents the most revealing information in absence of alternative data.

Next, consider Bhilwara with over 30 large and medium textile industries in the area. This cluster accounts for 47 percent of the total value addition by textiles and related products, and about 25 percent of net value addition of registered manufacturing in Rajasthan. Water is critical for textile processing, but currently there is no organized mechanism to meet demand. The water requirement in Bhilwara is estimated at 18 MLD, and the new growth center in Hamirgarh requires 4 MLD. The average discharge from the units is 9,000 to 11,000 kl/day and is very high in TDS, and requires expensive treatment methods. Industries here meet their water requirements from the following sources: 4.7 MLD from industry owned tube wells, 3 MLD from rented sources, 2 MLD from private tankers, and 8.2 MLD by recycling through effluent treatment plants (ETPs). It is becoming increasingly difficult to meet demand through these sources.

Industry needs to augment supply. Recycling treated water from domestic sewage treatment plants (STPs) for industrial purposes - boilers, gardening, floor washing and other similar uses - will not only reduce demand for fresh water, but will help conserve fresh water for potable use. Depending on end use of recycled water, various levels of tertiary treatment by common effluent treatment plants (CETPs) will be required. In addition to recycled water, CETPs will also address water pollution.

However, the handling of domestic waste itself is likely to pose a serious challenge. According to data for 2008[137], 11.2 million people lived in the 45 class I and II cities in Rajasthan. Water supply into these towns was 1,912.72 MLD, while 1,530.16 MLD of sewage was generated. The sewage treatment capacity was only 54 MLD in class I cities, while it was likely that class II cities had no capacity at all.

The wastewater treatment situation is quite alarming throughout India. Wastewater generation is calculated at a minimum of 80 per cent of water supplied. However, since people use their own sources of water, additional amounts of waste may be generated. Wastewater collection in most urban centers with sewerage systems usually does not exceed about two-thirds of that generated[138]. While smaller sized urban centers with sewerage systems treat less than one-fourth of the wastewater generated, even the metropolitan cities treat only about two-fifths. Wastewater disposal is done both on land and in water bodies by most urban centers. Proximity to water body, local conditions and financial constraints determine the place and method of disposal. Recycling and reuse of wastewater is practiced in very few urban centers and wherever it is done, it is mostly used for agriculture or horticulture.

There is no fixed mechanism to charge for wastewater collection and disposal, and cost recovery is generally very low from this service. Even metros show very small recovery rate, and the situation is worse in smaller urban centers. In cities where recovery is good, it is either due to collection of new connection charges or due to levying of sewerage/drainage tax. Further investigation and expert advice is required, but it seems any attempt to set up CETPs for industrial use would first require a mechanism to handle domestic sewage. This means increased costs and direct involvement with municipalities, adding to complexities.

[137] Status of Water Supply, Wastewater Generation and Treatment in Class-I Cities and Class-II Towns of India, December 2009, CPCB, Ministry of Environment and Forests, Government of India. Class-I (population of 100,000 or more) and Class-II (50,000-99,999 people).

[138] Status of Water Supply, Sanitation and Solid Waste Management in Urban Areas, June 2005, CPHEEO, Ministry of Urban Development, Government of India

Research for this report revealed that the Government of Rajasthan had, through PDCOR, a joint venture between Infrastructure Leasing and Financial Services Limited and the state government, commissioned PricewaterhouseCoopers (PwC) to undertake an infrastructure mapping exercise for the state in 2003. As part of the mandate, PwC had conducted initial screening for certain key industrial clusters to help set up CETPs and augment industrial water supply by diverting a portion of water meant for domestic use towards industrial supply. The final outcome of the exercise is however unclear. A few STP projects have been proposed under the Indian Business Alliance on Water (IBAW)[139] (refer to appendix F of this report and illustration IV under 11.3.1).

In light of the stressful water situation, which threatens the viability of certain industries, support from industry is easy to garner. The key for any private intervention would be to develop the right working model with municipalities where domestic sewage is part of the project. Costs, risks, cross-subsidies, and suitable uses for treated water would be the main areas to tackle[140].

11.1.7 Industry – Water Efficiency

Water foot printing studies of the kind already executed by IFC will be helpful in the context of water intensive industries such as textile, cement and marble. Findings could help establish much needed industry best practices in water use, and help influence policy direction and eventually help regulation of industrial water use. Other uses of such an exercise would be tariff reform to penalize wasteful units (refer to mention of water audits in SWP[141] in section 11.6 above). The CII-Triveni Water Institute based in Jaipur could be a relevant partner with IFC on this intervention (see details in illustration IV under 11.3.1) in this chapter.

[139] Current status of these projects is unclear. Last accessed on May 1, 2013 at http://www.ibaw-india.com/site/ibw/read.jsp?reqpage=Projects.

[140] Several lessons can be had from the well-known Tirupur project which was the first PPP of its kind in the country, executed by IL&FS.

[141] State Water Policy (February 2010) document

11.2 Analysis

(Highest priority)

- Human Drinking Water
- Livestock Drinking Water
- Other domestic, commercial & municipal water uses
- Agriculture
- Power Generation
- Environmental & Ecological
- Industrial
- Non-consumptive uses, such as cultural, leisure and tourist uses
- Others

(Lowest priority)

Figure 32

Source: SWP[142], February 2010, Ministry of Water Resources, GoR

Figure 32 details how the state government prioritizes water use, although, sadly, this is not always followed. For the best outcome, it is critical that IFC similarly set its own priorities before intervening in this stark water situation.

Now that the background and purpose, of each of the seven potential private sector interventions has been presented in sections 11.1 through 11.7 of this chapter, it is time to prioritize by assessing these interventions on the basis of:

Degree of positive impact in addressing Rajasthan's overall water problem, compared to the level of effort required to execute each intervention (refer to figure 33).

Figure 33 maps each of the seven interventions in terms of their impact on Rajasthan's water situation from high to low, and the corresponding effort needed for each intervention from easy to difficult. The placing of each intervention in the various gradients is based on the facts and their critical analysis presented in this report. With this background, the top three most effective interventions, numbered in brackets, in order of positive impact are:

1. Rural drinking water – off-grid (1)
2. Tie between rural/peri-urban drinking water on-grid (2) and agriculture – non canal (groundwater and rain fed) (5)
3. Agriculture – canal irrigated **(4)**

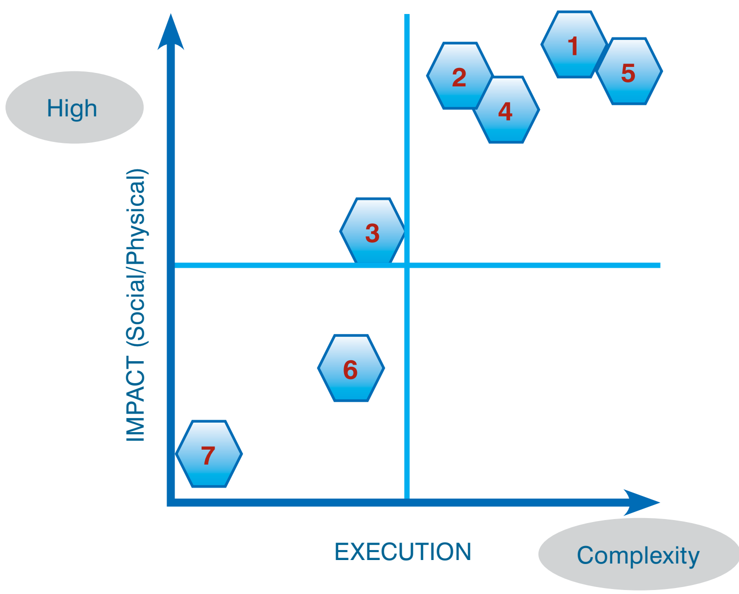
[142] State Water Policy (February 2010) version as accessed on April 30, 2013 at http://waterresources.rajasthan.gov.in/WaterPolicy/Rajya%20Jal%20Neti_English.pdf.

Drinking water needs come before all else and, compared to urban areas, have been neglected in the rural and peri-urban context. On the other hand, the sheer magnitude of water being consumed by rain fed and groundwater-irrigated agriculture in the state and its correlation to food-security explains the tie above.

The three most difficult interventions in terms of time, resource, and effort are:

1. Agriculture – non canal (groundwater and rain fed) **(5)**
2. Rural drinking water – off-grid **(1)**
3. Agriculture – canal irrigated **(4)**

As explained in earlier sections, interventions (6) and (7) relating to industrial water are comparatively lower on both the impact and effort scale, but still important in their own right, with efficiency of water use being the most actionable. Intervention (3) relating to on-grid urban water supply, both in terms of impact and effort, falls somewhat mid-way between industrial interventions as a group on one end, and rural/peri-urban drinking water and agricultural interventions at the other end.



Legend

1. Rural Drinking Water - Off Grid
2. Rural / Peri-Urban Drinking Water - On Grid
3. Urban Drinking Water - On Grid
4. Agriculture - Canal Irrigated
5. Agriculture - Non-Canal (Groundwater & Rainfed)
6. Industry - Waste Water Recycling (Including Municipal Waste)
7. Industry - Water Efficiency

Figure 33

11.3 Recommendations

The seven interventions and their analysis presented above, brings us to our concluding section on recommendations, that is, specific answers to the '*Where* do we go from here?' question.

After detailed assessment of all relevant facts, IFC could take up at least one initiative in each of these three sectors, namely, drinking water supply, agri-water nexus, and industrial water use.

Having a multi-pronged approach will allow IFC to deeply engage with the Rajasthan water sector as a recognized solutions provider. Since water is a common resource, each sector is linked to the other. Water efficiency created in one sector, can quickly dwindle if the misuse continues elsewhere. Having an integrated approach that comprehensively addresses all water use in a watershed/geography is most desirable. With current annual trends of deterioration, in a few decades, water sustainability itself could become an unachievable goal in Rajasthan. Hence there is a need approach the problem from all angles while there is time. It is however important to prioritize.

IFC can first take up rural water supply, agricultural water efficiency, and industrial water stewardship. These areas stand to benefit from the right kind of private sector intervention. Further due diligence and involvement of additional parties, both within and outside IFC, is required in order to crystallize recommendations into feasible projects. However effort has been made by the author to influence rapid action with **four** realistic project proposals for IFC to deliberate upon (see illustrations in section 11.3.1). Please note that certain proposals are presented in greater detail while a few are just ideas needing further diligence.

11.3.1 Illustrations

ILLUSTRATION I

Sustainable Agriculture with Water Efficiency in Rajasthan–SAWER[143] (pronounced 'saver')

Improving productivity of water use, or simply put - more crop per drop, in agriculture is an important part of the bigger goal of managing agricultural demand for water. The idea is to free up and transfer this saved water to higher priority areas such as drinking water, to use water more efficiently, and reduce groundwater draft while promoting recharge.

The author hereby proposes the Sustainable Agriculture with Water Efficiency in Rajasthan, or SAWER program. This will be an IFC supported program to address water use in agriculture for the state. Under a pilot program, specific geographies in the state will be shortlisted from both canal and groundwater irrigated areas. The overall program objective will be to achieve water saving, balance water use between agriculture and domestic sectors, and increase food security with enhanced crop yield in the project areas.

[143] Author's recommended name to convey the essence of the program - Sustainable Agriculture with Water Efficiency in Rajasthan, or 'SAWER' where the emphasis is on "W" for water. Should the program, under this name, be adopted by IFC, further due diligence is recommended to ensure there are no copyright and other violations. Preliminary Internet search on "SAWER" reveals no meaningful results.

> This would be achieved with an umbrella effort to bring together the following key interventions: (a) partner with manufacturers to bring suitable water saving technologies (WSTs) to farmers to increase irrigation productivity and reduce pressure on demand for water from the sector; (b) influence a shift towards cropping patterns suited to the agro-climatic conditions prevalent in the state, increase crop yields, and create market linkages for these crops geared to maximize economic benefits to farmers; (c) initiate public private dialogue (PPD) with the state government to address agricultural pricing and water delivery in a manner that ensures farmer acceptance for reform; (d) partner with the government to influence institutional reform for efficient subsidy payout designed to promote adoption of micro irrigation (MI) technologies, unlike the trend so far where subsidies have largely remained ineffective; (e) partner with appropriate microfinance institutions (MFIs)/financial partners to bridge subsidy gaps in purchase of MI equipment and aid construction of infrastructure needed to support MI devices; and (f) partner with local non-governmental organizations (NGOs)/communities to mobilize farmer participation, create awareness for WSTs aimed at expanding reach to all economic sections of farmers and increase probability of long term use.
>
> Based on response, the scope can be expanded to include additional agendas such as water security and sanitation in the pilot geography, watershed management, and economic inclusion through self-help groups (SHGs).
>
> SAWER would fall under interventions 11.1.4 and 11.1.5 described in this chapter. It is described in greater detail in the pages that follow. Since effective implementation of MI technologies is crucial to the program's success, that too is discussed in the following pages[144]. These findings have been researched and presented as market needs, failures, and barriers. As for market players, these are addressed in the concluding paragraph of this illustration. Further, in the conclusion to this section the author has recommended an action plan to help IFC initiate SAWER.

The effectiveness of WSTs in achieving water productivity varies between crops and technologies. Available data on MI and its impact on water usage, crop yield, water productivity, and economics of adoption, is heavily skewed towards drip systems, with little or no information on sprinklers and plastic mulching. There are several physical, socio-economic, and institutional/policy constraints limiting large-scale adoption of WSTs. This is despite heavy central and state sponsored government subsidies that have been around for several years now. Creating institutional capacity for technology extension, designing water/electricity pricing and supply policies, and building proper irrigation and power supply infrastructure will play a crucial role in facilitating large-scale adoption of MI systems.

[144] Two publications extensively referred for this report are - Adoption and Impacts of Microirrigation Technologies (Namara, Upadhyay and Nagar), study conducted on MI adoption in Maharashtra and Gujarat; and Water saving and yield enhancing technologies (Kumar, Samad, Amarasinghe and Singh), MI study in the national context. While this information is relevant to Rajasthan, a separate, similar study for the state is required to confirm several findings. Efforts have been made to specifically quote these reports as the source where possible; however this was not possible to do throughout this report where findings from these reports are referenced.

Market Needs

1. Awareness/Accessibility: Successful adoption of MI technologies requires technical and economically efficient models, awareness among target beneficiaries about the technical/economic superiority of these technologies, and accessibility of technologies to potential users.

2. Cultivable Command Area (CCA) Infrastructure: Intermediate storage systems are essential for farmers to use water from surface schemes for MI irrigation systems, and pumps are required to lift water from storage. These needs can be addressed with suitable private and government interventions.

3. Pricing and Supply Reform for CCA: In addition to measures suggested for groundwater irrigated areas relating to administration of subsidies and extension activities, the way to bring CCAs under micro-irrigation is to either change delivery practices or increase economic incentives. The practice of delivering water through gravity can be changed to accommodate MI systems. The delivery systems need to be designed in such a way that farmers can directly connect the source to their distribution system. This means that the irrigation agency would have to work out new schedules in such a way that the duration between two turns becomes much shorter than the present 2 to 3 weeks[145]. The cost of irrigation needs to be effectively increased (from the current free water), so that cost savings offered by MI act as an incentive, and justify heavy investment in storage tanks and extra pumping devices. Power tariffs for surface irrigation schemes will be important in achieving this, although this is difficult to implement. While pricing slowly catches up to reflect the true cost of irrigation water through power tariff reforms, a more acceptable solution in the near to medium term will be to incentivize farmers through subsidies for adopting these technologies. This could offset the cost of building intermediate storage systems. The increased returns from lift irrigation over canal irrigation and from drip-irrigated crops will be the strongest incentive for farmers to adopt intermediate storage systems[146]. The increased returns could be due to the better control over water delivery with lift or due to the increased ability to grow more profitable crops in the command areas.

4. Pricing and Power Reform for Groundwater Irrigation: Improving power supply, both quality of power and hours of supply, is needed to boost adoption of pressurized WSTs in areas where sufficient groundwater is available for irrigation. But power supply regulation restricts pumping, at least in the case of poorer farmers. The ideal policy environment for promotion of water-saving crop and irrigation technologies in well/tube well-irrigated areas will be pro-rata pricing of electricity. While this will create direct incentive for efficient water use, the extent to which efficient irrigation technologies will reduce energy use will depend on crop type and the type of MI technology, pressurized system or gravity drip system. This is because not all WSTs technologies are energy efficient. Hence, bringing non-conventional or non-pressurized drip systems under the ambit of subsidies is important once consumption-based pricing of electricity is introduced. It will also force farmers in areas irrigated by diesel engines to adopt WSTs as it could save precious diesel and reduce input costs. Introducing metering of agricultural pumps and recovering consumption-based charges for power use will not be easy. While in the long term, total metering and consumption-based pricing would be the most desired scenario, the government can start with metering of agricultural consumption. Cash incentives or heavy

[145] One of the reasons why the farmers in Israel adopt MI systems on such a large-scale is that the water is delivered in their fields under pressure through pipes.

[146] IRMA/UNICEF, 2001; Kumar and Singh, 2001. As quoted in Water saving and yield enhancing technologies (D Kumar)

subsidies for WSTs could be provided to farmers who are willing to use them, subject to reducing their electricity consumption. It could be an inverse function of the connected load or the average energy consumed and the area under WSTs for irrigation.

5. Mitigating Technologies for Groundwater Irrigation: Some new irrigation technologies such as sub-surface irrigation systems and micro-tube drips do not require pressure heads. Farmers who get water through underground pipelines can lift it to small heights to generate the required head to run sub-surface drip systems. Thus, the technical feasibility of using new non-conventional water saving technologies would be high among farmers who are either water buyers or share wells with other farmers. In the case of large well/tube well commands, if a low height overhead tank can be constructed in the middle of the command, the hours of water delivery can be increased from 10 hours to 24 hours for the entire command. This will ensure that the entire command is covered with enough water left over to irrigate additional areas as well. This is because discharge from the tube well remains unaffected while water requirement reduces significantly. Instead of applying water at weekly intervals, the fields can be irrigated daily or on every alternate day. This is important from the point of view of increasing the physical efficiency of the system. The storage efficiency, for instance, will increase when the amount of water applied is less than or equal to the field capacity of the soil. Different holdings can be covered in rotations over a day.

6. Subsidy and Payout Reform: Improving the administration of subsidies is important. Though subsidies have been in existence for the past several years, the benefits have been negligible. Farmers should be made to pay the full cost of the system initially, and subsidies could be released in installments based on periodic review of performance of the system in the farm. This will drive away farmers who are not motivated to use the system. Manufacturers should sell the systems at market prices instead of subsidized prices, which will compel them to improve the competitiveness of their products in the market. This will also compel them to provide good technical input services to sustain demand. On the other hand, there is a need to create a separate agency to promote MI, which will expedite processing of applications from farmers. The agency can work in tandem with the manufacturers and farmers to enable timely technical inputs to farmers. In areas where agricultural processing units are concentrated, providing all critical inputs including subsidies will not be a problem. But, this will be an issue in areas where demand for drip irrigation is scattered vis-à-vis crops and geographical spread. This underlines the need for a separate agency. The agency should facilitate the survey of farmers' fields by the manufacturer, and get designs and estimates prepared along with the most desirable cropping system. This will also help farmers procure the system well in advance of the crop season to make full use of it[147].

[147] Within a year of the creation of Gujarat Green Revolution Company, a separate entity engaged in promotion of drip irrigation in the state of Gujarat, a total of 6,000 hectares of crop land was brought under drip.

Market Barriers

1. Poor Outreach: A majority of low-cost MI technology adopters are farmers in the middle, rich, and richest groups. Reducing cost alone is not enough to improve reach of these technologies to the poor where, in addition to water saving, the socio-economic impact would be the highest. Available low-cost systems are suited to crops that are not popular among poor farmers who tend to allot a significant proportion of their land to staples such as cereals and pulses. Their socioeconomic attributes limit their access to information. Limited access to resources, specifically to groundwater, quantitatively and qualitatively, hinders poor farmers from successfully adopting low-cost MI technologies.

2. Inappropriate Cropping Pattern: Another major socioeconomic constraint to adoption of conventional WSTs is the existing cropping patterns in water-scarce regions. MI adoption may warrant shift to economically high yielding varieties to generate suitable returns and help pay back investment. Among easily available WSTs for irrigation, conventional drip irrigation systems are best to achieve highest efficiency. These systems are most suitable for horticultural crops from an economic point of view[148]. This is because the additional investment for drip irrigation has to be offset mainly by the better yield and returns to the farmer, since input costs savings are not very significant[149]. Low cost drip irrigation systems have low physical efficiency when used for crops in which the plant spacing is small[150]. The system can be used for some row crops which are common in the region, provided fixed spacing between rows and plants is maintained, and this is an issue. Due to un-even field conditions, designing and installing drippers become difficult. However, socio-economic viability of changing crops increases with the size of the farmer's holding. Since small and marginal farmers account for a large percentage of holdings, the adoption of horticultural crops by farmers in these regions will not be high without interventions, given horticulture crops need at least 3 to 4 years to start yielding returns (except for pomegranate). Therefore, farmers' agricultural practices need major changes for adoption of WSTs.

3. CCA Delivery Systems: Drips, including non-pressurized and sprinklers, are not conducive to flow irrigation due to two reasons. First, there is a mismatch between water delivery schedules followed in surface irrigation from canals and minor irrigation tanks and that to be followed when MI systems are to be used. Normally, in surface command areas farmers get their turn once in 10 to15 days at flow rates ranging from 0.5 to 1 cusecs. With sprinklers and drip, water should be applied to the crop either daily or once in two days with lower flow rates equal to the evapo-transpiration.

4. Co-owned Wells and Water Purchase Practices**:** The generally accepted belief is that adoption of drip irrigation will be more enthusiastic in areas irrigated by well water. But, there are two factors that that can negate this. In groundwater over-exploited areas ownership of wells does not always lie with individual farmers, but groups[151] who get water through underground pipelines at almost negligible water pressure (head). In order to use the conventional sprinkler and drip systems, greater water pressure (1-1.2 kg/cm^2) is required. This is not possible unless the systems are directly connected to the tube well. If the systems are not connected to the delivery pipe of the tube wells, a static head of nearly 12 m is required to run the sprinklers, in turn consuming high energy which is a constraint.

[148] Dhawan, 2000. Listed in Water saving and yield enhancing technologies (D Kumar et al.)

[149] Kumar et al., 2004. Listed in Water saving and yield enhancing technologies (D Kumar et al.)

[150] IWMI research in Banaskantha

[151] Such as north and central Gujarat, Coimbatore district in Tamil Nadu, and Kolar district of Karnataka. Dependable statistics for Rajasthan not available.

Second, there is a practice of purchasing water by farmers in some groundwater irrigated areas[152] making them insensitive to the use of water saving devices. In both these situations, adoption of MI systems will be technically infeasible. Further studies validating these or similar situations are required for Rajasthan.

5. Groundwater Quality: Another important constraint is the high TDS of groundwater pumped from deep aquifers in Rajasthan. If this water is used for irrigation, the conventional drippers that are exposed to sunlight get choked due to salt deposition in the dripper perforations, needing regular cleaning (using mild acids like the hydrochloric acid). Farmers generally are not willing to bear the burden of this regular maintenance.

Negative Externalities in Groundwater Pumping: Presence of negative externalities in groundwater pumping poses an important constraint for those who would like to adopt any WST. Most often, farmers tap groundwater from the same aquifer, and well interference is very common not only in hard rock areas, but also shallow alluvial areas. Under such conditions, pumping by one farmer will have an effect on pumping by another farmer. Due to this reason, cutting down pumping rates by a farmer may not result in increased future availability of groundwater for him/her. The efforts to save water from the system by an individual farmer might mean increased availability of groundwater to his/her neighbors. However, farmers who pump water from open wells have greater incentive to invest in water saving technologies. This is owing to the fact that the open wells act as groundwater storage systems as well as recovery systems and adoption of WST will mean greater water availability in the coming days. The most impact among MI adopters noted in study locations was changes in cropping pattern, cropping intensity and/or crop diversity, all of them significant factors that influence sustainable use of groundwater resources. MI adoption has further improved cropping intensity by enabling production of crops in the summer or *rabi*. In the long run, water sustainability objectives may conflict with poverty reduction and food security objectives unless a proper regulatory mechanism is instituted. This is because farmers previously suffering from frequent crop failure or yield losses due to water shortage will now use saved water to obtain a normal harvest or minimize yield losses. Secondly, those previously irrigating only part of their potentially irrigable fields due to the inadequacy of water will use saved water to increase the irrigated area; and third, the high marginal productivity of water may spark the demand for more groundwater resources. The second and the third scenarios could lead to groundwater overdraft, a fact reported by farmers in Maharashtra who claim that despite 15 years of using MI, groundwater levels have substantially declined and concentrations of wells have increased.

Market Failures

1. Limited Power Supply for Groundwater Irrigation: Power supply regulation is a major constraint in the adoption of pressurized irrigation systems. Under MI devices, well discharge will decline sharply when sprinkler and drip systems start running due to increase in pressure, though the water requirement for unit area of irrigated land will reduce. Since available power supply is fully utilized during important cropping seasons, the amount of time for which the well will be operational will be just sufficient to irrigate the existing command. Hence, farmers cannot expand the area under irrigation and increase irrigation intensity, or go in for high water-consuming cash crops, although debatable in the context of Rajasthan. Creating overhead storage for pumped water or installing an additional pump to generate adequate pressure will not be an economically viable proposition.

[152] Unlikely for Rajasthan with its high groundwater overdraft, but needs to be validated with further research.

2. Agricultural Power Tariff**:** For well owners under zero power tariff or flat rate system of pricing, marginal cost of pumping and using groundwater is zero. It is only the limited hours of power supply that acts as a constraint for farmers from using more water or expanding area under irrigation. Hence, the direct additional financial returns farmers can get by introducing water saving technologies are from increased crop yield and not cost savings. This will not happen unless the farmer adopts new agronomic practices. Hence in some areas, farmers would rather pump extra hours to sell water to the other farmers than use the water more efficiently in their own fields which would involve substantial financial investments. Conventional WSTs are physically and economically less feasible for smaller plots due to fixed overhead costs of energy and the various components of these irrigation systems such as filters and overhead tanks[153]. Farmers using diesel engines for pumping groundwater will have little incentive to adopt, as with farmers in areas with poor electrification or power supply.

3. Administration of Subsidies and Manufacturer Slack**:** The administration of subsidies for MI systems has also worked against the interest of their promotion. Many farmers purchase sprinkler systems just to avail of the benefits of government subsidy, which is up to 50 to 70 percent. Since in many cases, the government pays the subsidy directly to the manufacturer, the farmer gets the system at discounted prices. The company carries out the entire documentation for obtaining the subsidy and absorbs delays in getting the subsidy from the government. Due to this, manufacturers price high to recover their interest on capital and transaction costs. The companies which supply the systems are not interested in after-sales service or ensuring quality control while farmers themselves do not realize the full value of the asset, and do not maintain them. Moreover, since funds available for subsidies are limited, the smartest of farmers get the benefit. The government officials, who come and inspect the systems installed, only check the materials supplied and work out the subsidy that has to be paid.

[153] Kumar et al., 2004. Listed in Water saving and yield enhancing technologies (D Kumar et al.)

Policy Background

In addition to the policy thrust supporting agricultural interventions described in section 11.1.4 and 5 in this chapter, the Government of India issued updated guidelines under its National Mission in Micro Irrigation (NMMI)[154] scheme. These form the foundation for the proposed MI initiatives under the IFC supported SAWER program, hence the need to highlight its key points:

- **Subsidy:** Under the centrally sponsored scheme, 40 percent of the cost of the MI system will be borne by the center, 10 percent by the state government, and the remaining by the beneficiary either through his/her own resources or loans from financial institutions. Additional assistance of 10 percent of the cost of the MI system will be borne by the center for small and marginal farmers.
- **Eligibility:** All categories of farmers are eligible to avail assistance under this scheme. Assistance to farmers will be limited to a maximum area of five hectares per beneficiary. Seventy-five percent of the cost of drip and sprinkler demonstration, for a maximum area of 0.5 hectares per demonstration, will be borne by the central government. Assistance will be available for both drip and sprinkler irrigation for wide spaced, as well as close spaced crops. However, assistance for sprinkler irrigation systems will be available only for those crops where drip irrigation is uneconomical. Assistance will be available for irrigation systems for protected cultivation including greenhouses, polyhouses and shadenet houses. Assistance will be available for implementation of advanced technology like fertigation with fertilizer tank/venturi systems, sand filters/media filters, hydro cyclone filters/sand separators and other different type of filters, and valves required for MI system.
- **Planning/Monitoring:** Panchayat Raj institutions (PRIs), or rural local bodies, will be involved in promoting the scheme and identification of priority areas. At the national level, the executive committee of NMMI will review the progress of NMMI and approve the annual action plans of states. At the state level, the state micro-irrigation committee will oversee the implementation of the mission program in districts. The district micro-irrigation committee will coordinate the implementation of NMMI program at the district level. National Commission on Plasticulture Application in Horticulture (NCPAH) will coordinate and monitor the program of NMMI in different States.
- **Implementation:** The scheme will be implemented by an implementing agency (IA) at the state level duly appointed by the state government. Funds will be released directly to the IA on the basis of approved plans for each year. It shall prepare the annual action plan for the state on the basis of the district plans and get it forwarded by state MI committee for approval of the executive committee of NMMI. State agency shall forward copies of the consolidated proposal to Ministry of Agriculture. Payment will be made through wire to the IA, which will transfer funds to the identified districts. District committees will provide funds to the system suppliers through the farmers/beneficiaries.
- **Manufacturers:** Registration of system manufacturers will be done by the MI committee at state level for use in the districts. Supply of good quality system, both for drip and sprinkler irrigation, having Bureau of Indian Standards marking and proper after sales service to the satisfaction of the farmers, is paramount.

[154] NMMI guidelines in document dated November, 2010. Last accessed on May 1, 2013 at http://www.nhm.nic.in/Guidelines-NMMI.pdf.

- **Technical Support:** Technical support at the national and state levels will be provided by NCPAH, which will be suitably strengthened by deploying experts in various related fields of agriculture, water management, and information technology in the form of a technical support group, which at the national level will be housed in the NCPAH secretariat. NCPAH will recruit professionals, as required on contract basis. The honorarium will be fixed by the executive committee depending on qualifications, experience, and expertise of the experts in accordance with the norms being followed in other schemes like National Horticulture Mission and National Food Security Mission (NFSM).

SAWER - Action Plan

In light of the above information presented under market needs, failures, and barriers, there is a need to verify some of the concerns regarding limitations of MI technologies under certain conditions. Positive feedback from this due diligence should ideally be a pre-requisite to invest in the promise of these technologies. IFC could commission an independent Rajasthan-specific study on factors influencing MI technology promotion and adoption. The study should aim to clearly highlight the physical, socio-economic, and institutional/policy factors at play in various parts of the state. On the basis of research for this report, the recommended partner for such a study is the IWMI-TATA Water Policy Program. If findings are encouraging, as a first step it would be advisable to identify potential program partners, see initial input below. However once program objectives and format are made more clear, collective thought is required to include most suitable partners. Next, a two to three day workshop (format to be brainstormed) could be organized by IFC. Goal of the workshop will be to initiate idea exchange, and narrow down final program objectives, project geography, and partners. With this information in place, program structuring, timelines, and formal signing of memoranda of understanding with partners would be the next logical step before implementation. One-on-one meetings with government and potential partners during the event planning process for the workshop will provide IFC with the opportunity to introduce itself and provide context before the group event. Additionally, a formal kick-off event of this nature will provide a launch platform for IFC in the Rajasthan water sector and help generate needed media/public awareness of its efforts.

Potential Partners

In order to identify potential partners, additional investigation and discussions are required. However the following information provides a starting point:

1. MI Technology Players - Top three players in Indian market to be invited for discussion: Jain Irrigation (JISL), Netafim, and Finolex Plasson. One mid-tier representative, Nagarjuna Fertilizers and Chemicals or Premier Irrigation Adritec (these, along with the top three account for 85 percent of the market in India), can also be involved. Smaller/newer firms to be included for their unique perspective could be Driptech (US-based, selling through dealer network of Godrej Agrovet), and Mahindra and Mahindra (largest tractor manufacturer in India, which recently entered the market through an acquisition).
2. NGOs - Two of the most experienced in MI area - Aga Khan Rural Support Program (recruits and trains assemblers and village extension volunteers, mainly in Gujarat), and International Development Enterprises, which focuses on designing/redesigning MI technologies, to make them more poor-friendly, and creating awareness. While it does not subsidize financial investment, it may connect farmers to financial institutions. Rajasthan based NGOs, with focus on agriculture as part of their work, include GRAVIS (specifically focused on desert area), and CECOEDECON (focused in and around Jaipur). Soft support with community mobilization would be an important aspect. Here, most active NGOs in Rajasthan are Jal Bhagirathi Foundation, Bhoruka Charitable Trust, Sambhav Trust, and Tarun Bharat Sangh.

3. Agri Research - IWMI-Tata Water Policy Research Program was established under a financial partnership between IWMI and Sir Ratan Tata Trust, Mumbai with the idea of promoting practical, policy research in water resources management. The program has been in operation since March 2000; since then it has worked with some 40 partners and completed over 70, usually small, research projects. IWMI is a Sri-Lanka based non-profit scientific organization funded by the Consultative Group on International Agricultural Research. Swami Keshwanand Rajasthan Agricultural University and Precision Farming Development Centre (PFDC) at Bikaner, Rajasthan can help form the technical support group according to guidelines from National Mission in Micro Irrigation (NMMI).

4. Government **-** Agriculture Production Commissioner (APC)/Principal Secretary (Horticulture/Agriculture). According to NMMI guidelines, the State Micro Irrigation Committee (SMIC) will be under the chairmanship of the APC/Secretary (Horticulture/Agriculture). Principal Secretary, Water Resources (also a member SMIC). Other central and state bodies could be considered such as Ministry of Rural Development and National Commission on Plasticulture Application in Horticulture (NCPAH).

5. Finance - Center For Microfinance (CMF), which is actively involved in Rajasthan (example, the state government has launched a project[155] in western Rajasthan for which technical assistance will be provided by CMF, expected to impact 87,000 households across 1,040 villages in Western Rajasthan). MFIs to be considered are SKS Microfinance, BASIX Social Enterprise Group, Share MicroFin (sister concern of Asmitha), and Pustikar. These are active MFIs in Rajasthan with maximum loan outstanding and/or client reach as of March 2011. Efforts are needed to locate additional agriculture-specific MFIs, and CMF would be the potential link. Other institutions for consideration would be National Bank for Agriculture and Rural Development (NABARD) and non-banking finance institutions (NBFCs)/banks with special focus on agriculture.

6. Program Sponsors **-** IFC would itself be a sponsor; additional recommendations include Sir Ratan Tata Trust. Under its Water Sector Research Program, the trust is involved in several relevant topics that are common to SAWER objectives, many of these are directly focused on agricultural water use and Rajasthan among other similar arid/semi-arid geographies; and CII-Water Institute, a joint initiative of the Confederation of Indian Industries (CII) and the state government, meant to focus on all issues related to water management including detailed water audits for industry, facilitating zero water discharge, rainwater harvesting, wastewater treatment, and desalination. The state government has formed the Rajasthan Business Community Alliance on Water, an alliance with the World Economic Forum, CII and UNDP to implement statewide water, and water shed management programs incorporating PPCP models.

7. Agencies/Consortiums **-** Comprehensive Assessment of Water Management in Agriculture (CA) is a multi-institute process aimed at identifying existing knowledge on ways to manage water resources. Its main output is the assessment synthesis report along the lines of the millennium ecosystem assessment and the Intergovernmental Panel on Climate Change assessment reports, and has formal linkages with the International Assessment of Agricultural Science and Technology for Development. It provides in-depth analysis of water and food issues that are inadequately addressed in other global exercises. IFC could identify other international agencies as well as most relevant groups within the UN and the World Bank. Possibilities include WWF, UNDP, and IMI.

[155] Mitigating Poverty in Western Rajasthan (MPOWER) - with financial aid from International Fund for Agriculture Development, Rome and the Sir Ratan Tata Trust, Mumbai. Government of Rajasthan and Sir Ratan Tata Trust have entered into a MoU which recognizes the achievements of another successful program Sakh Se Vikas (SSV), initiated in 2003 with support from Sir Ratan Tata Trust to promote more than 4,700 women SHGs, spanning 70,000 poor households in Dholpur, Tonk, Ajmer, Alwar, Banswara, and Dungarpur districts of Rajasthan.

ILLUSTRATION II

Rainwater Harvesting Program - Harvest to Drink[156]

Rural/peri-urban drinking water supply could be a high priority area for IFC intervention in the Rajasthan water sector for reasons discussed in detail throughout this report. The over dependence on groundwater resources (85 percent) for current rural drinking water needs is on very shaky ground. While promised in the Public Health and Engineering Department reform agenda, the wait for surface resource-based schemes can be excruciatingly long for low priority rural areas. Besides, the capital-intensive nature of surface schemes and physical limitations imposed by locations, far flung as these are, raise serious doubts about the viability of these schemes.

Additionally, given the fact that more than half of rural habitations in the state remain either partially or fully uncovered by drinking water, combined with the state government's public acknowledgement of lack of funds and failure to meet goals under the National Rural Drinking Water Mission (NRDWM) mission, the need for intervention is clear. While NGOs, voluntary organizations, and international agencies among others continue to work in this area, there is potential to cover more ground under a professionally managed private effort. Part of the solution in rural areas clearly has to be RWH.

Harvest to Drink Program is recommended to be an IFC supported RWH program. The primary program objective will be to provide sustainable drinking water to rural communities in Rajasthan. For the pilot, the focus can be on rooftop RWH. These are individual assets, hence more dependable. Since they are insulated from complexities of community management they have better chances of being maintained. In exceptional cases where rooftop harvesting option is not viable due to any reason, and there are reasons to support an anomaly, alternate water harvesting options could be taken up under the pilot.

Under the program model, the cost of construction of structures will be broken into three parts – user funded down payment in cash or kind (mostly kind in terms of portion of the material and labor cost), user financed (with MF assistance), and government borne subsidy (assuming government cooperates). Based on user affordability, the model will further take two forms - a heavily subsidized model for below poverty line (BPL) (or alternate definition that accurately reflects the user's economic status), and another non-subsidized (or marginally subsidized) model for users who can afford with financing help.

[156] Author's recommended name to convey the essence of the rainwater-harvesting program – Harvest to Drink. Should the program, under this name, be adopted by IFC, further due diligence is recommended to ensure there are no copyright and other violations. Preliminary Internet search on "Harvest to Drink" reveals no exact matches.

In order to make this a robust proposition for the government, the following can be considered: (a) The possibility to integrate the program with the village water security plan (VWSP) exercise being conducted by the state government can be explored. During the author's meeting[157] with the Jaipur-based Indian Institute of Health Management Research which is engaged in this planning, it was revealed that, post planning, PHED will take over implementation. Lack of institutional capacity with the department to undertake such a project needing community engagement among other measures, is good reason to offer an intervention. (b) Under VWSP or separately, the potential to include a sanitation dimension to the program must be evaluated with the Water and Sanitation Program (WSP) of the World Bank as potential partner[158]. (c) Finally, given the glaring lack of livelihood options witnessed in some of these areas with acute drinking water crisis, possibilities to engage program beneficiaries in productive livelihood activities must be evaluated (potential for self-help groups).

Harvest to Drink - Action Plan

As a first step, in order to ascertain the feasibility of the program, IFC can engage in informal discussions with experienced participants in the water harvesting space in the state such as: IIHMR since they are in direct contact with the state government and have implemented several RWH structures with the help of their sister entity Bhoruka Charitable Trust; BASIX Social Enterprise Group, given its work with Safe Water Networks (SWN), and Center for Microfinance (CMF) given its insight into financial players active throughout the state; Ministry of Water Resources, Government of Rajasthan to evaluate its interest and explore possibilities to integrate the program with ongoing efforts under the ministry.

Based on responses, a brief evaluation must be commissioned to study the statewide landscape, especially to ascertain user affordability aspects. Based on the author's assessment so far, potential study partners could be one or more of the following - CMF, IIHMR, and IWMI-TATA. The study should highlight key geographic pockets for intervention, both from an impact and viability standpoint (ability of beneficiaries to pay), complete with supporting demographic, economic, and physical facts.

[157] Mr. Bastiaan Mohrmann of IFC was part of the meeting held on February 1, 2011 at IIHMR, Jaipur campus

[158] Author's meetings with WSP (unrelated to this matter), along with Mr. Mohrmann, indicate potential for positive response

ILLUSTRATION III

IFC supported Drinking Water Intervention under the PURA Scheme

Provision of Urban Amenities in Rural Areas or PURA, is a central government sponsored scheme under the Ministry of Rural Development (MoRD) to provide various infrastructure and related services under a PPP format, including drinking water supply, to a cluster of villages in about ten locations nationwide. With primary focus on rural areas, this is a unique scheme to bring private sector intervention through a risk, resource, and asset sharing partnership (touted to be one of its kind in the world). Here is a brief scheme description:

MoRD has re-launched the PURA scheme as a central sector scheme. MoRD with support from DEA, and the technical assistance of ADB, intends to implement the PURA scheme under a PPP framework between gram panchayats (elected local village bodies), and private sector partners. The scheme envisages twinning of rural infrastructure development with economic regeneration activities and is the first attempt at delivering a basket of infrastructure and amenities through PPP in the rural areas. The scope of the scheme is to select private partners to develop livelihood opportunities, urban amenities, and infrastructure facilities under prescribed service levels, and to be responsible for its maintenance for a period of ten years in select panchayats or cluster of panchayats. Private sector entities having experience in development and management of community-oriented infrastructure projects were selected through an open competitive bidding process based on rigorous qualifications and evaluation criteria. The selected private partners are required to provide amenities like water supply and sewerage, roads, drainage, solid waste management, street lighting and power distribution, and undertake certain economic and skill development activities as part of the PURA project. Private partners may also provide add-on revenue-earning facilities such as village-linked tourism, integrated rural hub, rural market, agri-common services center, and warehousing. In addition to the amenities mentioned above, where the PURA project spans several panchayats in a cluster, the private partner will propose sub-projects with PURA elements for each of the panchayats.

Informal discussions with concerned individuals were undertaken by the author to investigate potential IFC role in PURA for Jaipur and Rajsamand in Rajasthan. If there is broad internal interest in the scheme, IFC can specifically evaluate scope for participation around drinking water supply, either alone or including sanitation with WSP as potential partner.

This opportunity will allow IFC to engage in high priority areas of rural/peri urban drinking water, see sections 11.1.1 and 11.1.2. Depending on findings, there could be additional potential for IFC supported private sector interventions in PURA, especially agricultural.

ILLUSTRATION IV

IFC supported Industrial Water Stewardship Program

Recognizing IFC's prior experience with a water foot-printing project, a water foot printing/stewardship program could likely be the most actionable project for IFC in Rajasthan water sector in the near term. An important partner could be the CII-Triveni Water Institute a joint initiative of the Confederation of Indian Industry (CII) and the government of Rajasthan. CII-TWI has conducted water management studies and water audits in different sectors in Rajasthan[159]. IFC can initiate dialogue with CII around water intensive industries described in earlier sections of this report with the aim of helping establish sector best practices.

Additionally, IFC can consider the following specific developments and explore partnering possibilities. While the latest status and specifics of these proposals are unknown, the examples below serve as a broad idea of possible collaboration. In addition to industry, certain proposals relate to drinking water and agriculture related interventions recommended in this report. For ease of reference these are together presented here:

CII-Godrej GBC (division of CII) has formed the India Business Alliance on Water (IBAW)[160] with USAID support, managed by UNDP. Separately, the state government has formed an alliance called Rajasthan Community Business Alliance on Water (RBCAW), with the World Economic Forum, CII and UNDP to implement statewide water and watershed management programs incorporating PPCP models. IBAW is promoting RCBAW. RCBAW had short listed eight proposals in first round under PPCP:

Industrial - Shree Cements-Municipal Wastewater Recycling at Beawer town, Ajmer district to reuse 1,000 cubic meters of municipal wastewater for industrial purposes; and Doshion Municipal Sewage Treatment and Recycling Plant at Ajmer, Bikaner, Jaipur, Jodhpur and Kota (treated water will be used for gardening, toilet flushing and industrial use, proposed under BOOT).

Drinking Water - Doshion desalination plants at Barmer, Jaisalmer, Bharatpur, Jaipur, Jalore and Sirohi (to provide potable water and improved health, and reduction in morbidity/mortality rates, proposed under BOOT); Jal Bhagirathi Foundation Desalination in Godawas, Barmer district to set up community level desalination plants offering water at 10 paise per liter (or about $0.18 for 100 liters), compared to the current 25 paise per liter (about $0.45 for 100 liters) from private vendors; and IIHMR water harvesting structures, Jhunjhunu district (multi-tier architecture rooftop RWH consisting of home tanks, collective tanks and village tanks each of 20,000 liters, 100,000 liters and 300,000 liters respectively, for availability of water, and reduction in pumping ground water)

[159] Complete list of clients last accessed on May 1, 2013 at http://www.greenbusinesscentre.com/site/ciigbc/greenbuild.jsp?servid=198881.

[160] Detailed list of IBAW partners and projects in Appendix F of this report. Current status of these projects is unclear, however the list indicates the types of projects feasible in the state. Last accessed on May 1, 2013 at http://www.ibaw-india.com/site/ibw/read.jsp?reqpage=Projects.

Irrigation - NM Sadguru Foundation water harvesting structures in Banswara and Jhalawar district (construction of five water harvesting structures and five community lift irrigation schemes at an estimated cost of $890,000, to benefit 5,875 households or 35,250 people, and arrest distressed migration, recharging of ground water and ensuring food security in the project area); IIHMR water harvesting structures for irrigation, Churu and Banswara districts (to engage 90 percent farmers with active involvement of NGOs, construct 100 tanks of 30,000 liters each using local knowhow to meet irrigation water demand by way of integrated water resource management); and Sewa Mandir water harvesting structures at Patarpadi village, Udaipur district (detailed project report submitted to the government of Rajasthan by Sewa Mandir, water harvesting through gravitational flow for irrigation in the tribal dominated project area).

The water stewardship program will apply to the recommended intervention discussed under section 11.1.7 of this chapter.

Given the nature of certain industries in Rajasthan, that is high water consumption and high associated effluent discharge, any program to address water usage and wastewater discharge from these units will be an added effort in the sector equation. Importantly, the exercise could open PPD opportunities for IFC around industrial sector reforms, especially given CII's memorandum of understanding with the state government. This could further lead to an industrial wastewater recycling intervention (11.1.6), which otherwise could be challenging to break into.

Abbreviations

ADB	Asian Development Bank
AFD	Agence Française de Développement
BBMB	Bhakra Beas Management Board
BCM	Billion Cubic Meters
BOO	Build Own Operate
BOT	Build Own Transfer
BOOT	Build Own Operate Transfer
BPL	Below Poverty Line
BWSSB	Bangalore Water Supply and Sewage Board
Cs	Cusecs
CAGR	Cumulative Average Growth Rate
CAZRI	Central Arid Zone Research Institute
CBO	Community Based Organizations
CCA	Cultivable Command Area
CETP	Common Effluent Treatment Plant
CM	Chief Minister
CMF	Center For Microfinance
Cu.m	Cubic Meters
CWC	Central Water Commission
CII	Confederation of Indian Industry
CPCB	Central Pollution Control Board
CSE	Center for Science and Environment
DEA	Department of Economic Affairs
DPR	Detailed Project Report
EPC	Engineering Procurement and Construction
GIS	Geographical Information System
GSDP	Gross State Domestic Product
GSA	Gross Sown Area
GIA	Gross Irrigated Area
GoI	Government of India
GoR	Government of Rajasthan
Ha	Hectares
HUDCO	Housing Urban Development Corporation
IA	Implementing Agency
IIHMR	Indian Institute of Health Management Research
IGC	Indira Gandhi Canal
IL&FS	Infrastructure Leasing and Financial Services Limited
IIPDF	India Infrastructure Project Development Fund
IIFCL	India Infrastructure Finance Company Limited
IGNP	Indira Gandhi Nehar Pariyojna
IBAW	Indian Business Alliance on Water
IWMI	International Water Management Institute
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau
LPCD	Liters Per Capita per Day
LMC	Left Main Canal
MLD	Million Liters per Day

MP	Madhya Pradesh
MCM	Million Cubic Meters
MAF	Million Acre-Feet
MDG	Millennium Development Goals
MRFP	Model Request for Proposal
MoRD	Ministry of Rural Development
MoUD	Ministry of Urban Development
MTR	Mid Term Review
MI	Micro Irrigation
MF	Microfinance
NSA	Net Sown Area
NSDP	Net State Domestic Product
NIA	Net Irrigated Area
NGO	Non-Governmental Organization
NMMI	National Mission in Micro Irrigation
NBFC	Non-Banking Financial Company
NABARD	National Bank for Agriculture and Rural Development
NCPAH	National Commission on Plasticulture Application in Horticulture
NRDWM	National Rural Drinking Water Mission
NWP	National Water Policy
O&M	Operating and Maintenance Cost
PRI	Panchayati Raj Institution
PHED	Public Health and Engineering Department
PPP	Public Private Partnership
PPD	Public Private Dialogue
PPCP	Public Private Community Partnership
PPM	Parts Per Million
PSP	Public Stand Post
RBCAW	Rajasthan Business Community Alliance on Water
RIICO	Rajasthan State Industrial Development and Investment Corporation Limited
RWSSC	Rajasthan Water Supply and Sewage Corporation
RPCB	Rajasthan Pollution Control Board
RUIDP	Rajasthan Urban Infrastructure Development Project
RSEB	Rajasthan State Electricity Board
RMC	Right Main Canal
RO	Reverse Osmosis
RGDWM	Rajiv Gandhi Drinking Water Mission
SEZ	Special Economic Zone
SWP	State Water Policy
SHG	Self Help Group
SPV	Special Purpose Vehicle
TDS	Total Dissolved Solids
TA	Transaction Advisor
TAC	Technical Advisory Committee
UP	Uttar Pradesh
ULB	Urban Local Body
VGF	Viability Gap Funding
VWSP	Village Water Security Plan
WST	Water Saving Technology
WSP	Water and Sanitation Program
WHO	World Health Organization
WUG	Water User Group

Select References

- National Health Profile (NHP) of India – 2011, Central Bureau Of Health Intelligence, Government of India
- National Water Policy Document, 2002 and 2012, Ministry of Water Resources
- State Water Policy Document, 2010, State Water Resource Planning Department, Government of Rajasthan
- State Annual Plan 2011-2012, 2012-13 and Draft 2013-14, Planning Department, Government of Rajasthan
- State Eleventh Plan (2007-2012), Mid-Term Review Document, Planning Department, Government of Rajasthan
- State Five Year Plan- Eleventh Plan (2007-12) and Twelfth Plan (2012-17), Planning Department, Government of Rajasthan
- Agriculture Statistics of Rajasthan 2010-11, Directorate of Economics and Statistics, Rajasthan
- Rajasthan Microfinance Report, 2010 and 2011, by Singh and Bhargava, Center for Microfinance
- Rajasthan State Action Plan on Climate Change, 2012, Government of Rajasthan, facilitated by The Energy and Resources Institute (TERI) and supported by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
- Environmental Management Guidelines and Action Plan of SWRPD for Water Sector in Rajasthan (Under Rajasthan Water Sector Restructuring Project), 2009 and 2013, State Water Resources Planning Department, Government of Rajasthan
- National Mission on Micro Irrigation- Operational Guidelines, 2010, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India
- Compendium of Issues Pending with Government of India, 2013, Government of Rajasthan, Planning Department
- Food Security Atlas of Rural Rajasthan, 2010, Institute for Human Development and World Food Program
- **India:** Bracing for a Turbulent Water Future, 2005, World Bank study
- Climate Change Impacts, Mitigation and Adaptation Science for Generating Policy Options in Rajasthan, 2010, Rajasthan Pollution Control Board, Government of Rajasthan
- Water Resources Planning for the State of Rajasthan, 1998, Tahal and WAPCOS
- **Drinking water and sanitation in India:** Need for demand management structures, 2003, Reddy and Mahendra, presented at Seminar on Drinking Water and Sanitation, Delft, The Netherlands

- **Upstream vs Downstream:** Groundwater Augmentation Through Rainwater Harvesting and its Implications for Agriculture Development, 2005, Ray and Mahendra, Institute of Development Studies, Jaipur
- **Surface and Groundwater Resources of Arid Zone of India:** Assessment and Management, 2009, by Goyal, Angchok, Stobdan, Singh, Kumar, for Central Arid Zone Research Institute (CAZRI)
- **Groundwater socio-ecology and governance:** a review of institutions and policies in selected countries, 2005, Mukherji and Shah
- Indira Gandhi Nahar Pariyojana—lessons learnt from past management practices in the Indian arid zone, K. D. Sharma, Central Arid Zone Research Institute (CAZRI)
- **Regulating Water and Sanitation for the Poor:** Economic Regulation for Public and Private Partnerships, 2012, Franceys and Gerlach,
- Rajasthan Development Report, 2006, Planning Commission, Government of Rajasthan
- Rajasthan- The Quest For Sustainable Development, 2007, edited by Vijay Shankar Vyas
- **Water sector performance under scarcity conditions:** a case study of Rajasthan, India, 2010, V Ratna Reddy
- **Understanding water in a Dry Environment:** Hydrological processes in arid and semi-arid zones, 2003, Simmers, International Association of Hydrogeologists
- **Groundwater Governmentality:** Hegemony and Technologies of Resistance in Rajasthan's Groundwater Governance, 2009, Trevor Birkenholtz, Geographical Journal
- The Coming Famine- The Global Food Crisis and What We Can Do To Avoid It, 2010, Julian Cribb, University of California Press
- Dryland Farming, Perspectives and Prospects, 1991, Bhanwar Lal Sharma
- **The Cornerstone of Development:** Integrating Environmental, Social, and Economic Policies, 1998, Schnurr and Holt
- **Adoption and Impacts of Microirrigation Technologies:** Empirical Results from Selected Localities of Maharashtra and Gujarat States of India , Namara, Upadhyay and Nagar, IWMI
- **Water saving and yield enhancing technologies:** How far can they contribute to water productivity enhancement in Indian Agriculture, 2005, Kumar, Amarasinghe and Singh, IWMI
- **Pepsee systems:** grassroots innovation under groundwater stress, 2004, Verma, Tsephalb and Josec
- **Unraveling Bhakra-** Assessing the Temple of Resurgent India, 2005, Shripad Dharmadhikary
- Background Note for Consultation Meeting on Review of National Water Policy (held on 28.7.2010), Ministry of Water Resources

- The Report of the Expert Group on Ground Water Management and Ownership, 2007, Planning Commission, Government of India
- Environmental Assessment Study and Development of Environmental Management Framework for Rajasthan Rural Livelihood Project, 2010, prepared by The Energy and Resources Institute (TERI), for Rajasthan Rural Livelihood Project (DPIP·II), Rural Development and Panchayati Raj Department, Government of Rajasthan
- Status of Water Supply, Wastewater Generation and Treatment in Class-I Cities and Class-II Towns of India, 2009, Central Pollution Control Board, Ministry of Environment and Forests, Government of India
- Status of Water Supply, Sanitation and Solid Waste Management in Urban Areas, 2005, Central Public Health and Environmental Engineering Organization (CPHEEO), Ministry of Urban Development Government of India
- Proposal for PPP Projects- Water Supply System, PHED, Government of Rajasthan as accessed in April 2013
- Rajasthan Infrastructure Agenda 2025 – Initial Screening Report, March 2003, PricewaterhouseCoopers
- Rajasthan 2013, India Brand Equity Foundation
- Water Resources Department, Government of Rajasthan http://waterresources.rajasthan.gov.in
- Planning Department, Government of Rajasthan www.planning.rajasthan.gov.in/
- Public Health Engineering Department, Government of Rajasthan http://www.rajwater.gov.in
- Rajasthan Krishi, Government of Rajasthan http://www.krishi.rajasthan.gov.in
- Central Arid Zone Research Institute (CAZRI) http://www.cazri.res.in
- Andhra answer to critical groundwater condition, March 06, 2010, Business Standard article
- PlanCom for regulatory mechanism to manage groundwater, August 13, 2010, Business Standard article by Devika Banerji
- Wrong Policies behind Rajasthan's Water Crisis, 25 May 2010, by Devinder Sharma
- Rajasthan farmers revive agitation over irrigation water, November 15, 2006, by Kirtiman Awasthi, Down to Earth
- IRRI, Jain Irrigation sign MoU on water efficient irrigation, February 20, 2010, Economic Times Bureau
- Drip irrigation developed for pulses, oilseeds- Jain Irrigation conducts trials in AP, Maharashtra, September 2, 2010, Suresh P. Iyengar,

Appendix A

River Basins of Rajasthan

River Basins of Rajasthan							
No.	**River Basin**	**Location within Rajasthan**	**Catchment Area (Sq Km)**	**Mean Annual Rainfall over Basin in mm)**	**Length of River (in Km)**	**Covered Geography by Districts**	**Tributaries**
1	Shekhawati	North-Eastern part	11,522	Data unavailable	Data unavailable	Data unavailable	Kantli, Mendha
2	Ruparail	North-Eastern part	3,855	576	104	Parts of Alwar and Bharatpur	Number of smaller streams rise e.g. the Narainpur, Golari, Sukri, Shanganga and Nalakroti rivers
3	Banganga	North-Eastern part	8,878	596	240	Parts of Alwar, Jaipur, Dausa, Sawai Madhopur and Bharatpur	Data unavailable
4	Gambhir	North-Eastern part	4,174	616	288	Sawai Madhopur, Bharatpur, Dausa, and Dholpur	Sesa, Kher and Parbati
5	Parbati	Eastern part	2,388	638	123	Parts of Sawai Madhopur and Dholpur	Sairni, Bamni, Mendka
6	Sabi	North-Eastern part	4,442	Data unavailable	Data unavailable	Data unavailable	Data unavailable
7	Banas	East-Central part	45,833	541	512	Parts of Jaipur, Dausa, Ajmer, Tonk, Bundi, Sawai Madhopur, Udaipur, Rajsamand, Pali, Bhilwara and Chittorgarh	Berach Menali Kothari, Khari, Dai, Dheel, Sohadara, Morel Kalisil

River Basins of Rajasthan							
No.	**River Basin**	**Location within Rajasthan**	**Catchment Area (Sq Km)**	**Mean Annual Rainfall over Basin in mm)**	**Length of River (in Km)**	**Covered Geography by Districts**	**Tributaries**
8	Chambal	Eastern part	31,460	797	See basin description	Parts of Chittorgarh, Bhilwara, Bundi, Sawai Madhopur, Tonk, Jhalawar, Kota, Baran and Dholpur	Alnia, Kalisindh, Parwan, Mej, Chakan, Parwati, Kunu
9	Mahi River	South-Eastern part	16,985	700	See basin description	Parts of Banswara, Chittorgarh, Dungarpur and Udaipur	Eru, Nori, Chap, Som, Jhakham, Moran, Anas, Gomti, Bhadar
10	Sabarmati	Southern part	4,164	575	Data unavailable	Parts of Udaipur, Sirohi, Pali and Dungarpur	Data unavailable
11	Luni River	South-Western part	37,363	320	495	Parts of Ajmer, Barmer, Jalore, Jodhpur, Nagaur, Pali, Rajsamand, Sirohi and Udaipur	Sukri, Mithri, Bandi, Khari, Jawai, Guhiya Sagi and Jojari river
12	West Banas	South-Western part	1,798	Data unavailable	Data unavailable	Data unavailable	Data unavailable
13	Sukli	South-Western part	947	Data unavailable	Data unavailable	Data unavailable	Data unavailable
14	Other Nallahs of Jalore Basin	Southern part	1,968	353	Data unavailable	Parts of Jalore and Sirohi	Data unavailable
15	Outside Basin	Northern & Western parts	166,464	Data unavailable	Data unavailable	Churu and Bikaner	Data unavailable

Source: Water Resources Department, Government of Rajasthan

Appendix B

Water Tariff and Connection Charges, 1999 - Rajasthan						
City/town	**Cost of Production of Water (1997-98) Rs./kl**	**Domestic**				**Non-Domestic**
		Metered	Unmetered (Flat rate)			Metered
		Consumption based rates	Based on ferrule size		Other flat rate (Rs./year)	Increasing block tariff (Rs./month)
		Increasing block tariff (Rs./month)	Ferrule size	Rs./year		
For all Urban areas of the state	n.a	1.56/kl - upto 15 kl	15 mm	min. 240	300 for 2 taps (for 15mm connection)	4.68/kl - upto 15 kl
		3.00/ kl - for 15 - 40 kl	20 mm	min. 1440		8.25 kl - for 15-40 kl
		4.00 / kl - above 40 kl	25 mm	min 4440		11.00/kl - above 40 kl
			40 mm	min. 10440		
			50 mm	min. 13440		
			80 mm	min. 26940		
			100 mm	min. 53940		
			150 mm	min. 134940		

Source: Respective urban local governments/relevant agencies, NIUA Survey, 1999
"Reproduced from: Research Study Series No. 88
STATUS OF WATER SUPPLY, SANITATION AND SOLID WASTE MANAGEMENT IN URBAN AREAS
Sponsored by Central Public Health and Environmental Engineering Organisation (CPHEEO), Ministry of Urban Development, Government of India
National Institute of Urban Affairs, New Delhi, June 2005"

Non-Domestic		Industrial			One time water connection charges	Year of last revision	Water tax
Unmetered		Metered	Unmetered		(in Rs.) Domestic	1998	No
Based on ferrule size		Increasing block tariff	Based on ferrule size				
Ferrule size	Rs./year	Rs./month	Ferrule size	Rs./year			
15 mm	min.612	11.00/kl upto 15 kl	15 mm	min.1440	15.00 per sq.mtr. Of total plot area		
20 mm	min.1440	13.75/kl for 15-40 kl	20 mm	min 2880			
25 mm	min 4440	16.50 /kl above 40 kl	25 mm	min 5760			
40 mm	min. 10440		40 mm	min 10500			
50 mm	min. 13440		50 mm	min 13500			
80 mm	min. 26940		80 mm	min 27000			
100 mm	min. 53940		100 mm	min 54000			
150 mm	min. 134940		150 mm	min 135000			

Appendix C

Crops and Agro Climatic Zones in Rajasthan

Rajasthan Agro Climatic Zones, Regions & Major Crops									
Agro-climatic Zone	**Regions**	**Total Area (Million Ha.)***	**Net Sown Area (Million Ha.)***	**Average Rainfall (in mm)**	**Min-Max Temp °C**	**Major Kharif Crop**	**Major Rabi Crop**	**Soil**	**Districts**
IA-Arid Western	Jodhpur	4.74	2.34	200-370	8.0 - 40.0	Pearlmil-let, Moth-bean, Sesame	Wheat, Mus-tard, Cumin	Desert soils and sand dunes Aeolian soil, coarse sand in texture some places calcareous	Jodhpur (Jodhpur, Phalodi, Shergarh, Osian), Barmer
IB-Irrigated North Western Plain	Ganga-nagar	2.1	1.6	100-350	4.7-42.0	Cotton, Clusr-erbean	Wheat, Mus-tard, Gram	Alluvial deposits calcareous high soluble salts & exchangeable sodium	Ganganagar, Hanumangarh
IC-Hyper Arid Irrigated Western Plain Partially	Ganga-nagar, Jodhpur	7.7	2.44	100-300	3.0-48.0	Pearlmil-let, Moth-bean, Cluster-bean	Wheat, Mus-tard, Gram	Desert soils and sand dunes aeolin soil, loamy coarse in texture & calcareous	Jaisalmer, Jodhpur, Churu (Sujangarh, Ratangar, Sardarshahar, Dungargarh)
IIA-Transitional Plain of Inland drainage	Jodhpur	3.69	2.68	300-500	5.3-39.7	Pearlmil-let, Clus-terbean, Pulses	Mus-tard, Gram	Sandy loam, sallow depth red soils in depressions	Nagaur, Sikar, Jhunjhunu, Churu (Taranagar, Churu, Rajgarh)
IIB-Transitional Plain of Luni Basin	Jodhpur	3	1.93	300-500	4.9-38.0	Pearlmil-let, Clus-terbean, Sesame	Wheat, Mustard	Red desert soils in Jodhpur, jalore & Pali sierzoems in Pali & Sirohi	Pali, Jalore, Jodhpur (Bilara, Bhopalgarh, Reodhar, Sirohi, Shivganj)
IIIA- Semi Arid Eastern Plain	Jaipur, Kota	2.77	1.41	500-700	8.3-40.6	Pearlmil-let, Clus-terbean, Sorghum	Wheat, Mustard Gram	Sieroznes, eastern part, alluival, west north west lithosols, foot hills, brown soils	Ajmer, Jaipur, Dausa, Tonk

Rajasthan Agro Climatic Zones, Regions & Major Crops									
Agro-climatic Zone	**Regions**	**Total Area (Million Ha.)***	**Net Sown Area (Million Ha.)***	**Average Rainfall (in mm)**	**Min-Max Temp °C**	**Major Kharif Crop**	**Major Rabi Crop**	**Soil**	**Districts**
IIIB- Flood Prone Eastern Plain	Bharat-pur	3.36	0.92	500-700	8.2-40.0	Pearlmil-let, Clus-terbean, Ground-nut	Wheat, Barley, Mus-tard, Gram	Alluvial prone to water logging nature of recently alluvial calcareous has been observed	"Alwar, Bharatpur, Dholpur, Karoli (TodaBhim, Karoli, Nadauti, Sapotara, Hindaun), Sawai Madhopur (Bamanwas, Bauli, Gangapur)"
IVA- Subhumid Southern Plain	Bhilwara, Udaipur, Jodhpur	1.72	0.57	500-900	8.1-38.6	Maize, Pulses, Sorghum	Wheat, Gram	Soil are lithosolsat foot hills & alluvials in plains	Rajsamand, Bhilwara, Chittorgarh (except Bari Sadari, Pratapgarh, Arnod, ChotiSadari), Udaipur (except Dhariyabad, Salumber, Sarada), Sirohi (Abu Road, Pindwara)
IVB-Humid Southern	Udaipur			500-1100	7.2-39.0	Maize, Paddy, Sor-ghum, Black Gram	Wheat, Gram	Predomi-nantly reddish medium texture, well drained calcareous, shallow on hills, deep soil in valleys	Dungarpur, Banswara, Bhilwara, Udaipur (Dhariyabad, Salumber, Sarada), Chittogarh (Bari Sadari, Pratapgarh, Arnod, ChotiSadari)
V- Humid Southern Eastern Plain	Kota	2.7	1.27	650-1000	10.6-42.6	Sorghum Soybean	Wheat, Mustard	Black of alluvial origin, clay loam, groundwater salinity	Jhalawar, Kota, Bundi, Baran, Sawai Madhopur, Bharatpur, Sawai Madhopur (Khandar, Sawai Madhopur)

Source: Rajasthan Department of Agriculture (http://www.rajasthankrishi.gov.in/Departments/Agriculture/main.asp?t=aboutus_top.htm&p=Aboutus_agrozone_eng.htm) & other publications

Appendix D

Sample Performance Parameters for PPP operator

Various sample performance parameters, that could be adopted for PPP projects, are listed below-

1. Coverage of Connections with 24x7: The PPP Operator shall cover all the water connections with 24x7 water supply progressively within a specified time period. Continuous pressured water supply shall mean that potable, safe quality water delivered continuously at 7m pressure at customer tap. Emergency stoppages of not exceeding twelve hours and no more than an average of three emergency stoppages of less than 12 hours each shall occur in any continuous period of six months.
2. Assessment and Billing improvement: There shall be absolute increase in revenues other than arrears collected by the PPP OPERATOR due to all his management efforts measured as percentage revenue increase during every six months duration under review when compared to the revenue collected during the preceding six months duration. The increase in revenue due to improved billing, collection, new connections and reduction of illegal connections shall be attributed to the performance of the PPP OPERATOR. Any increase in revenue due to increase in tariffs occurring due to change of law or change of policies shall not be attributable to the performance of PPP OPERATOR. Revenue shall include all income from water consumption including interest on outstanding payments, connection charges and pro-rata charges if any but exclude any deposits remitted by customers.
3. Revenue Water in 24x7 Area: The revenue water shall be progressively increased by PPP operator up to 85 percent within a specified time limit. This quantity shall mean the proportion measured in percentage terms of total volume of water billed to customers in a designated supply area to that of the total system input volume in that designated supply area in the Distribution Operating Zones to which the PPP OPERATOR is supplying continuous pressurized water supply to the customer properties.
4. Resolution of Complaints on Services in 24x7 Area: The operator shall resolve progressively 98 percent of consumer complaints pertaining to water supply service issues including poor quality of water, low pressure, no water, leakage, poor quality road restoration and any such service issues within 24 hours
5. Resolutions of Complaints in the Entire Zones: The operator shall resolve progressively 98 percent of consumer complaints pertaining to water supply service issues including poor quality of water, low pressure, no water, leakage, poor quality road restoration and any such service issues within 24 hours.
6. Leakage levels in 24x7 Area: The PPP operator shall reduce leakage level in the designated area progressively to the level of 25 liter per connection per day per meter of pressure head.
7. Quality Compliance in 24x7 Area: The water quality in the entire designated area shall be maintained in terms of residual chlorine content, chemical quality and bacteriological quality. The exclusion is the situations where the bulk water quality is tested for non-compliance of the specified water quality standards.
8. Pressure Compliance in 24x7 Area: The PP operator shall maintain 7 m residual pressure at customer tap or 10m residual pressure at the critical measurement point for 95 percent of water connections and critical points in the designated area.
9. The timeline for achievement for these parameters could, typically, be as follows for a project period of 84 months (can be viewed on Public Health and Engineering Department Website)

Source: PHED, Government of Rajasthan

Appendix E

Notified and formally approved SEZs in Rajasthan				
1. Operational SEZs				
Sr. No.	**Developer**	**Location**	**Type of SEZ**	**Area in hectares**
1	Rajasthan State Industrial Development and Investment Corporation Limited (RIICO), Jaipur	Sitapura, Jaipur (SEZ-I)	Product Specific for Gems and Jewellery	8.6
2	Rajasthan State Industrial Development and Investment Corporation Limited (RIICO), Jaipur	Sitapura, Jaipur (SEZ-II)	Product Specific for Gems and Jewellery	35.8
3	Rajasthan State Industrial Development and Investment Corporation Limited (RIICO), Jaipur	Boranada, Jodhpur	Product Specific for handicrafts	72.4
4	Mahindra World City (Jaipur) Ltd.	Jaipur	IT/ITES	155.0
5	Mahindra World City (Jaipur) Ltd.	Jaipur	Handicrafts	102.8
6	Mahindra World City (Jaipur) Ltd.	Jaipur	Light engineering, automotives	222.7
2. Notified SEZs				
Sr. No.	**Developer**	**Location**	**Type of SEZ**	**Area in hectares**
1	Somani Worsted Limited	Khushkera, Bhiwadi	Electronics Hardware and Software/ ITES	20.0
2	Vatika Jaipur SEZ Developers Ltd.	Jaipur	IT/ITES	20.1
3	RNB Infrastructure Pvt. Ltd.	Pugal Road, Bikaner	Textile	103.4
4	GENPACT Infrastructure (Jaipur) Pvt. Ltd.	Jaipur	IT/ITES	10.0
5	Mahindra World City (Jaipur) Ltd.	Jaipur	Gems and Jewellery	11.1
3. Formally Approved SEZs				
Sr. No.	**Developer**	**Location**	**Type of SEZ**	**Area in hectares**
1	Mansarovar Industrial Development Corporation	Jodhpur	IT	10.0
2	Mahindra World City (Jaipur) Ltd.	Jaipur	IT/ITES	56.9

"Source: Rajasthan State Industrial Development and Investment Corporation Limited (RIICO) Retrieved on May 12, 2013"

Appendix F

Indian Business Alliance on Water			
S.No	Submitted by	Proposal on	Activity
1	Shree Cements	Municipal waste water recycling at Beawar town, Ajmer district, Rajasthan	The project proposes to reuse 1000 cubic meters of municipal wastewater for industrial purpose. This will help to minimize the effects of municipal waste water discharge.
2	Shree Cements	Construction of water harvesting structure (ANICUT) in Andheri Deori village and RAS village, in Ajmer and Pali districts	The proposed construction of water harvesting structure envisages to address the drinking water and agricultural needs in the identified area. This would result in creation of additional command area and also improvement in the quality of life of the farmers
3	Chambal Fertilizers and Chemicals Ltd	Construction of WHS (ANICUT) Masonry Weir Across Kali Sindh River in Gadepen village of Kota district	Commissioning of the project will ensure availability of drinking water in near by villages.
4	ITC Rural Development Trust	PPCP for Water Harvesting and Management at Chittorgarh, Jhalwar and Bundi districts	The project conceptualizes construction of approximately 200 Water harvesting structures in the proposed districts. This would benefit 2500 farmers and also create 2400 ha of additional command area.
5	ITC Rural Development Trust	Watershed management at Pratapgarh Tehsil of Chittorgarh district	The project proposes ecologically sound regeneration in the project area, introduction of effective soil and water conservation measures for improving agricultural productivity, and livelihood
6	Doshion	Desalination Plant at Barmer, Jaisalmer, Bharatpur, Jaipur, Nagpur, Jalore and Sirohi *	The proposal envisages installing desalination plants at the identified areas. This would result in availability of potable water, improvement in the health condition of people and reduction in morbidity and mortality rates. Doshion has proposed to set up the plant on Build Own Operate Transfer (BOOT) basis.
7	Doshion	Municipal Sewage Treatment and Recycling Plant at Ajmer, Bikaner, Jaipur, Jodhpur and Kota*	A STP would be set up in the identified areas that would treat municipal wastewater. The treated water could be used for applications like gardening, toilet flushing and industrial use. The said plant would be set up under a BOOT model.
8	Jal Bhagirathi Foundation	Desalination	The proposal envisages setting up of a community level desalination plant. With the commissioning of the scheme, water will be available @ 10 paise/ litre in Godawas of Barmer district compared to the current 25 paise / litre from private vendors.
9	NM Sadguru Foundation	Water Harvesting Structure in Banswara and Jhalawar district	The proposal envisages construction of five Water Harvesting Structure and five community lift irrigation schemes with an estimated cost of Rs 1485 lakhs. It is estimated that nearly 5875 household (35250 population) would be benefited under the scheme leading to improvement of overall economic condition of the community, arrest in the rate of distressed migration, recharging of ground water and ensuring food security in the project area.

Indian Business Alliance on Water			
S.No	Submitted by	Proposal on	Activity
10	LUPIN	Desilting of ponds in Bharatpur district	Work order is issued to LUPIN Human Welfare and Research Foundation for taking up desilting of 55 ponds at an estimated cost of Rs 99.73 lakhs. The desilting of ponds apart from address the drinking water problem of human and cattle's in the project would also ensure conservation of water. Furthermore the water level in wells already constructed on the banks of the ponds will automatically come up and curtail ground water exploitation.
11	Sewa Mandir	Water Harvesting Structure at Patarpadi village of Udaipur district	A Detailed Project Report is submitted to GoR by Sewa Mandir for taking up construction of WHS in the project area. The water harvested through gravitational flow would be primarily used for irrigation purposes in the tribal dominated project area. The scheme bears a direct relationship with the livelihood of the farmers in the area
12	IIHMR	Water harvesting structure for drinking water purpose in Jhunjun district	The project proposes to demonstrate the effective use of rain water harvesting for drinking water through a multi-tier architecture roof top rain water harvesting consisting of Griha (Home) tank, Samooh (Collective) tank and Gram (Village) tank each of 20000 liters, 100000 liters and 300000 liters respectively. The project envisages increase in availability of water, reduction in the cost of pumping ground water, qualitative improvement of groundwater through dilution of excessive chemical and enhancement of the moisture content of soil which in turn facilitate good vegetation
13	IIHMR	Water harvesting structure for irrigation purpose at Churu and Banswara district	Under this initiative it is expected that more than 90% of the farmers with the active involvement of NGOs would be able to make an effective dent in meeting the water demands by adhering to rain water harvesting in the project area. 100 tankas of 30000 liters each would be constructed using local know-how to meet the water demand for irrigation purpose with the involvement of the community by way of integrated water resource management.
14	CII and Government of Rajasthan	Water Harvesting Institute at Jaipur	A MoU was signed between GoR and CII for setting up of Water institute. The institute envisages providing water related services for ensuring overall management of water, pursuing research on water management, liasoning with organizations for promoting water conservation, advocacy for water management and conservation and influence policy measures on water.

Source: http://www.ibaw-india.com

Photo Credits: Sweta Mirdha Hooda

Contact Information

International Finance Corporation
Maruti Suzuki Building
3rd Floor, 1 Nelson Mandela Road,
Vasant Kunj, New Delhi - 110070
India
T: +91 11 4111-1000
F: +91 11 4111-1001
www.ifc.org

International Finance Corporation
World Bank Group

2013