Managing Water for Sustainable Development: An Indian Perspective

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Water scarcity is a paramount concern that affects growth and sustainable development. It parallels the climate change effects in terms of space and scale. Both these intertwined concerns are challenging human security and crossing the boundaries of nations. Water crisis and its impacts are unambiguously noticeable at the local, regional, national and transboundary levels. Water insecurity threatens peace not only by accelerating existing conflicts, but also by creating the risk of new conflicts. It is closely linked to food security and economic growth prospects at all these four different levels. To be precise, water scarcity makes development inequitable and unsustainable.

There are many poverty-stricken economies that are yet to transform themselves on social, economic and other parameters. Water crisis in these economies may rather lead to regressive developmental changes, even if right corrective policy and institutional interventions on other developmental fronts are in place. Water scarcity makes development unsustainable not only in poor economies, but also in relatively well-off economies.[1] The rapid increase in demand for water accompanied by the shrinking supply of limited water sources increases social costs for those economies. Noticeably, social costs are borne mainly by the poor (UNESCO, 2015). This situation also brings in the intra-generation equity notion of sustainable development. That is, managing water in a sustainable manner could significantly contribute to poverty reduction in water-starved countries like India.

Water, once considered to be a renewable resource, is gradually becoming a non-renewable resource. Hence, current water management practices warrant a new and conservative approach. Water, a natural capital, generates a variety of heterogeneous ecosystem services. Freeman III (2003, pp. 148–155) has categorized the ecosystem services into *use values* and *non-use values* based on the nature of utilization. Use values include *direct use values*, for example, drinking water, and *indirect use values*, for example, the removal of pollutants. On the other hand, non-use values include *option value*, for example, people's willingness to pay a premium for using the services in future, and *existence value*, for example, people's willingness to pay for a mere existence of the services. These ecosystem services are being utilized in innumerable consumption and production activities at different levels in the Indian economy, helping the expansion of national income, improvement of economic welfare of people and an increase in rural prosperity. In other words, water is a critical factor in India's overall growth and sustainable development and, therefore, even a small depreciation in water as a natural capital leads to a more than proportionate decline in the inter- and intra-generational economic welfare.

Water-based ecosystem benefits constitute a significant amount of income for the poorer households (TEEB, 2010, p. 9). Therefore, managing water resources and their ecosystems properly is crucial for reducing poverty and inequality in the Indian context. For example, Chilika Lake in the state of Odisha generates ecosystem benefits equivalent to Indian Rupees (INR) 4,000 million per year, and a larger percentage of the benefits are shared by the households at the community and local levels (Kumar, 2010, p. 17). This implies that in the absence of such direct benefits, either the beneficiaries would have been poorer by INR 4,000 million per year or an equivalent amount of tax payers' income from other parts of India have to be brought into the Chilika region every year in order to compensate for the welfare loss. Most of the ecosystem benefits are complementary to households' consumption activities. Certain benefits are used as an input to produce food, for example, irrigation water, some benefits are used to prepare food, for example, water for cooking purpose, and some other benefits are used as food, for example, fish, aquatic plants and so on. Thus, managing water sources does ensure the increased availability of such complementary benefits to the households, thereby enhancing their food security. Undeniably, the current level of poverty and inequality in India has both direct and indirect links with the gradual deterioration of water resources.

Notably, most of the water-based ecosystem benefits are *non-marketable* in nature and, therefore, their contribution to economic welfare is not being adequately captured by the existing market systems. In other words, the market fails in reflecting the *scarcity value* of water and its ecosystem services, leading to their mismanagement. There are *government/policy failures* too. Governments in the developing and emerging world are yet to incorporate the economic values of the natural resources in their national accounting systems (Ahmed, El Serafy, & Lutz, 1989, p. 3). For example, India so far has not made any real effort to incorporate the economic values of non-marketable ecosystem services and economic costs of deterioration of the environment in the system of national accounts. As an outcome, the GDP does not reflect the *true economic* welfare of a society.[2] Indeed, India's current GDP estimation 'commits' a significant amount of environmental damage costs and such costs of growth largely fall on the society (Mani, 2013, p. 2). Furthermore, weak government policies *per se* are leading to increased social costs in the Indian economy, which is another form of government failure. For example, India's current command-and-control-based pollution control policies cause a decline in water quality, thereby increasing damage costs in the household, agriculture, animal husbandry, fishery and biodiversity sectors.

This example reflects government's failure in the area of water management. The community as an institution that successfully managed watersheds in the past is no longer managing them, which could be attributed to the rapidly changing socio-economic and institutional context in rural areas. Similarly, if the user communities act as rational utility maximizers, then they may not be able to manage watersheds at a socially optimal level, paving the way for conflicts among the users (Venkatachalam, 2011, p. 105). Therefore, there is a community failure as well. Altogether, there indeed exists an institutional failure in managing water resources, and as an outcome, India's water resources unambiguously experience two types of negative externalities: water depletion and water degradation.

Depletion and degradation of water resources are reflected in terms of groundwater over-exploitation, decline in the number and size of surface water bodies, water quality changes from point source pollution caused by environmentally harmful industries and non-point source pollution by innumerable urban and agricultural activities, among others. On the other hand, we also encounter a situation where a significant quantity of unused water is enhanced by changes in the land-use pattern and agricultural practices. For example, the land area irrigated (both net and gross) in the state of Tamil Nadu, India, has been declining over the years (Athreya, 2015, p. 73). As a consequence, water once used for irrigation purpose is no longer used for the same. Similarly, the introduction of improved irrigation technologies that are gaining momentum in agriculture, for example, micro-irrigation, saves a substantial amount of irrigation water that could be potentially used for other high-value crops (Narayanamoorthy, 2003, p. 435). Researchers claim that with appropriate institutional arrangements, transferring even a small quantity of irrigation water to other sectors would significantly minimize the problem of inter-sectoral water conflicts and bring in a non-zero-sum outcome (Cullet, Bhullar, & Koonan, 2015; Molle & Berkoff, 2006).

However, where does all the saved or enhanced water in the Indian economy go? Why, despite having saved water, the inter-sectoral conflicts are still on rise? The answer lies in the fact that, at present, water in India is being mismanaged.

Managing and allocating water in an efficient, equitable and sustainable manner, especially in a complex socio-economico-political and environmental context, has turned out to be a challenging task. A key policy question is: How to correct the existing institutional failures and create appropriate institutions in the relevant sectors, thereby generating adequate incentives and disincentives to change the behaviour of the stakeholders for managing water on a sustainable basis? Several steps should be taken in this direction. Developing *water accounting* at the river basin level on a periodical basis is a pre-requisite for any water allocation decision. If the available amount of water for a specific purpose is known, then only it can be allocated efficiently. Based on the information from water accounting, a firm decision could be made.

A basin-level water account has two sub-components (Pearce, Markandya, & Barbier, 1989, pp. 93–119): (a) *physical account* and (b) *monetary account*. The physical account deals with the quantity of water available at the beginning of the accounting period. This is called the *opening stock* that changes during a period due to additions, that is, water replenished from rainfall, inflow from tributaries and return flow from various uses, and subtractions, that is, evaporation, evapotranspiration, deep percolation, export to other basins, run-off into the ocean and withdrawal for use. Finally, the *closing stock* deals with the amount of water available at the end of the accounting period. On the other hand, the monetary account deals with assigning the monetary value to various components in the physical account and can inform us as to how the scarcity value of water changes due to flows of water resources over a period of time, leading to change in the stock. Placing monetary values on the *non-market* components of water is possible with various non-market-valuation techniques developed by environmental economists over the years (Champ, Boyle, & Brown, 2003), which could be appropriately used to estimate the scarcity value of water. At present, water allocation decisions are based on the *engineering approach*,[3] which embodies the notion of *surplus water* being measured only in terms of physical units. However, water that is *physically surplus* may be *economically scarce* as reflected by the monetary measures. In order to manage water more efficiently and sustainably, future water-allocation decisions—both within and across river basins—will have to be guided by an economic approach that deals with the scarcity value of water measured in monetary terms.

Degradation of water sources by pollution from various point and non-point sources is a serious concern in India. Although water in many river basins is treated as surplus, the reality is that it can no longer be used for productive purposes. The social costs (or the social benefits lost) due to water pollution in India has not yet been adequately quantified in economic terms.[4] Therefore, the extent to which water pollution impacts the sustainability of India's development is not yet known. More studies on the economic valuation of the impact of pollution on ecosystem services as well as on those sectors that utilize these ecosystem services are warranted for.

Water pollution imposes social costs in terms of the reduction in production and productivity in the agriculture and allied sectors, in industrial output and labour productivity, in quality of life due to mortality and morbidity from water-borne diseases and so on. At present, the decision to control water pollution in India is based mainly on the extent of the pollution abatement cost but not on the damage cost avoided. Unfortunately, as the pollution abatement cost is considered to be high in absolute terms and pollution control measures result in palpable trade-off between water conservation and economic development, the polluters and policy makers are not in favour of sacrificing development to support conserving water sources. In reality, the hidden social costs imposed by the current level of pollution are much higher than the abatement costs. It implies that the marginal social benefits of abating pollution are much greater than the commensurate marginal social costs. Therefore, measuring the economic value of marginal benefits and pollution abatement costs would provide a strong economic justification for stringent water pollution control measures in India.

At present, India follows a pollution control policy dominated by the command-and-control-based approach. However, it is found that there is a lack of incentives for the polluters to control pollution. Rather, the current policy encourages the polluters to bribe the pollution control officials (Venkatachalam, 2012, p. 94). In various parts of the world, the implementation of market-based instruments (MBIs; Sterner, 2011) with an appropriate government regulation has resulted in desirable outcomes in terms of pollution control (Stavins, 2001, p. 45). India's pollution control policy too should focus more on implementing MBIs in addressing pollution problems. MBIs could play a crucial role in managing water bodies in an efficient, equitable and sustainable way. In the Asian context, the payment for ecosystem services (PES) is one innovative and promising MBI that leads to the win-win situation for both suppliers and buyers of ecosystem services (Adhikari, 2009). For example, PES played a crucial role in protecting and conserving Kulekhani watershed in the Makwanpur district of Nepal (Adhikari, 2009; Huang & Upadhyaya, 2007). In China, two nationwide programmes—the Sloping Land Conversion Programme (SLCP) and the Forest Ecological Services Compensation Fund (FESCF)—have already incorporated payment for water services to protect major river basins against siltation and floods (Huang et al., 2009).

An arrangement to compensate the villagers who participated in protecting upstream drinking water sources for the people downstream areas in the Sukhomajri watershed region in northern India has been a classic example of how the PES-type mechanism could work efficiently in the Indian context (Huang et al., 2009; Kerr, 2002). Another notable example from India is the user groups managing the Rettaikulam irrigation tank in the Tirunelveli district of Tamil Nadu. They levy *ayacut vari* (a tax based on the size of landholding) on the borewell owners in the command area and utilize the tax revenue to meet their financial requirements of maintaining the tank (Sakthivadivel, Gomathinayagam, & Shah, 2004, p. 3525). These examples suggest that PES has a greater potential to manage small water bodies in India (Venkatachalam, 2014). It could significantly benefit the poor as well (Wunder, 2008). We could say that the institutional failure and the resulting mismanagement of water sources in India could be addressed through appropriately integrating communities, markets and governments.

Continuing with the above discussion, 11 articles in this special issue, divided into 'Perspectives' and 'Articles', highlight a range of problems in managing water for sustainable development in India and also provide policy prescriptions. We wish to thank all the authors for their contributions and co-operation. We appreciate their adherence to the deadlines that has helped in bringing this special issue on time.

Katar Singh provides an economist's perspective on managing water for sustainable development. He concisely presents a bird's eye view of the overall water scenario in India and carves out possible solutions for both contemporary and future water issues. While reiterating the fact that India's water resources are being grossly mismanaged, he also argues that judicious management of water is a pre-requisite to avoid the unsustainable development path. He warns that the average amount of utilizable freshwater available in India is likely to decline further in future due to increased water consumption in household, industry and agriculture sectors. Climate change is also likely to further escalate water scarcity. Therefore, the most serious policy challenge is how to minimize the water deficit or demand–supply gap, especially the regional and seasonal deficits. Highlighting the seriousness of the issue, Katar Singh provides policy prescriptions that target both supply- and demand-side aspects of water management.

Managing water in urban settings that requires sustainable strategies for both supply- and demand-side aspects of water management is becoming a major challenge for policy makers. In the past, the issues pertaining to water transfer from rural areas to meet the ever increasing water demand in urban areas dominated the policy discourse on inter-sectoral water allocation. However, India's urbanization process at present brings in a set of complex issues that require innovative approaches for managing water to meet the growing supply–demand gap in cities. A close look at India's urbanization process, especially during the post-reform era, reveals that it is undergoing a unique 'periurbanization' process wherein the traditional rural areas are increasingly becoming urban in nature. Such a process exerts enormous pressure on water bodies which once served agricultural purposes. One major concern is that the water bodies are being consumed by upcoming infrastructural, industrial and real-estate projects. Land acquisition for infrastructural and real-estate purposes in periurban areas leads to the reduced groundwater table and increased water conflicts. Such conflicts escalate the transaction costs to different water users due to the periurbanization process. In this context, Vishal Narain in his perspective based on the analysis of Gurgaon—popularly known as India's Millennium City—reveals a cascading effect of land acquisition, diminution and degradation of surface water sources, reduced groundwater table, increased conflicts among water users and increased social costs due to escalating transaction costs. Vishal suggests that India's development policies, in general, and urban policies, in particular, should approach the periurban water security from the perspective of justice and equity.

Institutions—the rules of the game—play a crucial role in addressing water scarcity, in general, and groundwater overexploitation, in particular. Efficient institutions, both formal and informal, minimize the transaction costs of water conflicts. Two perspectives in this special issue deal with how emerging, new institutions in the groundwater sector could provide a solution to overcome groundwater resource scarcity and produce non-zero-sum pay-offs to the stakeholders. Amrtha Kasturi Rangan discusses the results of a pilot project on the Participatory Groundwater Management (PGWM) Programme, supported by Bangalore-based Arghyam, a grant-making foundation with a focus on groundwater and sanitation, and developed by four premiere institutions in India working on groundwater management. Through community participation and decentralized application of hydrogeological knowledge, the PGWM approach generated positive results in four pilot sites. The evolution of local norms for better water use played a significant role in reducing water scarcity and increasing agricultural benefits.

While Amrtha's perspective deals with how the non-governmental organizations could produce desirable results, P. S. Narayan's perspective illustrates how corporate bodies could play an effective role in groundwater management, especially at the decentralized level. Narayan shows how Wipro's larger, cooperative and multi-stakeholder approach has translated into a successful PGWM in Sarjapur in Bangalore—popularly known as Silicon Valley of India—where it has its corporate headquarters and a large special economic zone (SEZ) facility with more than 10,000 employees. Wipro's water conservation endeavours suggest that an effective networking among the corporate sector, the communities and the governments and the site-specific rules of the game designed by the stakeholders themselves could bring in the win-win outcome for all the stakeholders of water management. Wipro's multi-year engagement in PGWM in Sarjapur also guides how corporate houses could effectively employ funds, especially set aside for corporate social responsibility for sustainable water management at the local level.

Watershed programmes with massive government resources were initiated in the middle of the 1990s in order to efficiently utilize scarce water for enhancing agricultural productivity and subsequently to address the poverty and livelihood issues, especially in semi-arid areas in India. In general, the watershed programmes have not been able to generate expected results due to various technical and institutional problems. One major reason is the lack of participation of beneficiaries in formulating and implementing the watershed programmes. Therefore, the *collective action* required to carry out certain joint activities under the watershed programmes did not emerge adequately. Such a lack of participation originates from the individual rationality of the beneficiaries who experience a higher level of transaction cost of participation. The new institutional economics suggests that a better way of enhancing collective action is to reduce the transaction cost by creating alternative, efficient institutions.

Dinesh Jain and Vasant P. Gandhi, in their article, outline an alternative framework for correcting institutional failures and making watershed management more efficient in India. They reinstate eight different types of *rationalities*, namely technical, environmental, economic, social, political, organizational, financial and governmental that influence good governance and performance. They utilize a demand-and-supply framework within which the institutions interact with each other and illustrate such an interaction by analyzing a case study of local institutions managing watersheds in three districts in the state of Andhra Pradesh. Their findings suggest that apart from the quantitative aspects of interaction between institutions, the qualitative aspect is also equally important for successful management and governance of watersheds. They conclude that the improvement in the performance of watersheds could be brought about through better institutional design, well-thought-out programme guidelines that incorporate various rationalities, setting up of complete organizational structures that facilitate the people to participate, incorporating more participative decision-making and enhancing capacity building for promoting leadership.

Small water bodies like wetlands play a crucial role in generating highly useful ecosystem benefits that significantly contribute to the welfare of the people, especially at the local level. Wetlands supply enormous social benefits including water for drinking and irrigation purpose, food and fibre, flood control, nutrient recycling and toxic removal. In fact, wetlands have a greater potential in mitigating the climate change impacts (Palanisami, Meinzen-Dick, & Giordano, 2010, p. 183). In recent years, however, the size of the wetlands in India is significantly declining due to negative externalities associated with rapid urbanization and pollution from various point and non-point sources. In addition, the traditional institutions managing small water bodies in India have gradually eroded (e.g., Balooni, Kalro, & Kamalamma, 2008, 2010; Koul, Singh, Neelam, & Shukla, 2012; Palanisami & Balasubramanian, 2002). Such an institutional failure leads to the deterioration or degradation of wetlands as well as it results in loss of economic welfare. In order to correct such a deep-rooted institutional failure (or institutional vacuum), Nitin Bassi, in his article, suggests that there should be a well-defined legal framework that should deal exclusively with wetland management, strengthen the policies that put more emphasis on wetland management and make the regulation more stringent, especially for protecting the smaller wetlands—those not coming under the purview of Ramsar Convention. Nitin also suggests initiating more decentralized-level monitoring of wetlands with a periodic assessment of hydrology, ecology and water quality.

Groundwater irrigation plays a predominant role in agricultural production and productivity in India. Green revolution and subsequent food security for the majority of people in India were made possible due to technological improvements in groundwater irrigation. In order to increase agricultural production and productivity, many state governments in India provided electricity subsidy for groundwater irrigation. Although such a subsidy initially generated larger benefits to the society, continuous over-exploitation of groundwater has adversely affected the inter-temporal welfare of the farmers. The question is what went wrong with India's groundwater sector? Dinesh Kumar, in his article, argues that groundwater is being used excessively because of certain policy failures in the agriculture and groundwater sectors. Therefore, he suggests that introducing suitable MBIs, such as increasing the power tariff with the regulation of power consumption, and introducing tradable water rights could provide appropriate incentives and dis-incentives for the farmers to conserve and utilize the groundwater optimally.

What is the impact of agricultural water markets on small and marginal farmers who dominate the agricultural landscape in India? Sarbani Mukherjee and Durba Biswas through a case study in the groundwater-market-dominated regions in the state of Madhya Pradesh where water extraction is facilitated through electricity subsidy find that small and marginal farmers have benefited significantly from the water markets facilitated by electricity subsidy. To find out the equity implications of the groundwater markets, the authors have compared water markets in a region where farmers use diesel pump-sets for water extraction and another region where electric motors with subsidized electricity are used. The results reveal that the farmers participating in the electricity-based groundwater markets are better-off compared with those participating in the diesel-powered groundwater markets. While electricity subsidy has favourable equity impacts, it also leads to groundwater over-extraction. It implies that in the long run, groundwater over-exploitation could negatively affect the inter-temporal welfare of the farmers. Drawing from their in-depth analysis, Sarbani and Durba suggest that electricity subsidy should be removed in a phased manner. Simultaneously, they opine that there is a need to introduce other alternatives for the farmers, such as improving the performance of small water bodies and investment in water-saving technologies.

To eliminate electricity subsidy, in a phased manner, in India, other alternatives for efficient and conservative water use in agriculture should be explored. Recent developments in agricultural technologies have helped the farmers not only to increase agricultural productivity, but also to optimize the use of scarce resources, such as labour and water. Two such promising examples are the system of rice intensification (SRI) and drip irrigation. A. R. Durga and D. Suresh Kumar in their case study on SRI adoption in the Palakkad district in the state of Kerala examine various factors that influence the farmers either to adopt or to discontinue SRI. They find that SRI is a suitable technology to cope-up with water scarcity, but the basic minimum irrigation required for rice cultivation under SRI, especially in water-scarce areas of Palakkad, should be ensured. What is the impact of drip irrigation? A. Narayanamoorthy, N. Devika and M. Bhattarai, using the discounted cash flow method, estimate the benefits of drip irrigation employed for cultivating green chilli in Tamil Nadu. The authors find that investment on drip irrigation in green chilli cultivation is economically viable even without state subsidy. In fact, the marginal and small farmers benefit more from drip irrigation and that there is a need to promote awareness programmes to scale up drip irrigation across the country.

Vivek's article 'Rainwater harvesting in Chennai: What made it work?' deals with the supply augmentation measures in the groundwater sector in the context of Chennai Metropolitan Area in Tamil Nadu. During the late 1980s and early 1990s, private water markets emerged on a large scale to supply water to the ever increasing demands from rising population and booming construction industry. The private water markets comprised mainly of lorry tankers that supplied water extracted from the Minjur aquifer along the coastline of Bay of Bengal. Competition for extracting groundwater by the private borewell owners resulted in the over-exploitation of the aquifer. As a result, seawater from Bay of Bengal intruded into the aquifer, making the existing groundwater brackish. In order to correct this market failure, the state government of Tamil Nadu initiated rainwater harvesting measures in 2003 which gradually improved the groundwater table in Chennai Metropolitan Area. Vivek's study analyzes the factors that brought about collective action among different stakeholders who harvested rainwater and increased the groundwater table significantly, which is considered a success story at least partially by many observers. Vivek attributes the successful outcome of rainwater harvesting efforts to the strong political leadership and effective bureaucracy, awareness-building among stakeholders, stringent enforcement and monitoring and active community participation.

Among all the issues that India's water sector experiences right now, groundwater over-exploitation has become the single most important issue that needs to be dealt with adequately through appropriate policy measures. Otherwise, it will have profound negative implications on India's sustainable development and social welfare in the coming years. As the Brundtland Commission's report, *Our Common Future*, suggested long back, we need to think globally and act locally (WCED, 1987). The local efforts, such as participatory groundwater management and rainwater harvesting initiatives, which are proved to be successful in recharging groundwater, will have to be scaled up across India through appropriate institutional interventions. Similarly, water demand management is equally important. It has been proved that improved efficiency of water use in the agriculture sector would ease sufficient amount of water for use in other sectors, thereby mitigating the inter-sectoral water conflicts. Farm-level water-saving technologies, such as SRI and drip irrigation, need to be expanded through appropriate incentives that would motivate the farmers to reap the benefits from adopting these technologies. The institutional failure in the watershed approach in India can be addressed by improving the programme guidelines and by enhancing the effective participation of the stakeholders from conception to the implementation of the programmes by way of building adequate capacity among the stakeholders. To conclude, the lessons that we learn from the perspectives and articles included in this special volume are not only relevant for managing water in India, but are also applicable for other developing countries where similar scenario prevails.

Notes

1. One prominent example is the United States of America. Hanak et al. (2011) highlight how the State of California is moving on a development path with environmental and economic deterioration due to ever increasing water scarcity, continuous deterioration in the ecosystem and its inability to supply adequate water to the agricultural sectors and cities, growing conflicts over groundwater use and declining soil quality and crop yields in several regions.
2. National Statistical Organisation (2013) of India has recently developed a framework for computing green national accounts which will be complementary to the existing established system of national accounts.
3. For example, the discussion on the inter-linking of Indian rivers mainly revolves around the engineering approach (Bandyopadhyay & Perveen, 2004; Vaidyanathan, 2003).
4. There is one exceptional study. Mani (2013, p. 15) quantified India's environmental damage costs in monetary terms. The total value of it is equivalent to INR 3,751 billion per year which constitutes 5.7 per cent of India's GDP in 2009. The cost of health damage caused by water- and sanitation-related issues alone amounts to INR 540 billion per year or 14 per cent of the total environmental damage costs.

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Kulbhushan Balooni
Professor, Indian Institute of Management, Kozhikode, Kerala, India.
E-mail: kbalooni@iimk.ac.in

L. Venkatachalam
Professor, Madras Institute of Development Studies, Chennai, Tamil Nadu, India.
E-mail: venkat@mids.ac.in