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Table of Contents

List of Tables

List of Figures

1. Introduction

The industrial revolution has been one of the major transformations the planet has undergone. However, this has led to the advent of an era of quantity-oriented, expansionary growth heavily based on the extensive input of labor and capital. This along with rapid global population growth has brought about widespread environmental degradation, unsustainable consumption habits and other pressures on Earth's limited natural resources. This old developmental model threatens the sustainability of the entire world and needs a new growth paradigm that can address the challenges of resource depletion.

Green growth is the new development paradigm that sustains economic growth while at the same time ensuring climatic and environmental sustainability. It focuses on addressing the root causes of these challenges while ensuring the creation of the necessary channels for resource distribution and access to basic commodities for the impoverished. Under this new paradigm, new ideas, transformational innovations, state-of-the-art technology and traditional knowledge is expected to become the major drivers for growth. Recognizing this new reality, various countries, including India, are striving to implement sound policies for green growth.

The Government of India has formulated various polices relevant to green growth. Green growth development in the water sector mandates several policy and governance initiatives in order to enhance water use efficiency. The National Water Policy 2012 (NWP 2012) clearly states that water needs to be managed as a common pool community resource that is held by the State under the public trust doctrine to ensure equitable and sustainable development for all.

India is moving towards perennial water shortage. The current per-capita water availability is estimated at around 1720.29 m^3 per capita according to data from the Central Water Commission of India. India has been ranked 133 (Out of total of 182 countries) in terms of total renewable per capita water resources. The total water demand is projected to increase by 22% by 2025, and 32% by 2050 (Amarasinghe et al., 2007). A major part of the additional water demand will come from the domestic and industrial sectors. The water demands of the domestic and industrial sectors will account for 8% and 11% of the total water demand by 2025. There is also a huge disparity in water supply in urban and rural areas. Unless a strong policy initiative is taken up at the national as well as state level, the water sector scenario is expected to worsen. Figure 1 gives a realistic account of the water resources in India.

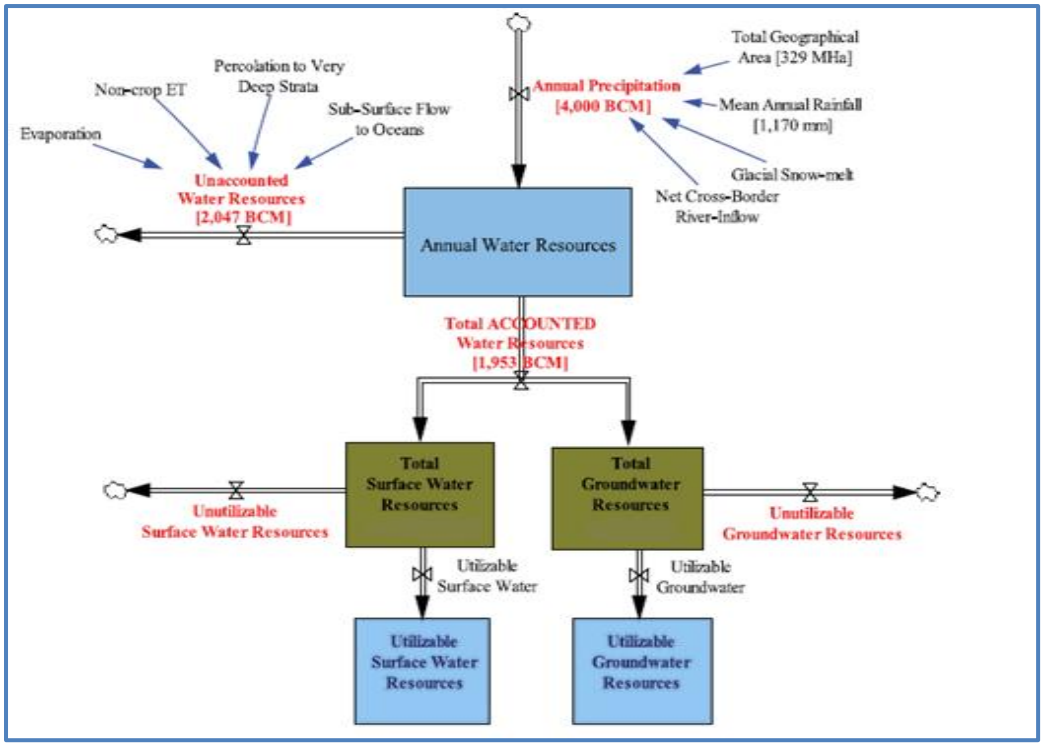

Figure 1 Water Resources of India

Source: (Verma &Phansalkar, 2007)

There is a need to improve the governance and management of water in order to ensure availability of water for all purposes. There is plenty of room for improvement in the management of water in agriculture, industry and domestic sectors, in particular in terms of demand management, regulation, water use efficiency and controlling pollution. The key challenges are inadequate storage capacity, governance deficit and fragmented institutional framework, inefficient agricultural practices and wastage in water for irrigation, inadequate water management by and for industry, leakage in water supply network and wastage of treated water. Recycling water in industry is not common and the technology is not percolating at the scale as required. The National Water Policy 2012 as well as the National Water Mission would provide a broad overarching framework of general principles on water which will necessitate the requisite administrative frameworks needed for greater clarity on demand management, protection of water resources, and improving efficiency of water use.

2. Institutional Framework

The National Water Policy of the Government of India came into being in 1987. The policy laid down an allocation prioritization principle for water as follows:

- Drinking water
- Irrigation
- Hydro-power
- Navigation
- Industrial and other uses

Subsequently, the National Water Policy 2002 (NWP 2002) was introduced to address the emerging issues in water sector and provide critical policy inputs. For the first time, emphasis was given to ecological and environmental aspects of water allocation. National Water Policy 2012 (NWP 2012) which evolved a decade later called for a common integrated perspective to govern the planning and management of water resources. Such a perspective would consider local, regional, and national contexts and be environmentally sound. NWP 2012 clearly states that water needs to be managed as a common pool community resource that is held by the State under the public trust doctrine to ensure equitable and sustainable development for all.

NWP 2012 has done away with water allocation prioritization mentioned in NWP 1987 and NWP 2002, but has emphasized on treating water, over and above the pre-emptive need for safe drinking water and sanitation, as an economic good. NWP 2012 also emphasizes the fact that the service provider role of the State has to be gradually shifted to that of a regulator of services and facilitator for strengthening the relevant institutions.

Box 1: National Climate Missions to tackle climate change

1. National Solar Mission
2. National Mission for Enhanced Energy Efficiency
3. National Mission for Sustainable Habitat
4. National **Water Mission**
5. National Mission for Sustaining the Himalayan Ecosystem
6. National Mission for Green India
7. National Mission for Sustainable Agriculture
8. National Mission on Strategic Knowledge for Climate Change

The National Water Mission (NWM) of India, which is one of the eight Missions created under the National Action Plan for Climate Change (Box 1), emphasizes research studies on all aspects related to impact of climate change on water resources including quality aspects. The National Water Mission reiterates the need for sensitization of the local communities and community leaders and public representatives of overexploited areas on dimensions of the problem and also stresses on the investment under MGNREGA towards water conservation by ground water recharge. Furthermore, the NWM suggests an increase of 20% in water use efficiency by 2017.

The former Planning Commission (now NITI Aayog) of India prepared a draft Model Bill (Draft Model Bill, 2011) for the conservation, protection, and regulation of ground water which aims at equitable regulation and control of ground water and addresses many of the concerns, including 'Right to Water', and water use prioritization principles. Importantly, it sets out an institutional framework for planning and regulation which is based on the Panchayat and Municipal framework provided in Article 243 of the Constitution. The States need to enact legislation based on a Model Law at the earliest. At the same time, the Model Law itself needs to treat ground water and surface water more effectively as a common resource.

3. Pricing

3.1 Current interventions in India

The National Water Policy (2012) of India states that water needs to be treated as an economic good and therefore, may be priced to promote efficient use and maximizing value from water. Water pricing is a contentious issue, especially in the context of equity and meeting minimum needs, particularly for the poor. However, appropriate pricing ensures more efficient utilization, thus increasing water availability in general. While rational water pricing can facilitate water management, new methods for subsidizing the water supply to poor sections of the society need to be evolved. Some measures that could play a role include:

- Rationalization of consumption through slab based tariff system,
- Affordable loans to consumers for purchase of water efficient irrigation technologies
- Direct subsidy to manufacturers of water efficient irrigation technologies

All the cities in India currently operate a mix of measured/ metered or unmeasured/unmetered tariffs. There exist two different pricing regimes in two-tier tariff system consisting of a demand charge and variable charges; and Increasing Block Tariff (IBT). IBT is more appropriate for domestic users, while uniform volumetric charges are recommended for non-domestic users. There is a need to enforce 'water returns', which is annual return to be filed by water users on similar lines of tax returns—should include key measures like water utilisation per unit produce, effluent discharge details, rain water harvested, water reuse details, fresh water consumption. Table 1 discusses the institutional and regulatory framework; the operational framework; tariff mechanism and structures; and water utility performance (in percentages) with regards to the water sector, for select Indian cities.

Table 1 Framework and actors for water sector for select Indian cities

Particulars	Ahmedabad	Delhi	Chennai	Hyderabad	Bangalore	Raipur
Institutional and Regulatory Framework						
Agency type	Municipal Corporation	Para-statal	Independent Board	Independent Board	Independent Board	Municipal Corporation
Utility	Ahmedabad Municipal Corporation (AMC)	Delhi Jal Board (DJB)	Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB)	Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB)	Bangalore Water Supply and Sewerage Board (BWSSB)	Raipur Municipal Corporation (RMC)
Independent Regulator	Bill drafted, Act pending	Nil	Nil	Nil	Nil	Nil
Operational Framework						

Particulars	Ahmedabad	Delhi	Chennai	Hyderabad	Bangalore	Raipur
Operation and maintenance	Yes	Yes	Yes	Yes	Yes	Yes
Capital works	No (State Govt.)	Yes	Yes	Yes	Yes	No
Revenue function	Yes	Yes	Yes	Yes	Yes	Yes
Tariff mechanism and structures						
Tariff fixation	State Government	DJB (with state intervention through subsidies)	CMWSSB (with state intervention through subsidies)	HMWSSB (with state intervention through subsidies)	BWSSB (with state intervention through subsidies)	RMC (With approval from state govt.)
Tariff structure	Single part; Non volumetric flat rate	Two part; IBT	Two part; IBT	Two part; IBT	Two part; IBT	Single part; ferrule based
Tariff subsidy	Yes	Yes	Yes	Yes	N/ a	N/ a
Water utility performance (in percentages)						
Coverage area	85	N/ a	89.3	N/ a	N/ a	85
Full cost recovery	No	No	O&M cost fully recovered	No	O&M cost fully recovered	No
UFW	20	50	17	55	50	N/ a
Metering	Nil	76	3.5	N/ a	100	Nil
Collection efficiency	70-75	35	100	N/ a	99	N/ a

Source: TERI compilation

For major water using industries and businesses, reuse and recycle of wastewater in industry needs to be made mandatory. There is a need for regulations and incentives through national frameworks and a system of water returns. There has to be industry specific standards for promoting rain-water harvesting in industry, both within and beyond the fence through incentives and regulation. Equity-based and efficiency-based water pricing regime for industries needs to be created. Lack of a clear policy framework based on cost-recovery principles needs to overcome. In the current pricing regime, water is undervalued for all users. TERI has carried out a study in this area and Table-1 gives comparative summary of key institutions, legal framework and pricing mechanisms in Urban

Water Supply & Sanitation Services in some of the Indian cities reviewed under this study. Maharashtra Water Resources Regulatory Authority (MWRRA) is an exemplary case of water pricing policy and implementation in India (refer to Box 2).

Box 2: Maharashtra Water Resources Regulatory Authority

The Government of Maharashtra enacted the Maharashtra Act No. XVIII of 2005 called as Maharashtra Water Resources Regulatory Authority Act, in June 2005. The MWRRA Act was enacted with the following objectives:

- To establish the Maharashtra Water Resources Regulatory Authority (MWRRA)
- To facilitate & ensure judicious, equitable and sustainable management, allocation and utilization of water resources
- To fix rates for the use of water for agriculture, industrial, drinking and other purposes and matters connected therewith

Accordingly, the Maharashtra Water Resources Regulatory Authority (MWRRA) has been established to regulate the water sector in the State, and is the first such authority anywhere in the country, with such a specific mandate. The MWRRA Act, 2005 empowers MWRRA to regulate the water resources within the State of Maharashtra, fix the water tariff system at sub-basin, river basin and State level, and frame Regulations and Orders for better management of water resources in the State.

MWRRA has been able to regulate the water tariff system in the State. It has been able to undertake water resource development and management as per the Integrated State Water Plant prepared by the State Water Board and approved by the State Water Council. It has also been able to facilitate the development of a framework for the preservation and protection of the quality of surface and sub-surface water within the state.

Source: Koonan, S and Bhullar, L., 2012

3.2 Future directions

Water is generally not perceived in India as an economic good. Nor does the 'polluter pays principle' being implemented. This makes the associated features such as the concept of user payments and 'Water Pricing' hard to be implemented in many parts of India, thereby adversely affecting the sustainability of water supply.

It is also seen that success in implementing bulk water pricing arrangements requires the cooperation and engagement of all key stakeholders. It is particularly important for agriculture and industry representatives to be involved at all stages of the design and implementation process.

An interesting mix of local and national involvement is required for developing a bulk water pricing framework. The local element relates to issues such as the need to involve regional stakeholders (rather than having decisions imposed from 'above') and the wish to reinvest collected funds in the water basin whose resources are being charged for. The national element relates to issues such as the need for a formal (and ideally transparent) subsidy

policy to be implemented alongside the pricing framework as it is unusual for the identified full costs of water allocation to be imposed on all customer groups in the short term.

Allied to the previous point, a successful bulk water pricing framework needs to be formally administered and organised – relying purely on market forces to allocate value to water resources does not work. In addition, the direct involvement of a federal agency helped to balance the interests of different groups whilst still allowing each stakeholder to negotiate terms. This central administration involvement can take many forms, but a robust and independent (as perceived by stakeholders) regulator may be the best alternative.

Bulk water pricing arrangements need to be accompanied by a well-defined water entitlement framework that is flexible enough to adjust rapidly to changing environmental conditions. In terms of pricing approach, marginal cost pricing (or variants thereof) is generally perceived to be the preferred option. Within this framework, two part pricing methodologies are commonly adopted in an attempt to send appropriate pricing signals and to help maintain the financial integrity of water utilities.

In India, water pricing is a contentious issue, especially in the context of equity and meeting minimum needs, particularly for the poor sections of the society. There is a need for the authorities to take into account development, management, and O&M charges while fixing tariffs. Additionally, the Water Users Associations (WUAs) or Panchayati Raj Institutions (PRIs) should be given statutory powers to collect (and enforce collection) water charges and retain a portion, manage the volumetric quantum of water allotted to them and maintain the distribution system in their jurisdiction.

4. Regulation

4.1 Current interventions in India

Despite having an environmental policy framework, countries often lack a clear set of regulations to help enforce policies and improve environmental compliance. The Government of India is aware that strong State control remains important for creating legislative and policy frameworks that encourage devolvement of management to community groups and the private sector. To meet the needs of a fully independent body or bodies to represent the stakeholders and the needs of the environment, it is important to establish independent regulators for ground water and regulators for water use who would support coordination and control of the planning and management of water resources including the catchments. The power sector has established an independent power regulator, which has achieved good success in the fiscal aspects of controlling the various developments but with less involvement in social and environmental aspects.

Outside the hydropower sector, there are some questions on the real need for regulators since most water sources are still maintained under government control. The key issue is whether the government as the planner, developer, and manager of water projects, can realistically also be an independent body to oversee and control, set tariffs, and ensure that consumers receive adequate levels of service delivery.

The Central Ground Water Board (CGWB), under the Ministry of Water Resources, Government of India, is the national apex agency entrusted with the responsibilities of providing scientific inputs for management, exploration, monitoring, assessment, augmentation, and regulation of ground water resources of the country. Central Ground Water Authority (CGWA) has been constituted for the purpose of regulation and control of ground water management and development in terms of the Environmental Protection Act (EPA). This enables it to regulate withdrawal of ground water in critical and overexploited areas and to prevent construction of ground water structures or drilling of tube wells in areas notified as critical or overexploited.

4.2 Future directions

Regulatory action through pricing of water is critical for its economical and efficient use. On similar lines of CGWA, the State Water Regulatory Authority can be statutorily empowered to fix appropriate tariffs, enforce recycling measures, prevent and control pollution, ensure the preservation and management of water sources.

Regulatory functions need to extend to proper management of the resource and a specific legislation is required for the proper management of not merely ground water but for surface water and ground water as a jointly managed resource.

The Central Government needs to enact a framework law or develop a Model Law, so that States can enact legislation conforming to a broadly uniform framework. While the regulatory authority can regulate, it is essential to separate the planning function and energize the National Water Board and the National Water Resources Council for the purpose. Similar boards at state level would need to discharge the state level planning functions, suitably providing for planning role for municipal and panchayat bodies at the regional level.

5. Finance

5.1 Current interventions in India

There is considerable support by the Government of India in green economy and there exists a judicious mix of government support and domestic targets to stimulate the respective green sectors. According to the UN report (UNEP 2011), the transition towards a green economy demands significant financial resources. Estimates indicate that USD191 billion per year until 2030 and USD311 through to 2050 are required only for investments in water and sanitation services. India faces a major problem of poor and ill maintained water infrastructure both in its rural and urban areas. A number of irrigation projects remain incomplete, many are redundant. Water supply is often disrupted and the distribution system suffers huge losses due to leakages, and wells and tanks remain clogged due to lack of regular maintenance due to non-availability of funds for operation and maintenance (O&M). There is often no community ownership, nor any financial contribution from the community in sustaining a project. Accordingly, not only is there an urgent need to direct investments towards maintenance of existing structures and development of new ones, but also to improve the efficiency in use of funds to make better use of scarce financial resources.

Some of the important measures in this direction include:

- Establishment of special purpose vehicles for investment in water supply and infrastructure at the river basin level
- Replication of successes in energy supply through private sector participation in the metropolitan areas, to water sector
- Privatization of waste water treatment systems in urban areas

In spite of the efforts by the government and private parties, there exists a big gap between what is required and what has been committed. Major efforts are needed to mobilise and channelize sufficient financial resources towards sustainable development and green growth activities. The various states of India have their respective strategies in dealing with green growth developments.

5.2 Future directions

There have been several attempts in India to involve the private sector in urban water supply services. These attempts have had mixed outcomes: while several projects planned during the initial years were abandoned in the development phase, there has been an increase in the number of contracts awarded to the private sector in recent years. There has also been a change in the type of projects developed and the role of the private sector in these projects.

A study by Water and Sanitation Programme of the World Bank (WSP 2011) covers Public Private Partnership (PPP) attempts in urban water supply from 1990 till 2009, mentions that the presence of a regulator can strengthen the performance orientation of local bodies and provide an objective basis for tariff setting and targeted subsidies. In doing so, it can help create a more transparent and predictable environment for attracting investment into the sector, including from private sources, and facilitate improved project design and implementation through PPP structures. The introduction of sector regulation, however, needs to be also accompanied by other enablers such as rationalized public funding, tariff frameworks, increased role clarity, and stakeholder participation.

6. Innovation policy

6.1 Current interventions in India

National Water Policy (NWP) 2012 gives top priority of water allocation to drinking water, and emphasizes the need for river basin based planning of water resources. Besides drinking water requirement, significant amount of water is required for production of food, fiber, fuel and other industrial outputs. As the country's water resources are limited and the demand for water is increasing with growth in population and increasing urbanization, satisfying water requirements using less quantities and still achieving efficiency targets is major challenge for domestic, irrigation and industry sector. NWP 2012 envisages suitable policies for adequate water supply and sanitation, water use efficiency in the agricultural and industrial sectors, issues related with impacts of climate change, robust institutional arrangements and water pricing. The National Water Mission suggests an increase of 20% in water use efficiency by 2017. The National Water Policy also stresses on efficient use of

water, as part of the demand management strategies. This is an achievable goal and must be strongly supported by state level policies. This should require states to adopt technological as well as regulatory measures, such as:

- Methods to encourage water saving during irrigation
- Aligning cropping pattern with natural resource endowments
- Application of micro-irrigation techniques such as drip, sprinkler, automated irrigation operation, and evapotranspiration reduction.
- Conjunctive use of surface water and ground water
- Local level micro-irrigation through small bunds, field ponds, and agricultural, engineering methods for watershed

6.2 Future directions

Water use efficiency needs to be incentivized by proper energy pricing for use in agriculture, both in ground water extraction and lift irrigation. Water audit needs to be made mandatory for specified types of industries and/or identified areas in order to efficiently manage water resources in the industrial sector. In order to locate policy and management gaps, regional water audits with respect to water use in agriculture on sample basis needs to be institutionalized.

7. Technology

Innovative water technologies can help close the increasing gap between water supply and demand. Water challenges and technical solutions to address them are dependent on many regional and local factors. Choosing available technologies and adapting them to the local conditions must be the result of local decision making. Research is needed to develop technology solutions that require minimum energy and cause minimal water loss. The government should encourage investment towards the development and implementation of such technologies through enabling environments.

International cooperation is needed to establish programmes that support developing countries to assess their technological needs in different sectors; to assess the appropriateness of various technologies, taking account of the environmental, safety, social and economic aspects; to identify the obstacles to the development or transfer of these technologies; and to devise policies and measures to overcome the obstacles. A network of technology experts in various areas should be made available to advise developing countries. Technology funds should be established, including under relevant conventions such as the United Nations Framework Convention on Climate Change (UNFCCC) and Convention on Biological Diversity (CBD), as well as in the social and development areas, to finance technology development and transfer.

The development and deployment of environmentally-sound technologies require a strong and dedicated programme at the national level, with significant public investments in developing countries, for projects such as feed-in tariffs to enable large-scale development and use of renewable energy. Due to the limited resources of developing countries, a significant part of the financing for such technology programmes could be facilitated from

international funds in order to ensure sustainability of the innovative technologies.
India has undertaken considerable investments for infrastructure development in order to meet the country's water and agricultural needs, particularly in support of technology-based interventions to improve production of food grains, pulses, oilseeds, and vegetables. Israel

Box 3: Water Technologies in Israel

Israel has succeeded in forcing the desert to recede. Since independence in 1948, cultivated agricultural land has nearly doubled while forested land has increased more than twentyfold, to nearly 274000 acres from about 13000, according to Israel's Central Bureau of Statistics. Satellite images show a nation that is now largely green.

The transformation began in the 1950s with the construction of Israel's National Water Carrier, a pipeline that transports water south from the Sea of Galilee – Israel's main source of fresh surface water into the Negev Desert. Around the same time, an engineer named Simcha Blass was developing a system of spiral plastic tubing that would revolutionize agriculture by nourishing plants drop-by-drop.

Six wastewater treatment plants stretch the country's resources even further. They clean sewage, which is then sent to one of nine facilities that disinfect the wastewater, making it sanitary enough to irrigate crops. Nearly 95 billion gallons of water — roughly 75% of Israel's sewage — is reclaimed this way each year. But perhaps no technology has done more to satisfy Israel's thirst than desalination. Five massive plants dot the country's coastline, sucking billions of gallons of water from the Mediterranean each year.

In Israel, the concept of extracting drinking water from the sea began as early as 1965, when a desalination plant in Eilat on the Red Sea became functional, though it was an energy-intensive distillation process. Over the next several years, Israeli firms developed and advanced a much more efficient process using reverse osmosis, a filtration-like technology. Since the 1970s, the cost of removing salt from sea water has plunged from about $2.50 per cubic meter of water, or 264 gallons, to as little as 50 cents, according to academic research in Israel. Still, the cost of water is not cheap: Israelis pay an average of $11 per 1,000 gallons of water, compared with Bostonians who pay less than $6 on average.

Israel, however, is confident that new advancements in desalination will push costs even lower, and by 2020, become capable of supplying the entire nation's domestic water consumption. But in a country where water remains the most valuable commodity, innovations to make the most of it never stop.

Drip-irrigation and related systems — many pioneered by Netafim — today nourish about 75% of Israel's agricultural land and 5% of the world's irrigated crops. From the original coil of plastic tubing that regulated the drip-drip-drip, Netafim has transformed the main component of the technology into an inch-long rectangle with a labyrinth of tiny channels to deliver the precious drops even more precisely.

Source: Water Technologies in Israel, 2014

depicts a very good practice in terms of technological innovation (Box 3) in meeting drinking water needs by desalination as well as practicing water use efficiency by enhancing water use efficiency.

7.1 Future directions

Water use efficiency (WUE) can be enhanced in irrigated agriculture by increasing the output per unit of water (agronomic, engineering, management and institutional aspects), reduce losses of water to unusable sinks, reduce water degradation (environmental aspects), and reallocate water to higher priority uses (societal aspects). Specific examples of achieving WUE can be agronomic approaches for crop management by selection of optimum cropping pattern and less water intensive crops. Additionally, it is important to enhance moisture conservation or to reduce water percolation and evaporation, using techniques such as conservation tillage and plant spacing. Engineering approaches that help promote WUE involve irrigation systems design by laying hydraulically and geometrically efficient systems to reduce application losses and/or improve distribution uniformity, lining of canals, furrow irrigation, pressurized irrigation and others. Then, the management approaches like demand-based irrigation scheduling, participatory irrigation management, multiple use of water also help in attaining WUE. Further, there are institutional approaches like participation in an irrigation district (or scheme) operation and maintenance, appropriate water pricing, and capacity building of farmers' organizations that are promising in achieving WUE.

8. Capacity building needs for India

Proper management of water as a resource cannot be ensured by the central government or even by the state governments on their own. Better and more efficient management requires the development of community institutions to help develop and propagate better local practices and apply social pressure to ensure proper regulation, minimize wastage, and enhance efficiency. Panchayati Raj Institutions (PRIs) and urban local bodies (ULBs) are instrumental in achieving sustainable management of water resources for the country, and thus their capacity-building has to be a matter of prime importance.

Institutional capacity building is of utmost importance in order to ensure that the mechanism of overall framework ensures efficiency in treating water as a finite but renewable resource to be carefully managed and judiciously utilized. Training and capacity building of engineers and water supply and sewage staff at all levels is essential to ensure efficiency and reduce waste. Each state should set up a training institution to provide training and develop skills for municipal, panchayats, and outsourced service providers and central government should set up research % development (R&D) institution with regional centres for research on all aspects related to resource use efficiency in the sector. There is a need to identify adequate number of national and state level key resource centres to build the capacity of the staff and officials on efficient management of water resources.

The training and capacity-building activities should be carried out in a sustained manner, with appropriate monitoring mechanism in place in order to effectively disseminate the learning and implement it on-ground.

9. Ways forward

Green economy requires a coordinated and planned set of actions leading to green growth development. A major objective of water planning is to determine the desired balance between water use and water protection within an integrated water resources management framework. River basins should be considered as the unit of water management. Further, water planning can only contribute to green growth if water is not perceived as a single sector or policy area, as is agricultural, energy and industrial policy, and rather the approach of integrated planning should be incorporated. Thus, effective regulation, coordination and management of water sector can play a significant role in India's transition towards green economy. Further, innovative methods and tools to transform the business-as-usual practices in water management can be explored.

A scientific appraisal of systemic issues in the water resources sector could be carried out and an implementation framework for interventions could be developed. An integrated set of interventions with implementation framework can be developed for reducing river pollution and facilitate its participatory implementation with stakeholders. Short to medium term and medium to long term strategies for green growth in the sector have been discussed below:

9.1 Short to medium term strategies

- Integrated water resource management for water conservation using rainwater harvesting and groundwater recharge as well as rejuvenation of lakes and ponds in the river basin catchment.
- Enhancing water use efficiency in irrigation, by using efficient irrigation techniques like drip and sprinkler systems and implementing micro-irrigation systems (MIS) through participatory irrigation management (PIM).
- Watershed management by design and construction of watershed structures (farm bund, farm ponds, check dams, contour bunding, and irrigation scheduling).
- Review the limiting factors and existing gaps in wastewater treatment in river basin (with respect to the technical, social, financial, institutional/ regulatory aspects) in order to reduce future challenges.

9.2 Medium to long term strategies

- Integrated wastewater management by treatment, recycle and re-use by identifying and designing innovative solutions for domestic and/or industrial sectors with appropriate use of decentralised and/or centralised options. Developing mechanisms and MIS platform with innovative information and communication technology (ICT) tools and technologies for an integrated and efficient monitoring, informed systemic responses and decision making.
- Developing water quality database and management using real time monitoring, linking billing with water supply network designs using Supervisory Control and Data Acquisition (SCADA) and cloud computing systems.

- Developing an implementation framework for policies & mechanisms for integrated river management.
- Regulatory/ institutional interventions by identification of existing gaps and bottlenecks in functional performance of the exiting institutions and developing an effective management framework with requisite reforms.
- Developing a mechanisms to facilitate all major commercial/institutional/industrial service entities to move to zero liquid discharge (ZLD) in a defined time frame.
- Review and devise inspiring incentives for water conservation (and reuse) and deterrent penalties for non-compliance
- Mechanisms for rational water pricing and sustainable financial performance of the local bodies.

In nutshell, green growth in water sector requires a paradigm shift, comprising of the following:

- Clear and comprehensive science-based Water Resource Policy (TERI, 2014) at central and state levels for integrated water resource management, which focuses on both supply-side and demand-side dimensions of water use.
- A Water Framework Law at central level laying out the architecture for planning and regulation and technical institutional support.
- Effective legislation at state level (based on the Central Model Law) for regulation of groundwater and surface water providing an explicit and increasing role for municipal and Panchayati Raj bodies in planning, management and regulation.
- Restructuring, strengthening and empowerment of the existing institutions (central, state, and local) involved in different aspects of service delivery so as to improve efficiency in management and sustainability of the resource.
- Major shift in approach in water resource management from purely engineering works to systems that incorporate traditional practices, local materials and are manageable and maintainable by local communities. The Gram Panchayat as well as the local community needs to be involved at all stages of discussion, planning, implementation, management and maintenance.

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About TERI

A unique developing country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across many continents to enhancing forest conservation efforts among local communities; from advancing solutions to growing urban transport and air pollution problems to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. However, while TERI's vision is global, its roots are firmly entrenched in Indian soil. All activities in TERI move from formulating local- and national-level strategies to suggesting global solutions to critical energy and environment-related issues. TERI has grown to establish a presence in not only different corners and regions of India, but is perhaps the only developing country institution to have established a presence in North America and Europe and on the Asian continent in Japan, Malaysia, and the Gulf.

TERI possesses rich and varied experience in the electricity/energy sector in India and abroad, and has been providing assistance on a range of activities to public, private, and international clients. It offers invaluable expertise in the fields of power, coal and hydrocarbons and has extensive experience on regulatory and tariff issues, policy and institutional issues. TERI has been at the forefront in providing expertise and professional services to national and international clients. TERI has been closely working with utilities, regulatory commissions, government, bilateral and multilateral organizations (The World Bank, ADB, JBIC, DFID, and USAID, among many others) in the past. This has been possible since TERI has multidisciplinary expertise comprising of economist, technical, social, environmental, and management.

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