Water Institutions And Access To Drinking Water

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EXECUTIVE SUMMARY

Improving access to safe drinking water in India is one of the major social development challenges. Water scarcity and conflicts between various uses are already a reality in some parts of India. The extent to which drinking water requirements will be protected from competing demands will depend on the nature of institutions that mediate water demands from various sectors. The objective of this study was to examine whether the prevailing water institutions can protect drinking water. The study involved literature review and case study of Ghataprabha sub-basin in northern Karnataka, where the conditions can be characterized as being semi-arid. The case study focused on understanding how various institutions govern water utilization.

Water is utilized in the sub-basin for agriculture, power generation, industrial production and to meet domestic and livestock needs. Municipal wastes are also disposed off through water bodies. The major source of water is the Ghataprabha river, the flows of which are harnessed by a publicly managed irrigation system and numerous barrages maintained by communities. Private wells extract groundwater primarily for agriculture. As the publicly managed system provides irrigation only during kharif and rabi seasons, groundwater is the major source of irrigation during summer for sugarcane, an important cash crop. Sugar processing is the major industry in the sub-basin. Two other industries located near urban areas, an aluminum plant and a cement factory, are supplied surface water by the organization that supplies water to urban areas for domestic consumption. Cane processing plants located in rural areas draw water from rivers or pump up groundwater. There are three power plants, one supplying power to the grid, and the other two small units generating power for a private textile plant. The use of water for power generation doesn't conflict with other uses. Groundwater is the source for more than 90 percent of the rural water supply schemes. Systems that supply small and large towns, and even some villages, depend on river flows.

A large number of organizations are engaged in activities that are related to water management. However, integrated planning and management is lacking, as ground and surface water are handled by different organizations. The management of surface systems alone comes under two different ministries. Water quality maintenance falls outside the purview of mainstream water resource management organizations.

The allocation of water in the publicly managed irrigation system is driven by government's stated priorities for using water. The priorities are in the order of drinking

water, irrigation, aquaculture, followed by industries with higher priority for agro-industries. As drinking water requirements are only a small portion of water that becomes available in the system, meeting them usually doesn't require significant tradeoffs. However, drinking water needs arise in summer precisely when there may be little water stored in the reservoir. Water supply to a town during a recent dry summer resulted in conflict with farmers who would have liked to use the same water for irrigating their sugarcane. Growing urban areas are becoming increasingly dependent on surface water sources, with the result that small surface irrigation systems may become drinking water systems.

Rural drinking water systems face competition from agriculture. Nearly all the habitations in the sub-basin have safe drinking water sources, but nearly 40 percent of them experience seasonal water shortages because of decline in groundwater tables that can be attributed to the agricultural sector. Depletion of groundwater is threatening the viability of drinking water systems.

Pollution is another threat to safe drinking water. The major source of water pollution in the sub-basin was municipal discharges into rivers. Lack of sanitation in rural areas also result in pollution of water bodies that would otherwise be used for domestic purposes.

Protecting drinking water is closely tied to the larger challenge of improving governance of water resources, an important objective of which is to maintain quality to support various uses. Institutions are necessary to introduce incentive to conserve water in its various uses and also facilitate allocation of water between various uses to meet the social objectives. The challenge is to develop a set of institutions that provide access to water to meet the basic needs and at the same time facilitate movement of water to higher valued uses.

Water allocations between sectors now take place through different mechanisms in ground and surface water. The rights of landowners to water beneath their land, and ineffectiveness of groundwater control measures enable all landowners to extract groundwater. When utilization exceeds annual recharge, those with deeper wells and superior extraction mechanisms deprive others. Typically, drinking water systems are affected. Surface water in publicly managed surface systems and rivers, on the other hand, is allocated through administrative mechanisms that are guided by policies. As policies place the highest priority on meeting drinking water needs, in times of scarcity they would be met even at the cost of depriving water to other users. Weak controls on pollution, however, continue to threaten drinking water.

Urbanization is likely to increase dependence on surface sources such as irrigation systems for drinking. Inter-sectoral allocations will increasingly take place through administrative and political processes in the absence of market mechanisms. Surface drinking sources may be better protected than groundwater sources. However, many of the surface sources themselves may be threatened by groundwater depletion. Bringing about sustainable use of groundwater on which the bulk of the rural population depends will be more challenging. In addition, pollution control and perhaps, greater investment s in sanitation and sewage treatments would be necessary to protect drinking water sources.

There appears to be greater political commitment to protecting drinking water compared to introducing general controls on groundwater extraction if legislation introduced by Governments of Maharastra and Karnataka are any indication. The Karnataka bill gives “appropriate authorities” the right to prevent digging of new wells and even close wells that interfere with drinking water sources. There is potential for effective implementation of this legislation as doesn’t affect all private wells and those affected by well closures are compensated. The political commitment, however, will be tested with the implementation of this legislation.

I INTRODUCTION AND OBJECTIVES OF THE STUDY

Providing access to safe drinking water for the population is one of the more difficult social development challenges for India. Limited access to safe drinking water is a major cause of poor health conditions accounting for bulk of the infant deaths. Nearly a million children in India die of diarrheal diseases each year as a result of drinking unsafe water and living under unhygienic conditions (UNICEF). An estimated 45 million people are affected by water quality problems caused by pollution, excess fluoride, arsenic, iron and ingress of salt water. Close to 90 percent of the habitations in the country are estimated to have safe drinking water facilities, but a smaller percent of the population is likely to have year round access to safe drinking water. Improving access to drinking water will be particularly challenging just as inter-sectoral conflict for water is increasing in the country.

Water conflicts have already emerged in some parts of the country. It is estimated that by 2025, around a third of the population of India is expected to face absolute water scarcity, defined as not having sufficient water resources to maintain 1990 levels of per capita food production from irrigated agriculture and also meeting the needs of domestic and industrial sectors (Seckler et al.1998). For India as a whole, water withdrawals are estimated to increase only by about 15 per cent between 1990 and 2025. Though water availability in the aggregate is adequate, because of regional differences some areas will face scarcity (Iyer 2001). By 2025, water will be scarce in 11 of 20 major river basins (World Bank 1998b). Attempts to meet urban water demands, for example, particularly by expanding supplies – moving from ponds and other sources within or close to urban areas to distant sources – are likely to lead to serious inter-sectoral water allocation conflicts (Saleth & Dinar 1997).

Water crisis in India is manifesting in the form of severe depletion of groundwater aquifers and water pollution (Seckler et al. 1998; World Bank 1998b). Groundwater extraction in India is estimated to exceed recharge by a factor of two or more. In many parts of the country aquifer levels are going down by 1 to 3 meters per year. As groundwater flows slowly through recharge areas to keep rivers from drying up when water is scarce, receding aquifers dry up surface sources such as lakes and rivers affecting fresh water supplies to villages. Aquifer draw down and pollution are major threats to maintaining growth in food production and safeguarding availability of safe drinking water.

How conflicts are managed through technological and institutional innovations will have significant bearing on access to water that the poor will have to meet their livelihood needs. Despite the apparent emphasis policies place on ensuring adequate safe drinking water to rural and urban communities, the domestic sector may be the biggest loser in the competition for water, and both rural and urban poor are likely to be affected by deterioration in quantity and quality of water supplies. Water crisis in general may be more threatening to the drinking water sector than other users for many reasons. First, the quality of water needed for drinking is usually much higher than in other sectors, although industrial use also requires water of high quality. Second, the type of sources that are usually used to meet drinking water and livestock needs may experience physical scarcity and decline in quality before other sources. Three, the drinking water sector may lose out because of its lower willingness and ability to pay for water, particularly in rural areas. Finally, a closely related problem is that establishing and protecting rights to drinking water entails collective or public action particularly among the weakest, which may not be forthcoming in many cases. On the whole, without strong political action of the affected population, the needs of the drinking water sector may be ignored.

Institutions, rules-in-use that are inherent in customs, policies, laws and markets that determine who uses the resource and how it may be used, play an important role in how water resources are governed. Coping with scarcity requires mechanisms to improve water use efficiency in different sectors and to facilitate transfers among various demands or sectors as required (Gleick 1993). Both technological and institutional innovations are required to manage scarcity. However, institutions are a priority as social ingenuity is a precursor to technical ingenuity (Homer-Dixon 1995). These institutions also need to evolve as resource conditions change (Saleth and Dinar 1999). But there is danger of resource scarcities affecting the potential for institutional solutions to emerge if they result in social friction and intense rivalries among interest groups (Barbier and Homer-Dixon 1996; Homer-Dixon 1995).

Deficiencies in institutions that govern the water sector are central to the problems of water management in India (Saleth 1996). These deficiencies relate to both those required to encourage conservation in various uses and those required to facilitate transfers from one use to another. Farmers, the major users of water, do not have the incentive to use surface water effectively. Groundwater control measures are ineffective and are also inequitable (Dhawan 1989). Groundwater markets may promote efficiency and equity, but they also encourage aquifer depletion (Shah 1993). Incentives to conserve resources are absent in other sectors too. The challenge in water resource management is to devise institutions that provide incentives to conserve in all its uses, ensure access to water to meet the human needs as a fundamental right, and, at the same time, subject the resource to market or non-market forces that direct it to superior uses.

The objective of the study is to examine whether prevailing water institutions will protect drinking water requirements. The answer may be somewhat obvious, but the purpose is to go beyond the obvious and examine the range within which prevailing institutions may work, and specific difficulties in operationalizing policies that seek to protect water for drinking and livestock purposes. The methodology adopted is literature review and rapid-case study of an area that is a hydrological unit. As water is the responsibility of state governments, and each of them may be organized differently, discussion around a case study was thought to be useful. We selected Karnataka for logistical convenience. Ghataprabha sub-basin was chosen for the case study as it represents semi-arid conditions in southern states where inter-sectoral conflicts are likely to become apparent. Again, the purpose was to examine the potential consequences of water scarcity for the drinking water sector as part of larger processes that govern water allocation in the economy.[1] (footnote fits well in the text).

[1] This study makes the distinction between protecting drinking water sources and organizing their supply - the utility dimension that is the primary concerns of drinking water programs – the two critical elements in

The case study involved discussion with various organizations engaged in the management of different aspects of water. In addition, we collected information from key informants on access to drinking water and status of water resources in a sample of 47 villages in the sub-basin. Utilizing the list of villages obtained from district officials and the estimated drinking water availability, we categorized the villages into two groups: those that receive less than 20 lpcd, and those that receive more. A five percent sample was drawn from each group for each taluk. Within taluks, villages with various levels of proximity to the Ghataprabha river were chosen to capture geographical diversity.

In the next section, we begin with a brief discussion of the larger context in India particularly relating to commitment to meeting drinking water needs of people. Then, we present the case study beginning with a description of the area. It is followed by a description of water resources available in the sub-basin, various organizations engaged in activities related to water management, and utilization of water for various purposes and the institutions that guide water utilization. Finally, we summarize what can be learned from the case study with supporting evidence from the rest of the country.

II NATIONAL CONTEXT

Provision of safe drinking water is one of the basic services identified to achieve an acceptable level of social consumption and minimum standard of living. The level of access that the government would like to provide is defined in terms of quantity made available, proximity of source to user and water quality (GOI 1999).[2] For rural areas, the objective is to achieve a supply of 40 litres per capita per day (lpcd); for urban areas, it ranges from 70 to 125 lpcd depending on the presence of sewage systems.

In 1997, there were 61,724 habitations without any safe source of drinking water, 378,000 which were partially covered and 151,000 habitations which had quality problems such as excess fluoride, salinity, iron and arsenic etc (GOI 1997). More recent assessments suggest that of the estimated 1.4 million habitations in the country, only 12 percent are partially covered and only 22,000 or about 2 percent were not covered (WSP ?)[3] In about 15 percent of the habitations, there is water quality problem. These statistics only suggest that most of the habitations are "covered" by organized systems in the sense

improving access to drinking water. The emphasis in this paper is on the first. However, both aspects are intrinsically linked: without protection of sources, the viability of organizing water supplies will be threatened (World Bank 1998c).

[2] The objective is to achieve the following: 1) 40 litres of safe drinking water per capita per day (lpcd) for human beings; 2) additional 30 lpcd for cattle in drought prone areas; 3) one hand pump or stand post for every 250 persons; 4) a water source within the habitation or within 100 metres elevation difference in the hills; 5) drinking water defined as safe if it is free from bacteria contamination, chemical contamination viz. fluoride, iron, arsenic, nitrate, brackishness in excess or beyond permissible limits.

[3] The priorities for expanding access to drinking water are to first provide water even at less than desired levels to all the habitations, then focus on areas with quality problems, and finally to achieve desired level of supply to everyone. More explicitly, the priorities are as follows: 1) to cover "not covered areas"; 2) to fully cover partially covered areas in which habitations get less than 10 lpcd; 3) to cover all habitations with water quality problems; 4) to bring up access to 40 lpcd; 5) to provide water supply facilities for the SC, ST and landless agricultural laborers; and 6) to provide safe drinking water in every rural primary school.

that they all have safe sources and their estimated average water availability is close to higher than accepted standards. As it it becomes evident through the case study and as has been reported by other sources, coverage by a safe source does not necessarily imply that there may not be seasonal shortages or disruption of service because of lack of upkeep of systems.

Pricing and system-financing recommendations of the government suggests a policy that requires beyond meeting the basic needs, the consumers need to share the costs of water supply; supply should normally be based on the principle of effective demand, which should broadly correspond to the standard of service that the users are willing to maintain, operate and finance; and there should be capital cost recovery of 10 percent from the users in all the new drinking water supply projects aimed at increasing the service level beyond 40 lpcd (GOI 1997).

III GHATAPRABHA SUB-BASIN IN KARNATAKA

According to Government of Karnataka (GOK), there are no habitations in the state without a safe source of drinking water (GOK 2000).[4] However, as in the case of the rest of the country, people do not have year-round access to safe drinking water. About two-thirds of the state that receive less than 750 mm rain is drought prone. Drinking water supplies are becoming increasingly unreliable in semi-arid parts of the state in which there is escalating competition for water (KAWAD 2001). As a result, water selling is common in dry seasons in these areas.

Boundaries and salient features of the Sub-Basin

Ghataprabha sub-basin is in the Krishna basin, which covers an area of nearly 270,000 sq km in three states Maharastra, Karnataka and Andhra Pradesh, an area in which there is rapid development of agriculture, industry and tourism. Krishna a 1,400 km long interstate river originates in the west and drains into the Bay of Bengal. The Ghataprabha is one of the southern tributaries of the Krishna in its upper reaches. It rises from the Western Ghats in Maharastra and flows east into Karnataka. In Karntaka, it flows for 216 km through Belgaum district past Bagalkot to join Krishna in Bijapur district. The principal tributaries of Ghataprabha are Tamraparani, Hiranyakeshi and Markandeya (Map 1). (where is the map)

The total catchment of the Ghatataprabha sub-basin is 8,829 sq. km, about 20 percent of which lies in Maharastra. In Karnataka, parts of Belgaum, Bijapur and Bagalkot districts come under the sub-basin.[5] Three-quarters of the area is cultivated. The

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[4]Universal coverage has also been achieved by redefining habitations to include at least 50 families/individuals. Therefore, there may be populations without access to water in districts in which populations tend to be dispersed, living on farmsteads instead of concentrated villages.

[5] Within Karnataka, the sub-basin includes 11 thaluks either full or part in Belgaum, Bagalkot, and Bijapur districts (Belgaum, Bailhongal, Saundatti, Ramdurg, Badami, and Bagalkot on the south of the river, and Bilgi, Mudhol, Gokak, Hukkeri, and Chikkodi north of the river). Only three taluks (Bagalokot, Mudhol and Hukkeri) completely fall in the Basin area, while other taluk areas in the basin range from 80% (Belgaum) to 10% (Badami).

culturable ares in the basin is about 680,000, of which nearly 540,000 is in Karnataka. This case study focuses on the area in Karnataka in which the bulk of the water in the sub-basin is utilized. About a third of the holdings are in the range of 4 to 10 ha. One fourth of the holdings are 2-4 ha.

The sub-basin receives rain only during southwest monsoon from June to October. The bulk of the rain falls June to September with July being the wettest month. The average rainfall at various locations ranges from 539 mm to 2,810 mm. Only about 8 percent of the land is sown more than once. About 28 percent of the culturable area is irrigated or 22 percent of the geographical area of the sub-basin. Sugarcane accounts for about 35 percent of the gross area irrigated in the sub-basin. Even if all the available sources are developed, only about 40 of the cultivated land would be irrigated. As agriculture is largely dependent on rain, agricultural production varies from year to year.

Agriculture is the main occupation of the people in the sub-basin. The density of population in the sub-basin is 236 and 372 per km^2 in Karnataka and Maharastra. About 24 percent of the population was urban in 1990. About 60 percent of the population is literate with literacy somewhat lower among females (46%). Nearly thirty percent of the population is estimated to lie below the poverty line.

Organizations Engaged In Water Resources Development/Management

A number of organizations engage in water management related activities. In recent years, several organizations have been brought into monitor various aspects of water utilization and collect information required for integrated management of water resources. One way to organize these water organizations is along the lines of those that relate to surface water, groundwater, drinking water, and water quality maintenance although there is considerable overlapping, and the categorization is somewhat odd as it cuts across sources and uses.

Surface and Groundwater

Water Resources Department (WRD) has the primary responsibility for what are called as major and medium irrigation systems in the state that irrigate more than 2,000 hectares. Within this department is situated, the Karnataka Neerawari Nigam Ltd (KNNL) which is responsible for water resource management in the Krishna basin (except the Upper Krishna project), which covers nearly 62 percent of the state area. WRD comes under the ministry of Major and Medium Irrigation. There is also a Department of Minor Irrigation that is responsible for systems that irrigated smaller areas. It is housed in the WRD, but is headed by a separate Minister for Minor Irrigation. WRD controls utilization of all surface water sources particularly the rivers. The tanks that are another major source of surface water in the state are controlled by the gram pachayats, zilla pachayats or the Minor Irrigation Department, depending on the area irrigated by them. GOK has now set up an autonomous organization, Jala Samvardane Yojana Sangha to rehabilitate the tanks and hand them over to communities.

KNNL is organized along hydrological lines: staff managing parts of an irrigation system in different administrative units report to an authority that is responsible for the entire system. The minor irrigation, on the other hand, is organized along administrative boundaries. NWDA a GOI organization prepares plans for further development of surface water resources with a focus on inter-basin transfer of resources. National Institute of Hydrology, another GOI research organization, is engaged in modeling of country's water resources.

Groundwater, on the other hand, is managed by a different set of organizations. There is a state organization, Groundwater Department under the Ministry of Mines and Geology, which monitors groundwater utilization and status. GWD is organized along administrative lines with a geologist heading operations in a district. There is also a central organization, Central Groundwater Board (CGWB), with offices in state capitals.

Drinking Water

The state is responsible for organizing drinking water supplies. The central government supplements the efforts of the state through the Accelerated Rural Water Supply Programme. The Ministry of Rural Development and Panchayat Raj (RDPR) at the state level, Zilla Parishads (ZP) at district levels, and gram or town panchayats at habitation levels share the responsibility for providing access to drinking water for the rural population. ZPs implement rural water and sanitation projects. Rural Development Engineering Departments (RDED) provide technical assistance in the design and construction of systems. With the introduction of the Panchayat Raj Act of 1993, the operation and maintenance of Rural Water Supply Schemes, that is mini supply systems and borewells, has become the statutory responsibility of gram panchayats (GP). The maintenance of hand-pumps remains centralized with Taluk Panchayats. These organizations seek to supply safe drinking water to rural habitations at the rate of 55 lpcd.

Karnataka Urban Water Supply and Drainage Board (KUWS&DB) is responsible for building urban water supply systems. They usually buy water from irrigation or multi purpose reservoirs or lift water from rivers. Their mandate is to handover the systems they have built to local governments after an initial period of maintenance. But in many cases where the local governments may not be prepared to takeover administration, they continue to operate as wholesalers of water to civic bodies. KUWS&DB is an agency under the control of the Ministry of Urban Development and Municipalities. They are mandated to supply water at the rate of 70 to 135 lpcd depending on the population of the urban area.

Pollution Control

There are two sets of organizations engaged in water pollution related work: one group collects information on the status of pollution, and the other enforces regulations. Those that collect information on quality include Groundwater Department, CGWB, and RDED. The second includes State Pollution Control Board. There is no single organization with the responsibility of monitoring and controlling quality of water supplies. RDED tests water from new wells. If the water is not suitable for consumption, they may develop new sources.

Water Availability

Surface Water

The NWDA estimates that surface water available in the sub-basin is 4,039 million m^3 at 75% dependability. The estimated export from the sub-basin is 1,119 million m^3, leaving a balance of 564 million m^3 (GOI 1999a) . Surface water in this sub-basin is harnessed through the Ghataprabha irrigation system, a series of barrages across the river, river-lift systems and tanks. There are an estimated 193 tanks, 94 barrages and 40 river-lift systems in the three districts. The Ghataprabha irrigation system comprises of a dam across the river Ghataprabha at Hidkal and a weir across Hiranyakashi at Dhupdal 20 km downstream of Hidkal. The system has two main canals. The Left Bank Canal (LBC) takes off from the Dhupdal weir, and supplies water to about 162,000 ha in Belgaum and Bijapur. The right bank canal (RBC), which takes off from the Hidkal dam, will irrigate nearly 156,000 ha in Belgaum and Bijapur (Map 2).

The Ghataprabha irrigation system, which is yet to be completed, is being built in stages. In the first stage of construction that was completed in 1976, LBC was built from Dhupdal weir to irrigate an area of nearly 45,000 ha. In the second stage, the length of the canal was increased from 72 km to 109 km to irrigate an additional 100,000 ha. Hidkal dam was also constructed to store 673.54 million m^3 of water. This work was completed in 1979-80. In the third stage, the height of the dam was increased to enlarge storage to 1,443.3 million m^3. Now the construction of RBC is in progress. When the system was built, it was assumed that the bulk of the water would be used for irrigation and that drinking water and industrial needs would be met without significantly affecting irrigation commitments.

The barrages include 4 major weirs between Mudhol and Bagalkot (Mirzapur, Jalibeli, Ingalige and Anagawadi). These systems were built within the last 15 years**.** Farmers lift water stored behind these barrages through hundreds of pumps to irrigate sugarcane, which doesn't receive irrigation during summer from the Ghataprabha system.

Groundwater

Groundwater occurs in this basin under phreatic and semi-confined conditions, and it is utilized through dug and dug-cum-bore wells. NWDA estimates that the total replenishable ground water resources of the sub-basin are 892 million m^3 (GOI 1999a). Leaving 198 million m^3 for domestic and industrial uses as per the Central Ground Water Board norms, the total ground water potential available for irrigation is 694 million m^3. As the existing draft for irrigation is estimated to be only 275 million m^3, a balance of nearly 420 million m^3 of ground water is available for irrigation development in the sub-basin.[6]

Water Utilization and Institutions

Water in this sub-basin is goes into irrigation, power generation, industrial uses, domestic and environmental uses. As in the rest of India, the bulk of the water goes into irrigation. The government's stated priority for the use of water in the Ghataprabha sub-basin is in the order of drinking water, flow irrigation, lift irrigation and industrial uses. Krishna basin of which this basis is a part of is relatively under industrialized. In 1990, water utilization was estimated to be 96.3 percent for irrigation, 2.9 percent for domestic use, and less than 1 percent for industrial use (CPCB 1990).

Irrigation

In the Karnataka districts in which the bulk of the sub-basin lies, nearly 85 percent of the land is already under some kind of economic use. The major crops are jowar, bajra, groundnut, cotton and fodder crops. Under irrigated conditions, the dominant crop is sugarcane, which is grown on a fourth of the irrigated area, followed by maize, wheat and jowar.

Crops are irrigated with water from three sources: the Ghataprabha irrigation system, water lifted from rivers behind barrages, and groundwater extracted from open and tubewells.

The GP system irrigates about 148,000 ha, against a designed capacity of 331,000 ha. Of this, about 60,000 ha are irrigated in kharif and 55,000 in rabi. The remaining 32,000 ha are two seasonal crops, presumably sugarcane and cotton. Farmers pay an area-based fee for irrigation from the system. An estimated 55,498 ha are irrigated by other surface sources. There are an estimated 22,000 wells in the command of the Ghataprabha system alone. They are estimated to extract 456 million m^3 of groundwater to irrigate 45,000 ha. Much of the irrigation takes place from November to February. Well owners pay an annual fee for power that is related to horsepower of the motor. As the incremental costs are nearly zero, pumping is often constrained only by availability of power. As only a small portion of the land cultivated land is irrigated, there is still considerable pressure to expand irrigation from both surface and groundwater sources.

Industrial

The sub-basin is not heavily industrialized. Total industrial water use in Ghataprabha sub-basin was estimated to be only about 30 percent of the domestic water use in 1990 (CPCB 2000). Sugar processing, which is usually located in rural areas, is one of the major industries in the region. There are 9 sugar factories and 3 distilleries.

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[6] Gross estimates of groundwater availability often exaggerate the potential for further development, as they ignore spatial differences in availability. It is not uncommon to have positive net availability of groundwater while groundwater tables are declining.

There are two large non-agro industries that require water in large quantities: an aluminum plant located at Belgaum, and a cement factory located in Bagalkot. [7]

The requirements of industries located in or near urban areas are usually met by systems that supply water to urban residents. In this sub-basin for example, KUWS&DB supplies water to the two large industries identified above. Industrial demand is perceived to be part of urban demand, and is almost considered the responsibility of whichever organization that supplies water to urban areas. The KUWS&DB in its estimates of water requirements for various urban areas includes the industrial requirements. In its system to supply water to Hukkeri and Sankeswar for example, 1 mgd has been allocated for industries. Urban industrial water requirements receive the same priority as urban drinking water needs, at least with regard to developing a source of supply. When water is scarce however, industries may be denied water to meet the drinking water requirements.

Rural industries, on the other hand, are encouraged to develop their own sources. They usually draw water from rivers, but are required to obtain permission from the WRD. They are assessed a fee for extracting water from rivers. They do not need permission to make use of groundwater, nor are they assessed any fee for water extraction. KNNL states that any supply that it makes to industries is only temporary; and that industries are encouraged to develop their own sources of water. It is not clear what that means. Presumably, the industries will be forced to use groundwater to meet their needs. It will add to pressure on groundwater from the agricultural sector.

The sugar companies in the sub-basin, draw water from rivers with permission from the KNNL or pump groundwater. The water requirements for sugar processing are approximately 0.75 kl/MT of installed capacity. The factories are typically permitted to draw more water during the crushing season. Athani Farmers Sugar Factory ltd. for example, is permitted to draw from Krishna river 158,300 gallons per day (gpd) for 210 days from October 15 to May 15, and 114,300 gpd for 150 days from May 16 to October 14, a total of 0.22 million m^3 per year. Another company is permitted to draw 2 cusec from October to May and 1 cusec from June to September. The factories are permitted to draw more water during summers when there may be greater demand from farmers for irrigation and the availability of drinking water also may be limited. In addition to making use of river flows, the sugar companies also withdraw groundwater.

The industries are not granted rights to water that are in any way deemed permanent. Both the sugar companies for example have permission to draw water for a period of 4 years. Presumably, they will have to renegotiate at the end of the period. The industries are charged from July 2001, Rs. 3,200 per mcft (Rs. 90.56 per m^3), up from Rs. 2,100 per mcft (Rs. 59.43 per m^3).

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[7] Small-scale industries include engineering works, ferrous and non-ferrous foundries, chemical industries and cotton ginning. There are also cottage industries like weaving, carpentry, leather, rope making, tiles, pottery and copper and brass work.

Power Generation

There are three hydropower plants in the sub-basin. The largest one, which generates more than 30 MW, is located just below the Hidkal dam. The second one, a recently built plant with a capacity of 2.8 megawatts, is located above the Dhupdal weir. It requires a flow of 2,600 cusecs. The third plant built in late 1800's is just below the Gokak falls, more than 60 km downstream of Hidkal dam. Its installed capacity is 2.04 megawatts.

Water supply to power plants is coordinated such that water can be utilized for other purposes as well. Nearly 1,274 million m^3 of water is released annually for power generation at Hidkal dam. The power plant releases the water into LBC for irrigation. It can also be released to RBC, but with a loss of nearly 4 feet of head. Water is released to the power plant at Dhupdal only when it is required for irrigation or drinking downstream along the LBC. Therefore, the plant usually receives its full requirement from November to March except when there are heavy rains. The Gokak plant receives a continuous flow of 204 cusecs from the Dhupdal weir. The water is released into the river, which provides drinking water for towns and villages downstream.

Water use hydropower generation is non-consumptive as it becomes available for other uses. To the extent that water is made available to power plants only when required for other uses, power generation doesn't compete with other uses. The information we obtained suggest that it is the case.

The power plants are expected to pay royalty to KNNL for the use of water. The rates vary, as they may reflect different uses the electricity is put to. Power generated at the Hidkal plant for example, goes to the state power grid where as the power generated at the other two small plants is used for operating a private textile unit. The Hidkal power unit is expected to pay KNNL Rs. 0.04 per KWH it sells to the state system. The newest plant, which was built with finance from a special renewable energy program, is expected to pay a royalty of Rs 0.0025 per KWH. They are also exempt from royalty for the first five years. The Gokak plant, which receives water round the year, pays Rs. 0.32 per KWH generated.

Drinking

Our survey of 47 villages showed that all but one of them had a safe source of drinking water. All received water daily. Nearly one-half of them received water for less than 3 hours daily; a third received water for more than 3 hours and the balance received water round the clock. Eighty five percent of the villages indicated that the source was adequate for the village. However, nearly 40 percent of the villages experienced seasonal water shortage. The incidence of seasonal shortages was not related to the estimated per capita availability of water; that is, seasonal shortage was not more common among villages with lower per capita availability. It suggests that those estimates are only notional at best, as the estimation methods do not overcome some of the difficulties in measuring access to water.

Key informants in the villages that experienced seasonal shortages attributed worsening of drinking water situation or reduced availability of water to increased extraction of groundwater for irrigation and reduced rainfall in recent years, in all suggesting that depletion of groundwater was primarily responsible for reduced availability of drinking water. This is consistent with information obtained from officials. In 97 villages of Bagalkot district for example, nearly 20 percent of the 600 handpumps cannot lift water. The wells are up to 140 feet deep, but water tables are estimated to go down to about 250 feet particularly during the hot season.

Water quality is also a problem. About 15 percent of the villages reported having some kind of quality problems. In nearly 40 villages in Saundatti taluk drinking water is brakish. In about a third of the habitations in the state, there is varying degrees of contamination from fluoride, brakishness, excess nitrate and iron (GOK, 2001). There is inadequate information on quality of groundwater sources. As noted earlier, the RDED is responsible for monitoring groundwater quality, but it does not have the required resources.

The problems of reduced water availability is further complicated by poor operation and maintenance of drinking water systems. Nearly 30 percent of the 4,800 hand pumps in the Belgaum district were reportedly not working. The organizations response do not have the resources required for repair and maintenance.

The residents of urban areas seem to do better in terms of average quantity of water supplied to them, but frequency and timing of supplies suggest that their situation is worse than what the average supplies suggest, and that poor water supplies impose considerable hardship on them. In all the urban areas, water is supplied to residents for only a few hours once in several days. KUWS&DB's objective is to achieve a supply of 120 lpcd in Belgaum and 70 lpcd in other towns. In Belgaum for example, water is supplied for 2 to 3 hours on alternative days, which may be changed to 1 to 2 hours every third day in summer. In Gokak with a population of 67,000 (approximately 7,000 families), nearly 1,800,000 gallons are supplied daily, which works out to nearly 100 lpcd. But households get water for about an hour on alternate days. The situation is similar in Bagalokot that has a population of nearly 91,000. The city claims that it supplies 2,500,000 gallons daily giving them a supply of nearly 100 lpcd. But residents get water once in two days. Only those who have individual storage capacity can enjoy convenient supply of water. Others have to expend considerable time on water collection when it becomes available and also invest in water storage containers and so on. The above numbers may also be summarised as below:

Place	Planned	In Practice
Belgaum	120 lpcd	2-3 hrs on alternative days in normal course 1-2 hrs on every third day during summer
Gokak	100 lpcd	One hour every alternative day
Bagalkot	100 lpcd	1-2 hrs once in two days

The supply of drinking water does get political attention. The politicians have come to realize that it is an issue that the electorate is sensitive to. Therefore, they are often overenthusiastic about building new infrastructure. In Bagalkot district for example, nearly all of the 700 habitations (581 revenue villages) have a safe supply - a borewell or a mini drinking water supply system. The engineering department of the ZP determined that 56 additional wells would be required to raise the level of access to 55 lpcd. The political representative apparently recommended that the number be increased to 82. During 1999-2000 alone in the district, 406 additional borewells were dug. It is not entirely clear whether the reason was unavailability of water in existing wells or breakdown of old systems due to poor repair and maintenance. Although there is enthusiasm in improving drinking water infrastructure, there doesn't appear to be adequate concern about protecting drinking water sources, at least at the local levels.

Sources used. In rural areas, drinking water systems are heavily dependent on groundwater. In the sample villages, nearly all of the villages used either tubewell or open wells as sources. More than three-quarters of them were supplied water from tubewells, nearly 20 percent from open wells or a combination of open and tubewells, and the remaining, that is, only two villages used surface sources.

The source of water used for drinking has changed over time: there is a shift from surface to groundwater sources, and within groundwater, from shallower open wells to deeper tubewells. Among the sample villages, 18 used openwells for drinking and additional 15 used tanks and rivers in addition to open wells in 1985. By 2001, 20 of them depended on tubewells alone and only 3 villages reported open wells as being their only source. Deterioration in the quality of surface water may be one o f the reasons for this shift in the source of water. More than one half of the villages indicated that surface water bodies – tanks and rivers- were polluted, and therefore, unsuitable for domestic and livestock consumption.

Some of the smaller towns and villages that have depleted sources of water closer to them are receiving water from surface sources such as rivers. The KUWS&DB-built system to supply water to Hukkeri and Sankeshwar, two small towns, also supplies water to 16 villages along the way. They are planning to extend the services to additional 10 villages, as the capacity of the system built to transport water has not been fully utilized. In Bagalkot, KUWS&DB supplies water to three small towns and a large industry in addition to Bagalkot.

Urban areas that have overgrown their sources of water are increasingly depending on surface systems what were built primarily for irrigation. Belgaum city with a population of nearly 500,000, for example, has its own source of water: Rakkaskop barrage across Markandeya river nearly 20 km from the city. The city is usually able to pump 9.5 mgd from this source, which was developed in two stages in 1962 and 1984. In summers water availability may reduce to 6 mgd. At 130 lpcd, the city requires 12 to 14 mgd. A KUWS&DB-built system to transport water from the Hidkal reservoir is now expected to meet the deficit of at least 3 mgd.[8] The city corporation maintains 18 open wells and 542 borewells (437 handpumps) to augment surface sources. The groundwater sources are estimated to supply about 1 mgd. The city also has two tankers that take water to areas that do not have any sources.

The extent to which the urban systems fail to meet the needs is indicated by the presence of private water suppliers. In Belgaum city alone, there are an estimated 200 private tankers that supply water to households and other users. They reportedly charge Rs. 250 for delivering 3,000 liters within 5 km radius of their operations. Most of the hotels, apartments complexes, and industries in the outskirts of the city reportedly depend on private water suppliers.

Gokak and Bagalkot are two other large cities that are going to demand more water from the Ghataprabha system. Gokak presently draws water from the river below the falls where there is a continuous flow because of water released from the power plant. In addition to pumping water from the river, they make use of nearly 40 borewells in the city, of which only three have been fitted with electric pumps. The city is building a new system to draw additional water from the river to meet their increasing needs. They proposed taking water from the top of the falls by gravitational force alone. The KNNL apparently did not grant permission, as it would have required it to release additional water from the Hidkal reservoir, as opposed to present situation in which the city makes use of the water that goes into power generation at the Gokak power plant.

Bagalkot, which is situated at the tail end of the river, also pumps water from the river through a KUWS&DB-built system. In the year 2000, the river dried up for about 2 months during the summer. The city had to draw water from nearly 30 borewells it had, and also dig additional 65 wells to meet its requirements. Though they were able to meet their needs from groundwater alone, the users were unhappy. There were complaints of numerous health problems such as joint ache, which people attributed to high levels of calcium in the groundwater supplied. The users here have a strong preference for surface water. The city administration also prefers surface water. Supplying surface water costs less: they employ only about 120 HP to pump the surface water; for groundwater, on the other hand, they need to employ nearly 500 HP, thus increasing their power costs. The bulk of the residents will be moved to a newly built city nearby, as parts of the city will be submerged by the Upper Krishna system. To supply water to the new city, a barrage has been built across the river to store water adequate to meet the needs for two months in summer.

User Charges. User charges are more or less uniform among cities and towns. Domestic connections are charged Rs. 45 rupees per month; non-domestic, Rs. 90 per month; and commercial connections are charged Rs. 180 per month. In Belgaum for

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[8] The KUWS&DB has permission from KNNL to draw 28.3 million m^3 per year from the Ghataprabha system. However, the contract stipulates that water should not be demanded from February 1 to June 15th and that the KUWS&DB should make its own arrangements for storing water during summer.

example, the charges are Rs. 450 per year for a private connection. Of the 47,000 households, nearly 27,000 have individual connections. Another 2,000 gain unauthorized access. Fee recovery is nearly 80 percent in Belgaum. The recovery rate appears to be much lower in smaller towns.

Urban water supply systems pay a fee to the irrigation systems. The charges for drinking water drawn from irrigation systems were Rs. 375 per mcft (Rs. 10.61 per million m^3).

Financial viability of many drinking water systems is in doubt. Some have not even begun recovering costs. In the KUWS&DB-built system that supplies water to Hukkeri and Sankeshwar for example, unpaid electricity charges have already accumulated to nearly Rs 12 million

Environmental Use – Using Assimilative Capacity

Dumping of untreated sewage into rivers and other water bodies appears to be a greater threat to maintaining water quality in the sub-basin than industry-caused pollution. All economic enterprises are required to obtain permission from the Pollution Control Board (PCB) to begin their operations. They are required to show how they will control pollution, and establish treatment plants wherever required. The PCB permits operations only if the required investments are made, and subsequently, it monitors the industries to see whether they are complying with the applicable standards for the release of effluents. Compliance is brought through legal action and denial of essential services such as power supply. None of the industries in the sub-basin appear to be polluting water sources, at least according to office of the state pollution control board. We did not hear from any sources of industry-caused pollution, although groundwater pollution by soaking pits used by sugar factories is a distinct possibility.

Dumping of untreated sewage into the rivers is, however, a common practice in the sub-basin. The local PCB office indicated that it had “served notices” on several city and town authorities, but was reluctant to reveal the exact number or the names. The notices appear to have had little effect on city administrations. Holding cities and towns accountable appears to be more difficult than making private companies change their behavior. The mechanisms such as withholding of utilities that could potentially make private companies take notice are not effective against public bodies representing towns and cities.

Towns and cities are estimated to release as sewage nearly 80 percent of water consumed by their population. In addition, they produce solid waste. Belgaum for example, generates nearly 80 tons per day of solid waste which is dumped into two sites within the city limits (Hanamagond &Divekar 2000). None of the towns in the sub-basin has a sewage treatment plant. Belgaum, Gokak and Bagalkot together release approximately 50,000 kl of sewage into river bodies. Belgaum for example, releases sewage directly into Bellary nala, once a perennial stream that has now turned into a sewer drain along its 30 km course. Farmers use the water to irrigate their crops; animals are washed in it, and children also play in it. Gokak dumps its sewage into the

Ghataprabha river. For a period of about 2 months in summer when there may not be any water in the river, the only flow may be of raw sewage. Similarly at tail end of the river, Bagalkot releases sewage into the river.

The situation is not any better in rural areas, although lack of sanitation may be less damaging to water quality in rural areas. Only about 30 percent of the villages surveyed indicated that they had households with toilets. In 80 percent of them, less than 20 percent of the households have toilets. Only in 4 villages, that is, in less than 10 percent of the total villages, more than 30 percent of the households had toilets. As noted earlier, a significant portion of the villages also indicated that water bodies had been polluted, primarily from lack of sanitation.

Status of Water Resources

There are signs of water crisis in the sub-basin. Groundwater tables are declining, and there appears to be significant pollution of water resources. There is also substantial "congestion" as new users are being added on to state managed surface systems and groundwater. Conflicts are beginning to take place.

There is limited availability of information on water quality, but limited information available suggests that quality of water in Ghataprabha has deteriorated substantially over time. The river now shows MPN of nearly 900 per 1,000 ml indicating high levels of bacterial pollution (Pawar 2000).[9] Bacteriological contamination of the river is high throughout its length primarily because of disposal of untreated sewage into the river (CPCB 1990). The Bellary *nala* (a small stream) into which Belgaum sewage is dumped, is highly polluted. Increasing concentrations of Ca, Mg, and Na are found in the wells along the Bellary *Nala*. Groundwater appears to have been contaminated through the use of polluted surface water and fertilizer use rather direct contamination from the stream flow. The wells near the solid waste dumpsite in Belgaum are also polluted (H&D 2000). Water delivered in many parts of the city also appears to be contaminated with sewage. There is considerable decrease in DO level, which indicates pollution due to sewage disposal (Jayashree 2000).

There is increasing pressure on water resources. The Ghataprabha system will be under pressure to reallocate water from agricultural use to meet domestic needs in urban areas. Belgaum, Mudhol, Gokak, Bagalkot, and perhaps Chickodi are some of the urban areas that are looking to meet their increasing water requirements from the Ghataprabha river, particularly from the irrigation system.

The demand from urban areas for drinking water will put them in conflict with farmers who would like to use the water for irrigating their sugarcane during summer. Such conflicts have already arisen. When the river ran dry in the summer of 2000, Bagalkot persuaded KNNL to release water into the river. The farmers along the way raised their barrages to use the same water for irrigation. The farmers were reluctant to let the water flow downstream to be used by urban residents while their sugarcane crops

[9] Water for human consumption should usually contain zero faecal coliform per 100 ml sample and less than 500 for bathing.

were dying. Senior politicians and administrators had to intervene to persuade them to release water for Bagalkot. The estimated demand from urban areas in 2025 is nearly 115 million m^3.

The Ghataprabha systems may not be able to meet the growing demand from various sectors without cutting back on irrigation. Already, it is not able to serve all the areas that it is designed to. Right bank canal is still under construction, but water available is not adequate to service the LBC area. The Left Bank Canal is drawing 35 percent more water than it is allotted, although it is irrigating less area than it is designed to. Moreover, water releases for other purposes such as industrial and domestic use is now restricted to non-summer months. If drinking water needs have to be met during summers, greater sacrifices will have to be made by the agricultural sector.

Groundwater situation is also worsening. Although estimated usage compared to recharge may indicate that there is room for substantial development, water tables are going down.[10] During a period of ten years, the total number of wells declined from 22,502 (21,698 dugwells and 863 tubewells) in 1987 to 21,819 (9,121 dugwells and 12,698 tubewells) in 1997. Nearly one half of the dug wells were replaced by tubewells suggesting decline in water tables. Decline of groundwater may be particularly high in taluks such as Hukkeri in which groundwater is the only source. Hukkeri has 121 villages that rely on open wells (6 m to 25m deep) for irrigation and bore wells (40 m to 110m deep) for drinking water. A survey indicated that in nearly 15 villages, open wells had gone dry (NIH 1995). The study attributed the decline in water table to increase in the number of irrigation wells and sinking of deep bore wells for drinking water.

Officials estimate that nearly 10 percent of the water supply systems in the sub-basin have been affected by private wells used for other purposes. For example, in parts of Jamkandi taluk the groundwater is below 450 feet. Borewells that usually begin yielding 8,000 lph come down to 2,000 to 3,000 lph in summer. Annually, 8 to 10 percent of the borewells are declared as “defunct,” and 5 percent as “permanent failures.” In 10-20 percent of the villages in which World Bank supported drinking water projects are being implemented in Karnataka, there may be water shortages that force people to depend traditional unsafe sources (Paramshivam, 2001).

Decreased availability of water has brought attention on increasing groundwater recharge as a means of overcoming the problem. An expert committee has recommended guidelines for artificial recharge of drinking water sources in Karnataka (GOK, 2000). Nearly 20 percent of the drinking water projects funds can now be utilized to protect or enhance supplies. The funds may be used for regulation of groundwater withdrawal, prevention of quality degradation, recharge of groundwater aquifers, watershed development, disiltation of tanks, afforestation and rainwater harvesting. Studies in a few watersheds in northern Karnataka show that the present demand for domestic water supply and sanitation and for livestock ranges from 3.2 percent of recharge to 11.6

[10] Within the Ghataprabha command, however, there is water logging and salinity. The total area affected is estimated to be 8,715 ha, of which 3,913 ha are water logged and 3,887 ha are saline, and the rest are alkaline. More wells are recommended here to lower the groundwater tables.

percent of recharge. The demand is estimated to double assuming that the population will grow at 2.5 percent and livestock at 1 percent, and consumaption of 40 litres per capita per day (KAWAD 2001). The present withdrawals for agriculture and domestic use are estimated to be fairly close to annual recharge suggesting that there may not be sufficient water to sustain the intensity of agriculture that farmers would like to maintain. Also, there are indications that at least in semi-arid conditions, there may be little scope for increasing water availability through watershed development (KAWAD 2001).

IV INSTITUTIONAL CHALLENGES

Water utilization in the Gahataprabha sub-basin demonstrates the nature of conflicts that are likely to emerge, and the need for institutions to encourage sustainable use and allocate water between sectors to meet social objectives. The prevailing institutions are not adequate to protect drinking water sources that are being subjected to pressures from competing uses.

Threats To Drinking Water

Access to drinking water is threatened by competition from other uses. Provision of drinking water infrastructure alone doesn’t seem to ensure year-round access to adequate drinking water for the population. According to the Rajiv Gandhi Drinking Water Mission, in nearly a third of the groundwater-based drinking water systems, there were seasonal shortages of water caused by aquifer depletion (GOI-WB, 1998c). In a survey of communities in which new drinking water systems had been built, nearly 50 percent in Maharastra and Karnataka states reported that adequate water was not available during critical periods (World Bank, 1998d). In about 20,000 of the 55,000 habitations in the state of Karnataka, for example, the supply of water is not adequate during the hot season (GOK, 2001).

Groundwater depletion is the primary threat to drinking water availability. Protecting drinking water, therefore, entails protecting both sustainable yield and quality of groundwater (World Bank 1998c). The regulation of groundwater extraction and recharge of groundwater aquifers are considered essential for sustaining rural water supply (GOI 1999a). Groundwater is the source for nearly 85 percent of rural population served by public drinking water supply schemes, and for nearly 50 percent of the urban and industrial water requirements (World Bank 1998c). Groundwater sources free from quality problems are still preferred for drinking water systems because of low cost of operation and maintenance (GOK 2000). A safe groundwater-based drinking water system can be provided in a day or two, as all that is required is digging of a well. Where as in the case of surface sources, water filtering has to be provided for, which often raises the cost several fold and also takes more time to complete.

Surface sources, however, are more important for urban areas, as it is more feasible and cheaper to organize supply of large quantities from surface sources rather than groundwater. The source of drinking water in class II towns was surface in 43 percent of the cases, surface and ground in 41 percent of the cases and only groundwater in 16 percent of the cases (CPCB 2000). Urbanization can be expected to lead to greater dependence on surface water sources in the future. Additionally, groundwater quality may not be suitable even where it is available. For example, an estimated 66 million people in India drink groundwater with too high a fluoride content (van der Hoek, 2001). Arsenic contamination of groundwater in the east is well known. Therefore, a shift towards surface water as a source for drinking can be expected with decline in groundwater quality and urbanization. However, this dependence on surface sources will be only for organized drinking water systems. The direct use of surface sources by consumers is likely to decline. The national family health survey indicates that only about 3 percent of the households in 1998-99 made use of surface sources compared to 11 percent of the households in 1992-93 (IIPS-ORC Macro 2000).

Demand from various sectors, primarily agriculture, is driving groundwater tables down. Groundwater depletion has had different consequences in different parts of the country: in the northwest, salinity is the problem; in parts of the west, it is fluoride contamination, and in the hard-rock south, deepening of wells, declining yields and increasing pumping costs (Shah et al 2001). The development of groundwater has been critical to green revolution in India. As rural livelihoods and the health of the economy are so strongly tied to vagaries of monsoons in the country, pressures to exploit water for crop irrigation will continue to be strong. Groundwater resources will be subjected to increasing pressure from other sectors as well. Though the requirements of the non-agricultural sectors may seem to be insignificant, and only a small portion of the total water demand, there are likely to grow at a much faster rate than the demands of the agricultural sector: domestic and industrial demands are expected to increase three-fold and their share in the total water consumption is likely to grow from 17 to 27 percent (World Bank 1998b).

Water pollution is another threat to availability of safe drinking water**.** Decline in water quality is as much a threat as scarcity of water is (Iyer 2001). Water quality problems relate to microbiologic and chemical contamination; the former leads to outbreak of acute diseases, and the latter leads to cumulative and chronic health risks. Inadequate sanitation, industrial pollution, and the practice of chemical input-based intensive agriculture affect water quality. Pollution of water caused by industries and release of untreated sewage is widespread in the country (Ramachandraiah 2001). As water quality status is dependent on quantity as well, quality problems are becoming apparent water become scarce (World Bank 1998).

Poor sanitation and absence of sewage treatment are important causes of water pollution. Even in a relatively water-abundant state such as Kerala, the availability of safe drinking water is a problem because of lack of sanitation (Hindu 1998). Nearly 2.9 million of the 5.5 million households in Kerala are estimated not to have safe sanitation facilities. Only 7 percent of the population in Karnataka had access to sanitation facilities in 1990. Though access to sanitation is somewhat higher in urban areas, the method of sewage disposal poses danger to water sources. Untreated sewage from most towns and cities is routinely dumped into rivers. On the whole, only about 66 percent of the population in medium sized (class II) towns, for example, have sewage facilities (CPCB 2000). Less than 5 percent of the wastewater generated is treated before it is disposed off. Even the towns that have treatment facilities may not be able to treat all the wastes produced. The majority of towns dispose indirectly into water bodies. Almost all the major rivers in the country do not meet the safety standards for drinking and bathing (CPCB 2000).

Chemical contamination of water by industrial effluents and non-point pollution by agriculture is also a major threat to maintaining water quality. Drinking water sources even in rural Punjab are contaminated by industries (Tiwana and Singh, 1996). Water pollution is extensive in industrialized regions such as south and central Gujarat (Indian Express 1999). Agriculture also presents less intensive but extensive contamination of groundwater with nitrates, trace metals and organic compounds. Yamuna river flows an important water source for New Delhi contain unsafe levels of pesticide residues (Down to Earth 1998).

Groundwater sources, which are usually perceived to be safer than surface sources, are also contaminated on a wide scale. Water from wells in urban areas have been found to be non-potable. Almost 50 percent of the groundwater used in and around Delhi is contaminated with fluoride and nitrates (Down to Earth 1998). Arsenic contamination in Bangladesh and West Bengal demonstrate the mistake in assuming that groundwater is safe for consumption. Arsenic poisoning has already affected nearly 840 villages in eight West Bengal districts; an estimated 2.5 million people are drinking arsenic contaminated water (Down to Earth 97). Nearly 30 million people are estimated to be at risk in this region. Although arsenic contamination of water takes place through natural leaching, some have attributed it to over-exploitation of groundwater for irrigation.

Improving Water Governance

Protection of drinking water is closely tied to the larger challenge of improving governance of water resources an important objective of which is to maintain quality to support various uses. Institutions are necessary to introduce incentives to conserve and use water efficiently in different uses, and also to allocate water to different uses. Efficiency enhancing measures that encourage water conservation in various uses would contribute to protecting drinking water as well, as they would reduce pressure on water resources. The challenge is to develop a set of institutions that provide access to a minimum quantity of water as a fundamental right, and at the same time facilitate movement of water to higher valued uses.

The thrust of reforms in the water sector is on improving efficiency of water use in agriculture. Decentralization is one of the principal measures identified to improve water use efficiency in publicly managed surface irrigation systems (Saleth and Dinar 1999). Community and state controls, management rather than development are seen to be essential to bring groundwater extraction more in line with its sustainable use (Moench 1994; World Bank 1998a). However, improving efficiency of agricultural use alone may not be adequate to solve the problem of protecting drinking water sources and fair allocation of water to various sectors (DFID 2001).

Policies that create market-like conditions for water are recommended for improving water use efficiency and averting conflicts between various sectors (Rosegrant and Gazmuri 1997). The establishment of water rights, which is a prerequisite to functioning of markets, is considered to be feasible in India (Saleth 1996). Though appealing to policy analysts, mechanisms that mimic market also cannot be easily established because of difficulties in establishing clear and tradable property rights. As water flows through river basins, it can be used over and over again for different purposes, achieving optimal use through market mechanism alone also may not be entirely appropriate. Market failures also limit the applicability of market mechanisms for allocating water resources. The potential for externality in water use, the nature of water flows through river basins, and high transaction costs may make it difficult to achieve optimal allocation through market mechanisms (Perry et al 1999).

There is also need for balancing market efficiency against social equity in allocating water between sectors (DFID 2001). Market mechanisms may not lead to socially desirable outcomes, as economic efficiency alone may not be what societies want to achieve. Therefore, water may need extra market management to serve social objectives (Perry et al 1999). Underlying various institutions are values in terms of principles of equity and fairness that is embodied in them, and the outcomes that they seek to achieve. Two competing values are relevant for mechanisms for allocating water (Perry et al 1998). One is that water is a basic need, and that it should be met regardless of the ability of people to pay for it.[11] The other is that, water should be treated as an economic good, and willingness to pay should dictate its allocation among users and uses. Given the nature of water, institutions with different values may be appropriate at different levels of water use.

The states need the capacity to manage water on a multi-sectoral basis (World Bank 1998b). But the state governments are not set up administratively to be able to take up integrated management of water resources. In Karnataka for example, several ministries are engaged in water management. Several different departments handle surface water alone. The supply of drinking water and pollution control falls outside the purview of the mainstream water management organizations.

Inter-sectoral transfer institutions and pollution control

Water transfers from one use to another takes place through different institutions in surface and groundwater. In some cases, the nature and extent of these transfers may not be clear as new users are added on to existing sources. The resulting congestion may dilute the rights or access of all the users. In other cases, there may be clear transfer of water from one use to another. In the case of groundwater, the rights of landowners to water that is below their land enables them, whether they are agriculturalists, industrialists, house owners or water traders, to acquire water through a well. To the extent water utilization is below the recharge, none of the present users may be affected

[11] This is not to imply that drinking water should be provided free. On the other hand, the lack of incentives to conserve drinking water is one of the reasons for unsustainability drinking water systems. As water is treated as a social good, those with access are not charged the full costs. This benefits the richer population with access to services (DFID 2001).

by new entrants, and there may not be any transfer from one use to another. As utilization exceeds recharge and groundwater tables begin to decline, the sectors with deeper wells begin to deprive other sectors. Typically, drinking water wells may be deprived by deeper agricultural and industrial wells. Or need arises for drinking water wells to be constantly upgraded to bring water from increasing depths. Groundwater transfers also take place through markets. Many agricultural well owners sell water from their wells to urban residents or industries when they can higher returns from sales compared using the same water for irrigating their crops.

In the case of surface sources of water, reallocations take place through administrative mechanisms. The mechanisms include licensing requirements to make use of river flows and allocation of water from multipurpose water projects. These allocations are guided by the priorities established in policies. The National Water Policy places the highest priority on drinking water. Individual states have their own priorities, but they all place drinking water needs at the top. The Government of Karnataka's priorities in the recently approved policy, for example, is drinking water, agriculture, aquaculture, agro-industries, non-agro industries and finally navigation.

There are difficulties in operationalizing such priorities, although they may represent values collectively held as to how water should be utilized.[12] One, only a portion of the water resources is under the direct control of state governments. The states can, at best, enforce these priorities in the allocation of surface water. As noted above, there are no sector-based controls on groundwater utilization. More importantly, general controls on groundwater extraction have not been effective. Two, priorities are difficult to implement without involuntary appropriation from some users unless it is in new systems. The problems usually arise in older systems when demands for water from different sectors deviate from established patterns of use. Markets or opportunities to negotiate, on the other hand, enable transfer from one use to another without opposition from existing users (Easter et al 1999; Bruns & Meinzen-Dick 1999).

A strategy that is followed by the governments to avoid the difficulties in rescinding rights is to not grant clear rights that are deemed permanent in any sense so that administrative reallocations can be made periodically. The rights of all users then become subject to periodic review and "rights" of some of the users may be diluted in the process. Allocations then become subject to intense political pressures and the ability to the government to enforce its decisions. Political processes to some extent moderate the rigidities of across the board priorities. Even if these processes can achieve value based allocations, the problems with administrative/political allocations are probably high transaction costs, and most definitely, greater uncertainty particularly for lower priority users.

In publicly managed irrigation or multipurpose surface systems, priority is usually given to meeting drinking water, wherever the existing infrastructures makes it feasible to meet the needs. As noted earlier, in larger systems drinking water requirements are only a small portion of the total water that is available, and therefore, there may not be need for

[12] Such priorities are inferior to allocation through the market for maximizing values.

making significant tradeoffs. Even in smaller systems in arid regions, drinking water is given priority over other uses during scarcity. In Gujarat for example, during periods of water scarcity, drinking water needs are met first before water is released for irrigation in Meshwo and Phophal systems (Kolavalli et al 1994). The 1987 national water policy recommends that water should be developed through multipurpose projects. Meeting drinking water needs receives attention in the design of large water projects.

It may be reasonable to conclude that surface drinking water sources would be better protected than groundwater sources, as policy-based priorities can be better enforced in the use of surface sources compared to groundwater. However, many of the surface sources of drinking water may be threatened by overexploitation of groundwater. It also implies that more immediate danger is to rural areas that depend on groundwater for drinking. In addition, there is need to improve enforcement of pollution control measures. It is often the poor that are most affected by pollution of drinking water sources (DFID 2001).

Poor governance both in an administrative and political sense offers only weak safeguards against pollution. The bureaucracies are either too corrupt or lack political backing to regulate pollution by industries (Hindustan Times 1993). The Report of the Comptroller and Auditor General of India on the implementation of the Water (Prevention and Control of Pollution) Act of 1974, which was tabled in the parliament, alleges that there is only weak implementation of the law (TOI, 2001). The report found that in Haryana for example, nearly a fourth of the industrial units were functioning without permission; in Karnataka, nearly a third. Lack of compliance was worse among urban units. None of the government hospitals had even bothered to apply for permission. Disposal of sewage is also a problem, leading to contamination of drinking water.

Communities affected by pollution and concerned individuals often seek redress from the judiciary, but relief comes too late, often after irreversible damage is done (Down to Earth 1997). Community action seems essential for protecting water quality. Civil society has played an important role, and industries indicate that one of the factors that influence their pollution control decision is pressure from communities and NGOs (Pargal et al 1997). Better enforcement of pollution control may require greater community action and greater investments in sanitation and sewage treatment. Sanitation, which is often perceived as necessary to get full benefits of supplying safe drinking water, may be necessary for sustained supply of safe drinking water.

New measures to protect groundwater sources

Grass root level institutions are considered necessary to manage conflict between rural water supply and agricultural water use or water pollution (World Bank 1998b). But controlling groundwater use has been one of the difficult aspects of bringing about sustainable use of water resources. It will be the principal challenge to protect drinking water resources. The political commitment to protect drinking water may provide new opportunities to rein in groundwater use for irrigation. Governments of Karnataka and Maharastra have now introduced groundwater control measures to protect drinking water sources. Karnataka Groundwater Act of 1999 prohibits the sinking of well for water extraction within a distance of 500 meters from a public drinking water source without the permission of an appropriate authority. The authority may prevent extraction from existing wells by declaring any area as water scarce. The authority also extends to declaring a watershed as being over-exploited and prevents sinking of wells or operation of any existing wells that may be affecting drinking water wells.

The protection measures introduced by the two governments offer greater potential to be successfully implemented than any general control on groundwater use. It will depend on who the "Appropriate authority," is and the extent to which wells that interferes with drinking water wells can be identified. Unlike general control on groundwater extraction, this act may not affect everyone: only those wells are interfering with drinking water wells will be affected. Given that everyone benefits from drinking water, there may be greater political support for implementation of the act. In addition, well owners who lose from the implementation of this act will be compensated. The political commitment to protect drinking water will be tested only when the implementation of the act begins and the kinds of tradeoff communities are willing to make for drinking water becomes clear.

Shashi, I was wondering, where action may focus (both from policy and execution point of view) that can generate, if we can generate for the top level bureaucrates (and UN). Some of them may be:

a) Absence of appropriate authority to enforce the suggested legal frame

b) Process of governance and enhancing its mechanism

c) Dealing with sewage disposal ,

d) Inadequacy of integration of environmental issues with policies

e) Institutions lack political backnig and adequate resource support

f) Lack of community action and role of civil society required for protecting water quality

There may be other points too.

(Right now, I feel, we have a good story for outside audience and stressing on above points with separate point based paragraphs (otherwise retaining the present sub-section headings) is fine. The present version has good integration for reading and connecting the points.

But let me know, if you have questions, in addition to the last email (on groundwater and others) to raise, when I am planning to meet GWDept on 8th. I am only worried about taking different route, with new set of data, if they provide. Let me have your views. Then I will procede.

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