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Water sector performance under scarcity conditions: a case study of Rajasthan, India

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Abstract

This paper makes an attempt to assess the water sector under scarcity conditions in the State of Rajasthan. It adopts the criteria of physical, economic, financial and equity performance across sub-sectors. The assessment brought out clearly that no indicator has shown satisfactory performance in any of the sub-sectors. Though the urban drinking water sector is relatively better in performance, a lot more needs to be done in order to bring it to the threshold level of economic and financial performance. The huge expenditures incurred in this sector are not going towards real investments that would improve the performance of the sector. Despite the fact that the water sector (except groundwater) is in the hands of the government, equity goals are not achieved. An urban and rich bias is prevalent as far as access to water and public distribution of water. Apart from suggesting some short-term measures to meet the immediate demands, this paper argues that institutional reforms are critical for sustainable water resource management under scarcity conditions.

Keywords: Equity; Expenditure gap; India; Performance; Policy; Price gap; Rajasthan; Scarcity; Water sector

1. Introduction

The importance of water in poverty alleviation and economic development need not be over emphasized, especially in Rajasthan where drought is a rule rather than an exception. Though a number of states or regions in India face drought, three factors place Rajasthan in a more precarious situation: (a) the frequency of droughts (four out of every five years); (b) extremely low and erratic rainfall[1]; and (c) very limited surface water sources, like perennial river basins, resulting in greater dependence on groundwater resources. Added to this is the high decennial population growth, which has stagnated

[1] Average annual rainfall is 575 mm, ranging between 267 and 600 mm during 1998–2002. Ten (western) districts of the 32 districts received only about 318 mm, often recording rainfall as low as 45 mm.

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during the last two decades (at about 28.4%). Together, these factors put a high pressure on the per capita availability of water which, in Rajasthan, is less than half (807 m^3) of the national average (2,000 m^3), and which is expected to decline further to 457 m^3 by 2045. This means the state will slip from scarcity to an absolute scarcity zone. These comparisons will be more revealing if the quality aspects of water are taken into account. Rajasthan accounts for 51% of the fluoride and 42% of the saline affected areas in the entire country. More than 75% of the villages and habitations are affected by poor quality water, affecting 20 million people in the state (ID&R, n.d.).

The severity of the problem is reflected in budget allocations to the sector in the state. Annual allocations to the sector are more than Rs. 24,000 million in 2003–04, which is about 15% of the total budget allocation. Given the precarious situation of the sector and the importance given in terms of financial allocation, it is necessary to assess the performance of the sector. Often, such scarcity conditions tend to push state machinery towards enhanced efficiency in management of the water sector. Unless backed by efficiency, sustaining even the present level of service is rather difficult in the medium term. Performance assessment of the sector helps to identify the key areas that need immediate attention in the policy process.

Are such huge budgetary allocations commensurate with the actual service delivery of water sector? In other words, how efficiently are these allocations resulting in effective service delivery? In this context, this paper looks at the over all performance of the water sector in Rajasthan in a comprehensive manner. The specific objectives of the paper include: (a) assessing the overall performance of the sector in terms of physical, financial, economic and equity performances; (b) assessing the performance of important sub-sectors like irrigation, drinking water (rural and urban), etc.; (c) assessing the water policy of the state; and (d) identifying future options for sustainable water resource management in Rajasthan.

The paper is organised in seven sections. Following this Introduction, the next section sets the context for the study by providing the status of the sector in physical and financial terms. Approach and methodology of the study is presented in section three, while the performance of the water sector in Rajasthan is assessed across sub-sectors in section four, and a water policy assessment is attempted in section five. Policy options for sustainable water resource manages are discussed in section six, and the last section makes some concluding remarks.

2. Context

In Rajasthan, surface water accounts for the largest share of the ultimate available water resources. However, at present, groundwater is the single largest utilised water resource in the state. In terms of economically utilisable water the state ultimately has to depend more on external sources. Further development of water resources only comes from surface water, as groundwater is already over exploited (Table 1). Water utilisation could be expanded by another 30% irrespective of economic costs, and by 21% economically[2]. However, the future development of water resources in the state is uncertain given the critical condition of groundwater resources, where the rate of exploitation is more than 100%. In 16 out of the 32 districts, groundwater is over exploited (more than 100%), and the rates of exploitation are as high as 165% in Junjhunu and 153% in Jodhpur.

[2] Presently the irrigation department does not approve any project that costs more than Rs 100,000 per hectare of irrigation.

Table 1. Status of water resources in Rajasthan. Figures in brackets are respective percentages to total water resources.

Category	Availability in BCM	Utilization in BCM	Percentage Utilized
Surface water	21.71 (42.6)		52
(a) Economically utilisable	16. 05 (35.6)	11.29 (31.6)	70
(b) Economically non-utilisable	05.66		–
Ground water	11.36 (22.3/25.2)	11.77 (39.3)	104
External water	17.88 (35.1/39.2)	12.66 (35.4)	71
Total	50.96 (100.0)		70
(a) Economically utilisable water	45.09	35.72 (100.0)	79

Source: GOR (2003), Vision-2045, Department of Planning, Government of Rajasthan, Jaipur.

The number of critical and over exploited blocks (administrative divisions in local governance structures below the district level consisting of 30–50 villages) is increasing progressively over the years. Such high levels of groundwater exploitation push the aquifers beyond their renewable threshold levels, converting them to non-renewable sources in the long run. Hence the availability of groundwater is uncertain if the present rates of exploitation are not checked. In the long run, groundwater availability will either decline or become unusable due to poor quality. The major casualty in this regard is drinking water, where dependency on groundwater is 90%. While irrigation is the single largest consumer of water, accounting for 83% of total water resources, drinking water accounts for about 9%. The state is gearing itself from various angles in order to address the water scarcity problem.

The water scenario in the state appears to be one that is busting at the seams. The water sector accounts for a substantial share of the state budget. There are four broad sub-sectors within the water sector: irrigation and flood control, drinking water and sanitation, soil and water conservation, and groundwater. Irrigation and flood control, and water supply and sanitation, account for 98% of the budget allocations (Figure 1). Given the limited scope for expanding water supplies internally as well as externally, future water demands ought to be met through improved performance of the water sector. For this, the present performance of the sector provides the background, that is, it helps in understanding the levels of performance across the sub-sectors and identifying the gaps.

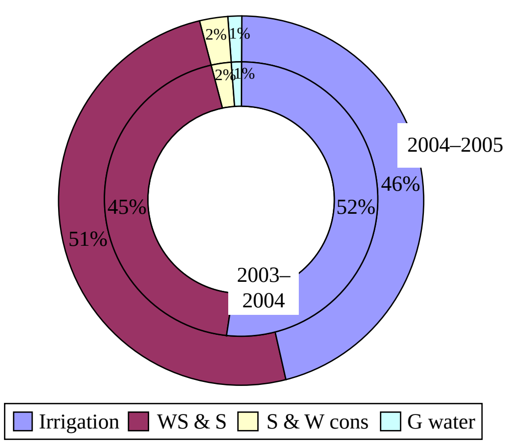

Fig. 1. Budget allocation to the water sector (Revenue and capital). (WS & S: Water supply and sanitation; S & W Cons: Soil and water conservation; Gwater: Groundwater).

3. Approach and methodology

This paper is primarily based on secondary sources of information. These include the data available in various publications of the State Government, especially the nodal agencies of irrigation, drinking water and sanitation, groundwater, soil and water conservation department, and policy documents, etc. Extensive interviews were conducted with the officials of these departments to verify the data and validate our analysis. Performance of the water sector was assessed for all the important sub-sectors such as irrigation, rural as well as urban drinking water, and sanitation. Performance was assessed for three consecutive years (2001–02, 2002–03 and 2003–04) for which detailed data were available. Performance was measured in terms of four indicators: (a) physical; (b) financial; (c) economic; and (d) equity (Saleth & Dinar, 2004).

3.1. Physical performance

Four indicators, namely demand-supply gap, physical health of water infrastructure, smoothness of water transfers across sectors, regions and users, and conflict resolution efficiency (low cost, less time) are often used to assess physical performance. Here we cover some of these aspects pertaining to drinking water (both rural and urban) and to irrigation.

3.2. Financial performance

Two indicators, namely the investment gap and the financial gap, are considered to assess financial performance. The investment gap is measured in terms of actual investments in the sector as against the investments required to achieve objectives. The financial gap is measured as the difference between expenditure on and recovery from the sector[3].

3.3. Economic performance

Price gap and scarcity, or incentive gap, are the two indicators of economic performance of the sector. Price gap is measured in terms of the difference between the supply costs and the actual price charged. The difference between the Operation and Maintenance (O&M) costs and the revenue from user charges is also used here, as covering O&M charges in itself is an efficiency indicator in most developing countries. The scarcity or incentive gap is the difference between the scarcity value of water and the actual value of water. We are not in a position to estimate the scarcity gap here, as we do not have information on the scarcity value of water. Estimates for willingness to pay (WTP) for irrigation and drinking water (rural and urban) (Reddy, 1995), which are expected to reflect the scarcity value of water, can be used in this regard instead. But the estimates reveal that, though WTP is substantially higher in all the contexts, they do not come close to covering the O&M costs fully.

[3] Often this is not strictly comparable as the current investments yield returns at a later stage. At the same time, current revenues are the result of earlier expenditure.

3.4. Equity performance

Equity between regions, equity between sectors and equity between groups are taken in to account while assessing the equity performance. Regional differences are seen in terms of geographical locations i.e. between districts or regions and between rural and urban locations. Irrigation, drinking water and industry are the main sectors that use water in Rajasthan, and allocations across these sectors are considered when assessing the equity between sectors. Differences between rich and poor as well as gender groups are examined in terms of equity between groups.

4. Performance of the water sector in Rajasthan

Performance of the important sub-sectors of the water sector is assessed using the four indicators. The sub-sectors assessed here include rural water supply, urban water supply and sanitation, and irrigation sectors.

4.1. Physical performance

4.1.1. Rural water supply. According to the Public Health and Engineering Department (PHED), 90.5% of total habitations (93,946) were fully covered and 6.6% were partially covered by the end of December 2004. However, there appears to be some discrepancy in the assessment due to the changes in guidelines[4] as to the basis of prescribed supply norms. According to these norms, only 33% of the total inhabited villages and habitations (122,250) were fully covered, while 53% were not covered at all. Though these inconsistencies are being verified at the state level and hence still can't be taken as final, the situation may not be very different as these guidelines take the quality, quantity and distance aspects in to account.

Piped water is supposed to be the most reliable, safest and easiest source of drinking water available. Hand pumps and tube wells are more labour and capital intensive, respectively, though they are relatively safe (after piped water). Hand pumps are the major source of water supply in rural Rajasthan, accounting for 57% of the villages covered. Piped water (treated water supplied through pipes, pump and tank, and regional schemes) is the second largest source (39%). Over the last decade, access to piped water has increased from 32% in 1995 to 39% in 2004 (Rathore, 2004). But in terms of access at the household level, only 21.6% of households have access to piped water (NSS, 1999). Household level access to tap water in fact declined between 1986–87 (24.4%) and 1998 (18.7%), though it improved after 1998 (Rathore, 2004). Moreover, 20% of the households having access to tap water reported insufficiency of water (Reddy & Mahendra, 2003). In terms of supply provision, 88.5% of the total villages and habitations receive less than 40 lpcd (litres/capita/day) of water. Among these, 8% receive less than 10 lpcd, 33% between 10–20 lpcd and 41% between 20–30 lpcd. Though the WHO norms are

[4] According to the Rajiv Gandhi Drinking Water Mission guidelines, villages and habitations are defined as per 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 litres/capita/day (lpcd). Partially covered = Supply of drinking water is less than 40 lpcd. Fully covered = Entire population in all the habitations including the main habitation in provided with good quality of drinking water as per the norms of the mission.

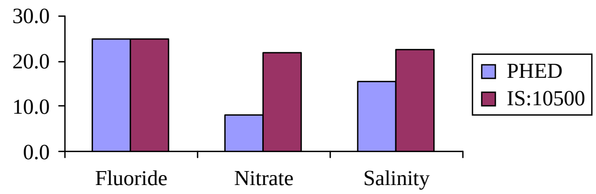

Fig. 2. Percentage of habitations affected by water quality.

quite high given the socio-economic conditions in Rajasthan[5], the demand-supply gap is quite substantial if we take net supplies, after accounting for leakages (40–50%) in the case of piped water supplies. The supply demand gap is also reflected in the proportion of households reporting purchase of water in rural Rajasthan (4%), which is the highest in the country (Reddy & Mahendra, 2003).

An added problem is the quality of water. As per Indian standards (IS10500), 25% of the total villages and habitations were affected by one or all water quality problems. Given the water scarcity conditions in the state, PHED has relaxed the quality norms (PHED, n.d.). Even according to the PHED norms, 25% of the total villages and habitations are affected by fluoride, above 15% are affected by salinity and about 9% are affected by nitrates (Figure 2). Fluoride is the most widespread problem, affecting about 16% of the rural population in the state (Rathore, 2004). Salinity and nitrates are the other serious problems. In fact, people drink saline water during the summer months of the year in many parts of the state. The worst affected districts include Tonk, Churu, Barmer, Pali, Sirohi, Jalore, Rajasmand, Ajmer, Nagaur, Jhunjunu, Barmer, Bharatpur, Bhilwara, Jodhpur, Baran and Jaipur.

Though water and sanitation are closely linked, information on sanitation is scanty. The National Sample Survey (NSS) is the only reliable source in this regard. According to the 54th round of NSS (1999), 86% of rural households do not have sanitation facilities, which is higher than the all India average of 82.5%. Only 14.6% of rural households have access to latrine facilities. Sewerage facilities are more or less absent in rural areas.

The poor health of infrastructure is reflected in the extent of leakages in the rural water supply schemes, which are estimated at 40–50%. Infrastructure, in terms of overhead tanks and distribution lines were constructed in order to provide piped water supplies to rural areas. Almost all these schemes depend on groundwater. In the majority of cases these water supply schemes have become defunct due to drying up of groundwater aquifers. Hence, the huge infrastructure (physical capital) is lying waste and dilapidated. A negative externality associated with this is the neglect of traditional water bodies. In the hope of getting assured piped water, rural communities have neglected the management of these systems, which have degenerated over time. But the hopes of the rural communities were short lived, as the modern systems could not sustain the pressure (Reddy, 1999). The result is a large-scale water infrastructure that is in a degenerated condition needing investments to renovate and upgrade.

There are about 25.4 million hand pumps installed in the rural areas. About 23% of these pumps are either unfit or unusable sources, as these are located in the areas where there is no water (12%) or with very poor quality of water (11%). Each hand pump (India Mark II) costs about Rs 44,000 and more than half of them are under repair at any point of time in the year, as reflected in the number of pumps repaired every year. The number of pumps installed is increasing every year, reaching a peak during 2003–04

[5] It is estimated that the actual water use for domestic consumption is between 15–20 lpcd irrespective of water availability (see Reddy, 1999).

(18,087). Hand pumps are supposed to be maintained by the panchayats through hand pump *mistries* (repair persons) (HPMs). There are about 2,350 HPMs located in the villages to repair and maintain the pumps regularly. Maintenance is carried out by Panchayat Samithis in 22 districts of the state, and by PHED in the remaining 10 desert districts in a campaign mode (PHED, 2004).

There are no clear or enshrined rules in the state that address the smooth transfer of water across sectors, regions and users. However, policy guidelines exist that indicate highest priority to drinking water followed by irrigation and other uses. Some argue that water used for livelihood purposes should be given priority over irrigation (Tarun, 2000). The main source of conflict is often the transfer of water to urban areas, since urban areas are given high priority in supplying drinking water and other amenities. In the absence of any clear understanding and proper compensation for the water transfers, conflicts arise and resolution mechanisms are often very adhoc, depending on the situation, as there is no agreed conflict resolution process in the state.

4.1.2. Urban water supply. In the case of urban drinking water, all the 222 towns are covered with treated piped water from 124 schemes. Of these schemes 14 are based on surface water, 54 are based on both surface and groundwater and the remaining 156 schemes are entirely dependent on groundwater. Uncertainty in the availability of groundwater, quality as well as quantity, makes urban water supplies as precarious as the rural ones. As per the latest figures, 86% of households and 83% of the population are covered by the house service connections in the state. The population covered through service connections has increased marginally from 78.5% during 1991 (Reddy, 1996). The remaining population mainly depend on stand posts. While this appears impressive, the actual service delivery is rather poor. At the aggregate (state) level the demand for water (1,803.84 million litres/day (MLD)) outstrips the installed capacities (1,798.91 MLD) and production or supply of water (1,475.71 MLD)[6]. The demand supply gap is as high as 57% when WHO norms are used for estimating the demand (Reddy, 1996). The situation is more precarious at the town level where the shortage levels could be very high in some towns.

Average supply of water through house connections is above 100 lpcd; through stand posts it is 39 lpcd. It is important to remember that these are gross supply figures and therefore need to be adjusted for supply losses, which are in the range of 40–50% in Rajasthan. The effective or net per capita water supplies are much below the urban standards of drinking water supply. Data on the coverage status of piped water supply in various towns reflects the situation of scarcity in urban Rajasthan. Only 14% of the towns are fully covered while 51% of the towns are in need of extension network as well as supply augmentation. In comparison to the situation in 1991, the proportion of fully covered towns has gone up substantially (from 1 to 14%) but absolute scarcity has increased considerably. Absolute scarcity (requiring supply augmentation) was observed in 51% of towns in 2003, as against 37% of towns during 1991.

The urban sanitation situation is somewhat better when compared to rural sanitation. At the state level, 25.5% of households do not have access to sanitation facilities, which is on a par with India's national average. Most urban areas do not have proper sewerage facilities, which are often limited to new colonies in most of the cities.

The condition of the urban water infrastructure is aptly reflected in the extent of losses that range anywhere between 40 and 60%, with more than 60% of these losses being due to technical reasons (leaking pipes, poor quality construction of storage, improper installation of machinery, etc).

[6] Based on data provided by the Chief-Engineer, Urban, PHED. This is based on office records.

It is claimed that all house connections in urban areas are metered but the quality of their functioning is poor, as a substantial proportion of them are often out of order. Given the present quality of the infrastructure, it is estimated that an investment of Rs 2,500 per house connection is required to address the problem of technical losses. Hand pumps are also installed in a number of urban locations, especially in slums, and their physical condition is akin to that of the rural hand pumps.

4.1.3. Irrigation water supply. The irrigation sector is the major consumer of water in the state, accounting for 83% of the total available water. Agriculture is the main sector providing 30% of the GDP, supporting 77% of the population and providing employment for 70% of the workforce. Irrigated agriculture contributes more than 50% of agricultural output. As in the case of drinking water, dependency on groundwater for irrigation is also high at 70%. The situation is equally bad in the case of surface irrigation. The potential of surface irrigation created through major, medium and minor projects has gone up from 0.4 million hectares in 1950 to 3.1 million hectares in 2004[7], but the gap between potential created and actual use has risen over the years. Infact, between 1985–86 and 2001–02, while the potential increased from 2.4 to 3.1 million hectares, utilisation only increased from 1.5 million hectares to around 2.0 million hectares. This situation has increased the pressure on groundwater further. In 13 of the 32 districts, the proportion of area under irrigation is less than 33%[8] (state average); the dependence on groundwater is more than 70% (state average) in 22 districts while 11 districts depend entirely on groundwater. This makes the future scenario grim in the absence of judicious management of water resources in the state.

It is estimated that the ultimate irrigation potential of the state is 5.1 million hectares, of which 3.1 million hectare potential is already created. While groundwater is fully exploited at the aggregate level, the existing irrigation gap is of 2 million hectares. Another way of looking at the gap is the difference between the normative irrigation[9] (33%) and the actual irrigation in the 13 districts that are lagging behind.

Irrigation development in Rajasthan is plagued by quality problems, not only because of greater dependence on groundwater but also due to improper maintenance/management of surface systems. In most of the regions, groundwater is saline. Farmers use saline water for irrigation. Large tracts of land in the surface irrigation systems are water logged and saline. This is mainly due to flood irrigation not being suitable for sandy and sandy-loam soils. Another reason is the seepage from the distributory (canal) systems.

The quality of the irrigation infrastructure, especially the distributory system, is poor and the extent of losses is in the range of 60%. A substantial portion of these losses is technical. Most of the distributory systems need canal lining. Often these canals are either not fully lined or characterised by poor quality lining. Moreover, these systems are not maintained properly resulting in wastages and water-logging in head reaches and water scarcity in the tail ends.

Of late, there is growing concern that conflicts may arise between upstream and downstream water users, or between users of existing irrigation systems and new structures (often small) in the catchments.

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[7] During this period the number of major and medium projects have gone up from 43 to 109 and minor projects from 2,272 to 4,890 (Dept. of Irrigation, GoR office records).

[8] As per the agriculture commission 1976, the area under irrigation should be at least 33% in order to make agriculture sustainable. Rajasthan is at the margin in this regard.

[9] As suggested by the Report of the Agriculture Commission, Ministry of Agriculture, Government of India, New Delhi (1976).

It is observed that downstream regions are receiving lower flows and well recharge due to the construction of water harvesting structures in the upstream regions (Ray & Mahendra, 2005). There is concern that these structures may reduce the reservoir inflows of the large irrigation systems. This could be a potential source of future conflicts, and there are no institutional mechanisms in place to address or resolve these conflicts.

4.2. Financial performance

Two indicators, namely investment gap and financial gap, are considered to assess the financial performance. Investment gap is measured in terms of actual investments in the sector against the required investments in order to achieve the objectives. Financial gap is measured as the difference between expenditure on and recovery from the sector. It is estimated that the investment gap in the irrigation sector is Rs 2,000 million per annum, as the required funds are Rs 8,500 million against available funds of Rs 6,500 million presently. In the case of water harvesting structures, it is estimated that 47,698 structures at a total cost of Rs 20,476 million are required; infact, 16,803 structures were completed by 2002 at a cost of Rs 3,680 million. In the case of soil and water conservation, the gap is Rs 4,000 million, as the available funds are placed at Rs 6,000 million, against required funding of Rs 10,000 million. But, no estimates are available in the case of drinking water where the investment gap could be substantial if the objective is the provision of safe and assured drinking water to all within a distance of 0.5 km from their homes. For instance, reducing the distribution losses in urban areas, for which there is no provision presently, would require Rs 3,803 million[10]. In the context of severe water scarcity, development of new water sources would be very expensive.

And the expenditure gap is as high as above 80%, which appears to be rising, when the entire water sector is considered (Table 2). The gap is more in the case of the irrigation sector when compared to water supply and sanitation and to groundwater. Within the drinking water sector, urban water is performing better for obvious reasons. Revenues from groundwater are mainly from the rental charges of their drilling equipment, which are charged at market rates; hence, recoveries appear to be better. And no user charges are levied in the case of soil conservation works and groundwater use. While the high expenditure gap in the case of irrigation is clearly not justifiable, the gap in the case of water supply and sanitation is only partially justifiable. For, while in most of the rural areas water is supplied on a community basis with limited emphasis on quality, urban area water is fully treated and supplied to the individual households. In the case of urban areas the rationale for supplying treated piped water at subsidised prices is weak.

4.3. Economic performance

Price gap and scarcity, or incentive, gap are the two indicators of economic performance of the sector. Price gap is measured in terms of the difference between the supply costs and actual price charged. The difference between the O&M costs and the revenue from user charges is also used here, as covering O&M charges in itself is an efficiency indicator in most developing countries. Scarcity or incentive gap

[10] This is rough estimate based on figures given by the PHED i.e. Rs 2,500 for each connection. There were 1,521,347 house connections as at 2004.

Table 2. Expenditure gap in the water sector (Rs, in millions).

Year	Irrigation	WS & S Total	WS & S Rural	WS & S Urban	Soil and water conservation	Groundwater	Total
Expenditure							
2001–02	3,367.2	6,772.51	2,765.9	4,006.61	747.9	366.7	18,026.82
2002–03	3,922.9	7,098.64	2,993.95	4,104.69	192.8	371	18,683.98
2003–04	9,164.47	7,302.35	3,075.2	4,227.1	224.4	421.2	24,414.72
Revenue							
2001–02	226.8	1,245.92	234.17	1,011.75	–	267.3	2,985.94
2002–03	238.5	1,275.93	240.12	1,035.81	–	182.3	2,972.66
2003–04	235.6	1,295.71	253.51	1,042.2	–	227.7	3,054.72
Expenditure gap (% of excess expenditure)							
2001–02	93.26	81.60	91.53	74.75	–	27.11	83.44
2002–03	93.92	82.03	91.98	74.77	–	50.86	84.09
2003–04	97.43	82.26	91.76	75.34	–	45.94	87.49

Source: Estimated, based on data provided by the Irrigation Department, PHED and budget documents; WS & S: Water supply and sanitation.

is the difference between the scarcity value of water and the actual value of water. We are not in a position to estimate the scarcity gap here, as we do not have information on the scarcity value of water. The estimates of willingness to pay (WTP) for irrigation and drinking (rural and urban) water (Reddy, 1995), which are expected to reflect the scarcity value of water, can be used in this regard. But, the estimates reveal that, though WTP is substantially higher in all the contexts, they do not come close to covering O&M costs fully.

In the case of irrigation, the price gap is the difference between the O&M costs and the actual prices charged; in the case of water supply and sanitation costs, these include the production, treatment and distribution charges. In the case of water supply and sanitation, we take O&M as well as supply costs that are available in a few cases. The O&M costs of surface irrigation are about Rs 642 per hectare while irrigation prices range between Rs 75 and Rs 290 per hectare depending on the crop and its water requirement[11]. The price gap is more than Rs 400 per ha if an average price of Rs 200 per hectare is assumed. In the case of drinking water and sanitation, the gap ranges between 55% in Kota and 89% in Udaipur (Table 3). Supply costs mainly depend on the source of water supply. For instance, Kota gets its water supply from the Chambal project and hence its supply costs are the lowest. Added to this is the poor recovery of O&M costs. Recoveries are less than 10% in the case of major and medium irrigation and rural water supply, while the recoveries are high, though less than 40%, in the case of urban water supply and minor irrigation (Figure 3).

Note that present allocations towards O&M are inadequate, as a substantial share in this goes towards establishment and power charges. For instance, in the case of irrigation systems only 20% of O&M is allocated towards maintaining the distributories and another 15% towards managing drainage systems in the case of large systems. In the case of urban water supplies, more than 90% of O&M goes towards power charges and salaries. There is felt to be a need for increasing allocations for works.

[11] Water rates were last revised in May 1999. Now there is a proposal to change.

Table 3. Price gap for water supply and sanitation.

City	Supply cost (Rs/KL)	Price (Rs/KL)	Price gap (%)*
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

* The Price gap is estimated by taking the average price (average of the range given in column 3) and would be much less for commercial and industrial uses.
KL: Kilolitres.

4.4. Equity performance

Equity between regions, equity between sectors and equity between groups are taken in to account while assessing equity performance. Regional differences are seen in terms of geographical locations i.e. between districts or regions and between rural and urban locations. Irrigation, drinking water and industry are the main sectors that use water in Rajasthan and allocations across these sectors are considered for assessing the equity between sectors. Differences between rich and poor as well as gender groups are examined in terms of equity between groups.

In terms of levels of rural water supply, the southern region fares best, followed by the northern, eastern and western regions. The western region is the desert region where average rainfall is very low. In the case of quality of water, the western region has the highest incidence of fluoride and chemical (nitrate, salinity, etc) contamination (Rathore, 2004). On the other hand, the western region also has the widest coverage of piped water supply (mainly regional schemes), followed by the north-eastern and southern regions. Dependence on hand pumps is very high at 91% in the southern region and 71% in north-eastern region. In urban areas, the coverage of house connections range from 100% in the towns of the Churu and Jhunjunu districts, to as low as 22% in the Kota district. On the other hand, water shortages are highest in Sawai Madhopur (83%) and Bharatpur (72%), while Dungarpur has the least shortages when WHO norms are applied for estimating the water demand. Similarly, regional differences are substantial even in the case of groundwater development and extent of irrigation.

Between rural and urban locations, there is a clear urban bias in the provision of tap water. While 80% of urban households have access to tap water, only 21.6% have that access in rural areas. The average supply of water is above 100 lpcd in urban areas as against 39 lpcd in rural areas. In urban Rajasthan,

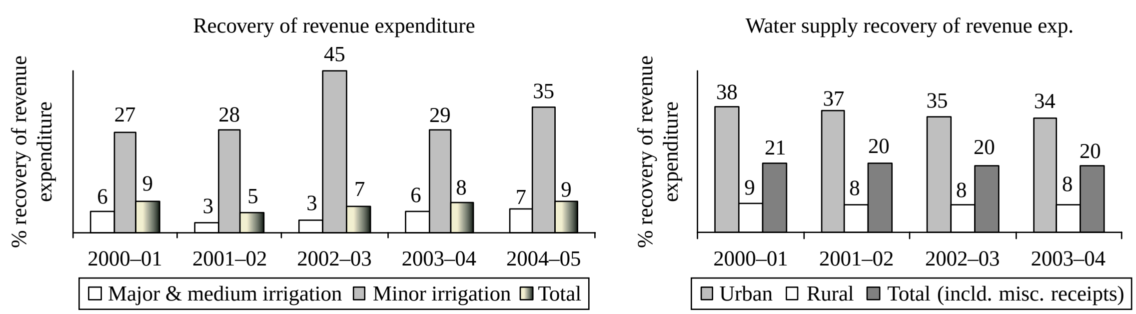

Fig. 3. Cost recovery in irrigation (left) and drinking water supply (right).

87% of households have a water source within the dwelling while the figure is 61% in rural Rajasthan. In the case of other sources, the rural-urban disparities in distance between source and dwellings are not substantial (Rathore, 2004).

Sectoral allocation of water is estimated at 83% for agriculture and 17% towards non-agriculture sectors. As estimated in an earlier study (Reddy, 1996), drinking water accounts for 95% of the non-irrigation water while industry accounts for the rest. In the absence of water productivity estimates across sectors it is difficult to say how efficiently water is allocated between the sectors. In terms of priorities, there is a need for allocating more water for drinking purposes, especially in the villages in order to cope with the severe shortages. It is envisaged (in the chief minister's vision statement) that water use in agriculture should be brought down from 83% to 70% in the coming years (GoR, Draft Report of the Irrigation sub-group, 2002).

Differences between rich and poor, especially in urban areas, are substantial. In urban areas the bias towards rich is of serious concern, as 97% of the highest expenditure groups have access to tap water, while only 58% of the lowest expenditure group have access[12]. The rich–poor differences are marginal in rural areas, 28% of highest expenditure groups as against 23% of the lowest expenditure group having access to tap water.

The higher income urban households use a major share of the subsidised tap water. In most of the urban areas, stand posts or hand pumps are provided for slum dwellers. The low per capita water supply through stand posts is often far below the prescribed norm and aggravates the already existing subhuman conditions in the slums. On the other hand, hand pumps involve drudgery. The situation during summer months is appalling with serpentine queues for collecting water from stand posts. And the dwindling groundwater tables make life miserable for the hand pump users. This inequitable distribution of water is a sign of socially inefficient allocation and wastage of scarce resources. This aggravates the disparities in the standards of living between the poor and the well off sections of society. Moreover, the rich bias does not justify the huge subsidies towards urban water supply.

5. Assessing the water sector policy

5.1. Sector policy

The state of Rajasthan has a Water Policy (GOR, 2003) that was approved by the state chief minister and placed before the cabinet. Rajasthan has a history of bringing out water policy documents preceded by India-wide national water policies (NWP), as happened in 1988 after the 1987 NWP, in 1999 after the 1998 NWP, and in 2003 after the 2002 NWP. The 1999 Water Policy was approved by the state cabinet. Often these policies are adopted straight away from the NWP without any modifications to address state-specific problems. But the 2003 State Water Policy was modified in view of state-specific water problems. It took inputs and suggestions from various link departments such as irrigation, PHED and groundwater. On paper, it was very comprehensive in terms of objectives, coverage of pertinent

[12] The latest NSS 54th round (NSS, 1999) does not provide information across income groups. However, analysis based on NSS 42nd round provides some insights (Reddy, 1996).

issues and identification of problem areas and suggesting solutions. The policy document addressed all the problems that have been discussed in the water sector assessment in the previous section of this paper.

The irrigation department prepared a master plan for water-harvesting structures based on remote sensing and a field survey. According to this plan, more than 47,000 structures were to be built at a cost of over 20,000 million. Similarly, the state groundwater department prepared a plan for 299 rainwater recharge structures at a cost of Rs 229 millions. However, no time frame or budget allocations were made for these plans. The respective departments prepared vision documents identifying the priority issues, though no action plans were provided.

Draft groundwater legislation was also in circulation for comments and improvements, though the commitment of the government to bring the legislation was not clear. Though the draft bill was in circulation since 1997 the state was not able to muster the courage to enact it. The perception was that enacting of this bill could spell political disaster. Recent and ongoing initiatives of the NGOs in the state pushed the state towards building consensus and awareness among people before introducing the bill. This is a long-term process. On the other hand, the experiences of various states that have enacted groundwater legislation indicate a lack of commitment in implementation. In the absence of proper implementation there is no use in passing the act. And none of the acts, including the draft groundwater bill in Rajasthan, address the issue of equity. Equity is the major concern in groundwater use, as groundwater is found to be privy to large and medium farmers, depriving access to small and marginal farmers. This is due to a lack of clarity on the use rights of groundwater. Groundwater use rights are given to land owners as per the Easement act, 1882. At the same time, groundwater is termed a common pool resource in the policy discourse.

The absence of clear rights assumes serious proportions in the case of groundwater, where *de jure* and *de facto* rights are different. Landowners do not have any obligations whatsoever in extracting as much water lying beneath their land as they want. Legally, landowners do not have any rights to the underground resources, including water. This has led to iniquitous distribution of water across farms, often depriving the marginal and small farmers who can't invest as much as their counterparts on water extraction. The inequalities tend to aggravate as the resources degrade due to over exploitation by a few farmers. In the absence of rights and obligations, groundwater exploitation is pushing the resource degradation to irreversible levels in most parts of the state, and well failure has become a common phenomenon in many parts of the country, which is one of the main reasons for the looming agrarian crisis in the country.

The ultimate solution to the problem of resource degradation and iniquitous distribution is to treat water resources, surface as well groundwater, as common pool resources in the true sense of the term. Water rights should be equally distributed irrespective of their location in the river basins or sub-surface aquifers. This would mean effective abolition of riparian rights. Similarly, de-linking of water rights from land rights would make groundwater a real common resource. Institutional arrangements should be evolved in order to reduce conflicts in resource sharing. Experience clearly indicates that regulation not only leads to high transaction costs of implementation, but also fails to ensure equity in the distribution of the resource. Water resources, therefore, should be brought under management regime rather than following regulatory mechanisms. Therefore, efforts should be diverted towards bringing consensus for moving towards equitable distribution of water resources. In the absence of equity in access to water, achieving the objective of poverty reduction in agrarian states like Rajasthan would be a distant dream.

5.2. Role of government in the sector: an economic framework

5.2.1. The market management role. The ultimate aim of the Water Policy is to take full control of the water resources in the state. This is a step towards establishing clear property rights for water. While it is easier to establish rights over water, it involves huge transaction costs to protect the rights. Institutional mechanisms at various levels are necessary to reduce the transaction costs of protecting property rights. No clear and standard guidelines are provided in the policy. On one hand, institutional arrangements involving user communities are initiated for the management of surface systems. On the other, groundwater management is being brought (proposed) under the regulatory mechanism of the state. There is no indication of involving local communities in the management of groundwater. Integrated management of ground and surface sources is crucial for sustainable resource management. Regulation is neither efficient (due to high transaction costs) nor it can ensure equitable distribution of water. There is also a need for making a distinction in the management regimes of drinking water and irrigation water. It can be argued that while user groups would be in a better position to manage irrigation, drinking water ought to be managed by village panchayats and with the help of women; drinking water is the concern of everybody in the village.

The Water Policy refers to private sector involvement in the water sector but does not provide any regulatory framework for such an involvement. The Water Policy also refers to establishing a water regulatory board. Only such a regulatory authority can provide and implement a regulatory framework for private sector participation. In the context of the resource constraints there is a need for exploring possible public–private partnership avenues, especially in the drinking water sector. Drinking water norms (quality and access) are set as per WHO norms, though the quality standards are relaxed due to severe scarcity conditions in the state. In order to address all these legal issues, a comprehensive water law needs to be in place. This would make the Water Policy effective.

5.2.2. Economic management. A range of other policies influence water sector and water management. The most important among these include power tariff pricing (which greatly influences irrigation levels), the guaranteed purchasing scheme for rice and wheat, agricultural subsidies and protection. These policies greatly influence the ways in which the benefits (and especially the extra water available) from water sector development flow.

While water policies strive to improve the economic efficiency of water, agricultural price policies tend to promote inefficient water use practices. A case in point is the support price mechanism, especially for wheat and paddy, which encourages the farmers to grow more of these crops through keeping their prices artificially high. This results in excessive and inefficient use of water resources. More value addition could be achieved through the reallocation of water to other less water-hungry crops. This would also facilitate more equitable distribution of the resource. Similarly, in the case of groundwater, the policy of a subsidised power tariff structure for agriculture is resulting in the widespread degradation of the resources. There are no policies, except for some regulatory ones linked with institutional credit dealing with groundwater, despite the fact that groundwater is the single largest source of irrigation in the state. Groundwater is conspicuously missing in the recent water user association (WUA) legislation. These different policies are set and administered by different branches of government than those responsible for water, reflecting the problems that come from institutional fragmentation.

Also, in the case of adoption of technologies, there is a need for policy coordination at different levels. It is evident that technological factors can play a major role in reducing water demand. Proper policies, legislations and institutions should foster technological developments. For, unless there are disincentives, such as pricing, for not adopting these technologies, they may not be successful. Alternatively, their adoption should be made mandatory. Legislation can also help in streamlining the supply of technological devices in a desired fashion, i.e. permitting the manufacture of certain models. Most of these devices need little convincing at the consumer level as they are water and energy saving and hence cost-effective in the long run, provided judicious pricing policies are followed (getting the prices right). Therefore, the stress should be at the manufacturing level, that is, through discouraging the production of conventional devices and encouraging modern devices. Adoption of water-saving devices would automatically take place once proper pricing policies are followed.

5.2.3. Correcting for market failure. Water is a common pool resource and hence characterised with the problems associated with market failures. First of all, water is a public good *de jure*. Except groundwater, all other water resources are developed and provided by the state. Groundwater development *de facto* is largely developed as a private good. Water resource use has positive as well as negative externalities associated with it[13]. It also gives monopoly power on the resource, especially in groundwater development, to those who can invest in water extraction technologies. Again, in the case of groundwater, information on its availability is imperfect. Together they result in widespread market failures ultimately leading to resource degradation.

One key and missing aspect that can address the market failure, to a large extent, is the emphasis on demand management. Demand management includes conservation of water, enhancing the productivity of water, etc., through following appropriate price policies and adopting technologies fostered with suitable legislations and institutions. Often, pricing policies are thwarted by the excuse of a lack of willingness to pay for basic amenities. Contrary to this general belief, households are willing to pay substantially higher prices (double the present price) for improved water supplies in case of domestic as well as irrigation water (Reddy, 1996). Therefore, willingness to pay is not a bottleneck for charging higher prices. In fact, it is willingness to charge which is the main obstacle. But, it should be noted that higher willingness is contingent upon better service delivery, be it irrigation or drinking water. At the same time, pricing should reflect the efficiency rather than the inefficiencies in the delivery system. Often, prices are hiked without improving the efficiency of the systems. As a result consumers end up paying for inefficiencies rather than for better service (for instance, transmission losses and theft of water are the main reasons for higher provision costs). More importantly, one should link the willingness to pay with ability to pay in the case of drinking water. In contrast to the general assumptions that households are willing to pay about 5% of their consumption towards water, in reality households' willingness to pay is less than 3% of their consumption in Rajasthan (Reddy, 1996).

5.2.4. Intervention for social objectives. Achieving the social objective of equity has been a daunting task of Indian planning. Rajasthan is no exception. There is a need to protect the interests of the disadvantaged sections of the community, such as landless families, the landed poor, women, etc. The most pressing issue is regarding access to water, to all sections of the community. Access to water can be

[13] For instance, groundwater over exploitation by one may affect the water levels in the nearby wells: a negative externality; development of a recharge structure by an individual may result in groundwater recharge in the neighbour's well: a positive externality.

ensured only through delinking water rights from land rights fostered with clearly defined property rights on water. This requires an appropriate legal framework and effective institutional arrangements. Though this dimension is often brushed away at the policy level by terming it as a difficult task, there is a need to make a beginning in this direction. For, this is not an impossible task given the experiences within India (e.g. pani panchayat in Maharastra) as well as elsewhere (South Africa, Mexico, Australia, etc.). Though it is not easy to do it in the short run, the current policy should lay the foundation for proceeding in this direction and achieving the ultimate goal.

6. Sustainable water resource management: future options

The main water concern of Rajasthan is dealing with severe scarcity. Improving the water situation in the state is a policy imperative in the short, medium and long terms. It has come out clearly from our analysis that the only possibility of enhancing water resources in the state is from surface sources—through inter-basin transfers and development of the state's own river basins[14]. This option is long-term and expensive. Short- and medium-term solutions lie in stabilising the existing water resources and efficient use of these resources. In what follows is a detailed discussion on the strategies broadly grouped under (a) groundwater stabilisation and management, (b) demand management, and (c) institutional approaches.

6.1. Groundwater stabilisation and management

Groundwater exploitation in the state has been stretched beyond its limits. Exploitation rates crossed 100% in 50% of the districts. Unless these trends are checked, groundwater may become extinct in the short- to medium-run in these districts. Realising the urgency, the state has initiated a massive programme of recharging structures across the state. Having an integrated, instead of an isolated, approach to groundwater development/exploitation, with surface water bodies like tanks and canals, is a must. These two sources of water should be treated as complements rather than substitutes. As well as this, there is an enormous natural capital of traditional water harvesting structures that lay idle, in the absence of proper maintenance, across the breadth and width of the state. These structures need to be revived and followed up with appropriate institutional arrangements for managing them in a sustainable manner.

6.2. Demand management

Demand management is the most cost effective option for enhancing water availability through promotion of water use efficiency. Important strategies or measures in this regard include: (i) Market/pricing/economic measures; (ii) technologies; and (iii) institutions. Note that these strategies may not be effective on their own and hence they call for a judicious mix of these measures, for effective

[14] The latest being the Bisalpur water project which is being taken up with the financial support from the Asian Development Bank (Rs 5,560 million). The works are expected to start in August 2005 (Hindustan Times, Daily New paper, Jaipur, 22 February).

implementation of pricing strategies requires appropriate institutional arrangements. Sustainability of institutions is often critically linked with the integration of market principles into the institutional arrangements. Similarly, incentive and disincentive structures such as pricing of resources and subsidising the technologies help to fast track the adoption of technology.

6.3. Institutional approaches

Institutional factors are considered the key for improving the efficiency of distribution systems. Moreover, to shift towards demand management (through pricing and technological variables), institutional arrangements ought to be in place. For, mere increase in the price of water may not result in financial sustainability of the systems unless and until the pricing policies are backed by institutions to recover the charges (Reddy, 1999). It is often argued that the reason for the ills of irrigation management is the alienation of farmers/beneficiaries from the process of planning and implementation. Maintenance and management of irrigation systems through user societies and participatory process is expected to bring in efficient and equal distribution of water resources (Sengupta, 1991; Mitra, 1992).

Hitherto, institutional reforms in the water sector have focused on surface irrigation systems at the farmer or user level. Such an exclusive focus often results in conflicts between user groups and the line departments, and also between different users. These conflicts can be minimised if the reforms are addressed at different levels e.g., user, irrigation departments and political entrepreneurs whose support and willingness to reform is the starting point of any reforms. Though simultaneous reforms are desirable, the order of initiation could play an important role. In the case of canal irrigation systems, initiation of reforms at the political and bureaucratic levels are crucial for devolving powers to WUAs. In the case of groundwater, the reform process should start at the farmer level, as some of them may lose their monopoly power on water. There is need for awareness building at the farmer level in order to facilitate sharing.

7. Conclusions

The assessment of water sector performance under scarcity conditions in Rajasthan brought out clearly that no indicator has shown satisfactory performance in any of the sub-sectors. Though the urban drinking water sector performs relatively better, a lot more is needed in order to bring it to the threshold level of economic and financial performance. The huge expenditures incurred in this sector are not going towards real investments that would improve the performance of the sector. In all the sub-sectors more than 80% of the expenditure is being spent on salaries and establishment charges. Despite the fact that the water sector is in the hands of the government (except for groundwater), equity goals are not achieved. An urban and rich bias is prevalent as far as access to water and public distribution of water is concerned. As a result, the poor do not enjoy water subsidies that are meant for them.

It is often presumed that performance of the sector increases under conditions of water scarcity. This does not seem to hold good in the context of Rajasthan, especially in an absolute sense. At the same time, the performance does not appear to be any worse in Rajasthan when compared with the experience of other states, or at the all-India level. In fact, Rajasthan is one of few states that have a water policy document. At the same time, water policies are not converted in to effective action plans. The proposed institutional reforms are neither comprehensive nor integrative in terms of achieving sustainable resource management and equity. Decentralisation at the grass roots level is at nascent state in Rajasthan, though devolution powers to village panchayats in the provision of drinking water is critical for a better service delivery in rural areas.

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