NATIONAL PRODUCTIVITY COUNCIL

Productivity

Vol. 57 January - March 2017 No. 4

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Focus

Economics of Water: Understanding India's Water Balance in a Globalized Economy

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This article deals with economic conception of water as economic good as well as natural capital for equitable and efficient management of water under the globalized economy. Understanding of water as an economic good ensures devising various new market instruments which help allocation of water efficiently and equitably among competing sectors of the economy. The recent international attempts to include Natural Capital in the Integrated Economic and Environmental Accounting or Green GDP consider the role of total economic value of water to economic growth. The growing scarcity of water, already reflected in market prices, limits future economic growth of India, unless the government takes policy measure of supply-side (water enhancement) management through catchment area conservation and demand-side (efficient) management by reducing the demand for water in the cities. The study of New York and Bangalore in the context of climate change led water scarcity helps in understanding the status of urban water management by the respective water utilities. Water scarcity, water use inefficiency and inequity in water distribution have already resulted in prevalence of water poverty all over India. In this context, this paper favours that the production and consumption behaviours of industry and consumers should be on the path of sustainable development practices.

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Introduction

1. Water as an Economic Good

In future, economies falling and rising not based on speculative stock prices but on real water prices similar to ancient civilizations falling and rising on the banks of rivers. But economists hardly consider the economic scarcity of water succinctly reflecting their view 'to know the price of everything and the value of nothing' even though Adam Smith explained 'Diamond-Water Paradox'. He states that 'nothing is more useful than water; but it will purchase scarce anything; scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value-in-use; but a very great quantity of other goods may frequently be had in exchange for it' (Adam Smith, 1776). This implies that nothing is more useful than water but still it is relatively underpriced or cheap where market fails to reflect the value of water. Adam Smith assumed that water is abundant whereas diamond is scarce; of course, he was right given the time of writing his treatise 'Wealth of Nations' in 1776. Still, economics literature in 21st century lacks in considering water as one among the factors of production except land, labour, capital and organization assuming that water is available freely and in plenty and it is embedded with the property right or ownership of land. Even today, economic research abundantly takes into account productivity of land, labour, capital, organization for estimating the economic efficiency of industrial or agricultural output squarely ignoring the contribution of water to total production and productivity. The Productivity Commission of Australia recognizes water (TERM-Water) as a key factor input for irrigation sector and marketable asset among cultivators. Virtual water trade in the form of water embedded in the products of grains, timber, meats, fruits, flowers and so on is gaining importance of understanding the economic importance of water. The main issue surrounding water is that if water is recognized as economic, environmental, social and cultural good, it allows understanding of the importance of water from various needs (consumptive and non-consumptive) and also easy to assess and compare its varied benefits (direct and indirect). However, International Conference on Water and the Environment, held in Dublin in 1992 (ICWE,1992) generally agreed the principle that water should be recognized and traded like economic good. The market and price mechanism governs the water towards its efficient allocation, distribution, efficient use and equitable distribution among competitive uses of the economy. Understanding of water as economic good will ensure devising various new market instruments to ensure water is allocated efficiently and equitably. Further, economics will play an important role in understanding the scarcity and availability of water for short-, medium- and long-term benefits of society. This will also help in understanding dynamic characteristic of water whether short-run economic priorities of water policy spoil sustainable allocation of water in the long run. It is a difficult task to value water due to varied benefits and to monitor given its availability and condition which varies across space and time, stock and flows. The difficulty of valuation of water is also imposed by its fugitive, bulky and non-substitutable character. This allows us to think that water possesses a combination of attributes that makes it different from other resources and products. Water acts as environmental good by serving ecosystem as input, as natural resource acts as both product and by-product (polluted water). It shows that some services of water are valued (benefits) and dis-services (costs) are not. This calls for rational judgement by the policymakers to treat whether water is free good (public) or private good (economic), and whether water is renewable (abundant) or non-renewable (scarce)/conditionally renewable resource. Water is considered as a free good (river water) when there is no opportunity cost involved in production. The properties of non-rivalry in consumption and non-excludability make water as public good. However, water becomes an economic good when it is scarce and it involves opportunity cost (time and resource) for its extraction or/and production. The physical supply cost and scarcity value make water as economic good but it depends on location, timing, quality and uncertainty or variability. Further, characteristics or attributes associated with water also influence to treat as economic or free good where quality variation results in variation of quantity demanded. There is willingness to pay for better quality and reliable water supply. However, many complexities exist to treat water as an economic commodity to its nature but it helps in understanding the economic value of water in a globalized economy. As Ward and Michelsen (2002) state,'in a market system, economic values of water, defined by its price, serve as a guide to allocate water among alternative uses, potentially directing water and its complementary resources into uses in which they yield the greatest total economic return'.

Table 1: Methods for Assessing the Economic Benefits of Water Use

For an aquifer or a catchment	For a region, a system of region or a nation
1) Cost-benefit analysis	1) Input–output and embodied water analysis
2) Water value-flow analysis	2) Computable general equilibrium models
3) Water balance accounting	3) Spatial price equilibrium models

Source: Adopted from David F. Batten (2007).

Various economic methods are applied by the economists to assess total benefits of water for a river catchment area or a region, state and country (Table 2). The quantity of water demanded by an economy considering various types of demands from producers and consumers of goods and services from agriculture, industry, service, domestic sector apart from water required for natural environment and the actual water supply in the catchment area will help assessing water-balance. Further, the net benefits and costs form an alternate water use reflects the relative prices, i.e., the price elasticity of demand for water. To estimate the demand for or price of water Stated Preference Methods (Non-market valuation) like Contingent Valuation Methods are increasingly applied over revealed preference methods to measure the consumer or producer willingness to pay which clearly reflect the shape of demand curve for a given period. The recycling and reuse of waste water or storm helps return flows of water as well as the value of the same water, the water value-flow approach considers the benefits derived from efficient of use of waste and storm water. Water balance accounting method estimates the water use, depletion and productivity of water in a water basin. The input–output approach uses water as an input like labour to calculate water multipliers (factor inputs) among different sectors of the economy. Water use intensities to produce different products in agriculture, industry, service and domestic sectors will be assessed based on the amount of water embodied in dollars' worth of products. This technique will also help in understanding the virtual water trade the amount of water used to produce the product which are internationally traded (import and export). A computable general equilibrium (CGE) model is also used to estimate how changes in water use or flow affect the behaviours of economic actors including industries, households, governments, investors, importers and exporters where consumers try to maximize their utility and producers prefer profit maximization. Above a few methods are used to assess the economic importance of water.

2. Water as Capital

Further, present economic growth models account the relative economic contribution of man-made capital and human capital to overall increase in Gross Domestic Product (GDP) and rarely recognize the natural capital including water. Thus, the stock of natural capital has decreased over time due to its underpricing or missing markets. The recent international attempts to include Natural Capital in the Integrated Economic and Environmental Accounting or Green GDP take into account the role of total economic value of water to economic growth. The widening gap in water supply and water demand for various economic needs calls for adoption of Green GDP approach and realizing sustainable development. The term'sustainability' needs to be understood both from strong sustainability and weak sustainability views. Is improvement in infrastructure and knowledge appropriate and adequate substitute for environmental or water losses? These concerns about ecosystems and limited availability of adequate substitute on account of depletion of water resources, demand adequate institutional measures and investment priorities to mitigate deforestation and address climate change. Even today, Indian textbooks conceptualize water as 'free good' and 'abundant in supply' which creates the wrong or notional impression that it can be used recklessly as it is observed in the behaviour of the economy or society be it for agricultural, industrial and domestic use. Water is most disregarded and abused good in terms of over extraction (excessive use of ground water) and exploitation (pollution of water bodies like The River Ganges). This has resulted in scarcity of water where water is no more treated as renewable resource, rather, it is treated as conditionally renewable if there is a huge mismatch between excessive water use and over its percolation of water table over time. It has become reality in India as ground water table reached rock-bottom whereas percolation is unable to restore the balance of water table. However, in case of surface water, overall it is unfit for consumptive and productive use due to awful quality issues such as water pollution. Both reckless use and abuse have made the water resource the scarce or economic good and it no more a renewable resource and it has become already a conditionally renewable resource. Therefore, the traditional societal attitude towards water as free good and renewable resource should change as water is essential for survival and it is already scarce it needs to be efficiently and equitably distributed among various needs of the economy and environment. Apart from treating water as economic good, water also be treated as social good as the right or entitlement of the society is involved, a minimum of 50 to 100 litres of water per person per day (WHO, 2016) are needed to be ensured to meet essential drinking and health needs at free of cost by the government. Water as an environmental good is very crucial to maintain the biodiversity or ecosystem or hydrological cycle. Water as cultural and aesthetic good, the implicit value must be recognized. This implies that water has multiple uses and benefits and overriding importance should be given to all attributes of water by considering the total economic value for its conservation. Therefore, a wide variety of economic models are needed to assess the economic benefits of water. Further, surface water bodies including rivers and lakes are considered as common pool resources which involve multiple users and water is non-excludable and hence, government plays an important role in ensuring equitable access and efficient allocation of water on a sustainable basis.

The land use and land cover modifications have already limited the availability of water and its services. Unless river catchments and basins are protected, it is difficult to bridge the growing gap between water supply and demand and achieve equity and efficiency in water resource management. Payment for ecosystem services as market-based instrument will help protection of river catchments. This approach helps in protection and conservation of natural capital including forests in river catchment areas like Western Ghats and Himalayan forests where most of the rivers originate and meet both economic and environmental needs of India (see Major River Basin Table 2 and Map 1).

Table 2: River Basins of India

S. No.	Basin Name	Area (Sq. Km)	Percentage
1	Indus (Up to border)	321,289	9.95
2	Ganga	861,452	26.69
3	Brahmaputra	194,413	6.02
4	Barak and others	41,723	1.29
5	Godavari	312,812	9.69
6	Krishna	258,948	8.02
7	Cauvery	81,155	2.51
8	Pennar	55,213	1.71
9	East flowing rivers between Mahanadi and Pennar	86,643	2.68
10	East flowing rivers between Pennar and Kanyakumari	100,139	3.10
11	Mahanadi	141,589	4.38
12	Brahmani and Baitarni	51,822	1.60
13	Subernarekha	29,196	0.90
14	Sabarmati	21,674	0.67
15	Mahi	34,842	1.07
16	West flowing rivers of Kutch and Saurashtra including Luni	321,851	9.97
17	Narmada	98,796	3.06
18	Tapi	65,145	2.01
19	West flowing rivers from Tapi to Tadri	55,940	1.73
20	West flowing rivers from Tadri to Kanyakumari	56,177	1.74
21	Area of inland drainage in Rajasthan	0	0
22	Minor rivers draining into Myanmar & Bangladesh	36,202	1.12
	Total and percentage	3,227,021	100

Source: Ministry of Water Resources, GOI (2016).

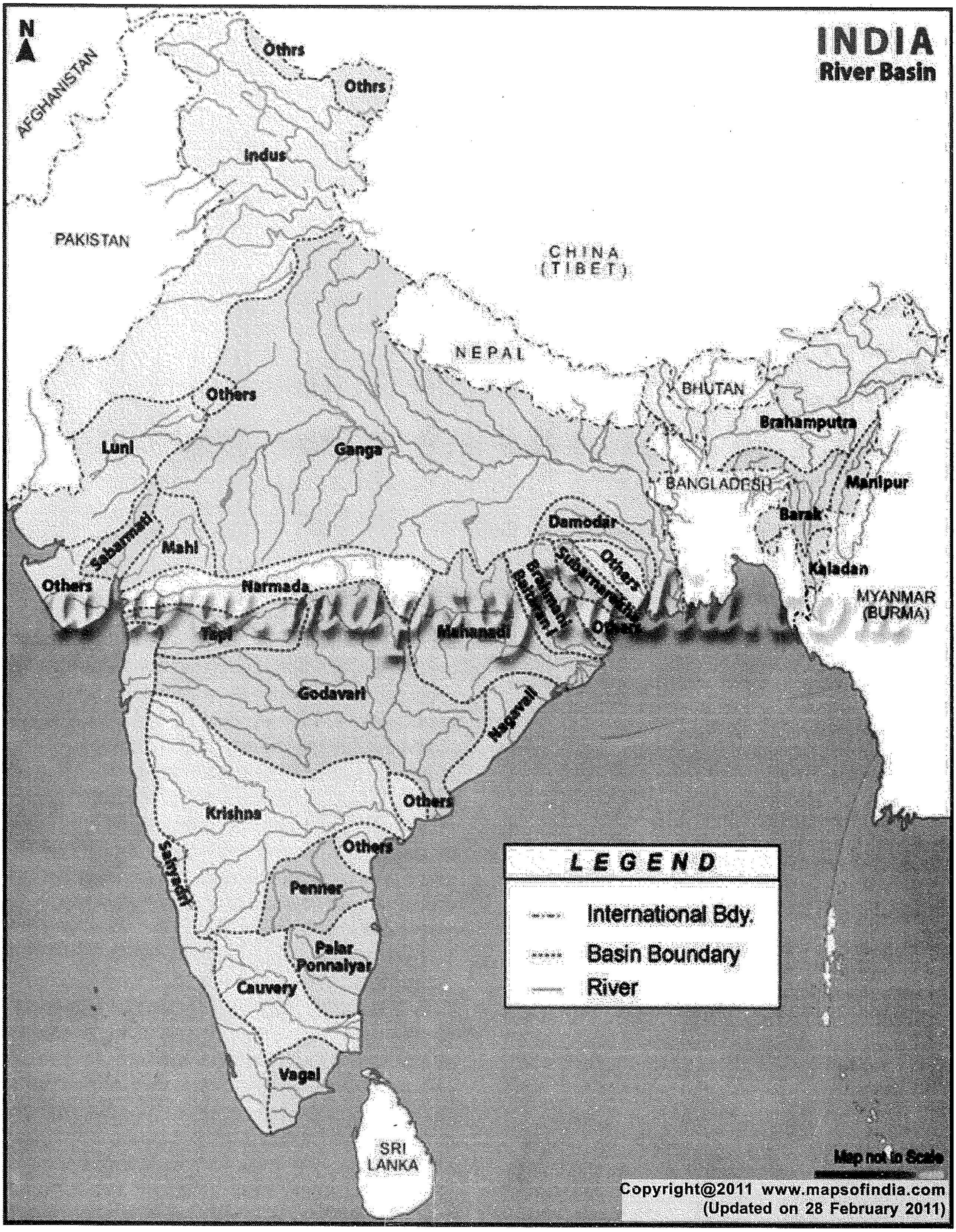


Figure 1: Major River Basins of India

Economic development of India and Indian states depends on sustainable availability of water resources in these river basins. Majority of the cities and towns impound water from these river basins for drinking water needs of billions of urban households. Bangalore city meets 90 per cent of drinking water needs from the River Cauvery. The water system becomes inefficient and costly in case water ecosystem dries up; this situation warrants allocate water to the highest value uses such as drinking water needs over agricultural and industrial needs which affect their economic activities and cause lasting water disputes among riparian states in recent years between Karnataka and Tamil Nadu.

The Western Ghats forests give birth to many rivers including the River Cauvery. Protection of these virgin forests which attract rain is completely neglected as deforestation and encroachment continues unabated. Commercial crops like coffee, tea, rubber, areca nut, have successively replaced virgin forests for many years. Fast growing species like eucalyptus and other trees which are alien to the ecologically sensitive region are rapidly introduced substituting native shade trees in coffee plantation areas. The recent land use change in Kodagu districts gives the stark reality of the Cauvery River, about 3,000 acres of agricultural land is being put to commercial and housing needs making the Kodagu forest fast dwindling which will catastrophically impact on the flow of river and availability of water both in catchment and command areas. Many developmental activities like erecting of power lines, construction of roads and hydel projects, sand extraction continues without valuing ecological sensitivity of the regions. The trees hold more than 30,000 litres of water that slowly makes its way into rivulets and rivers. Land use change, uncontrolled growth of home stay and tourism activities have destroyed the forests in Kodagu district. Kodagu district alone contributes for 70 per cent inflow of water to the Krishna Raja Sagar dam in Mandya district of Karnataka state.

Frequent incidents of climate change make water scarcer and also expensive as rainfall pattern are uneven over the years. Severe droughts would adversely affect the water flow in the river basins and replenishing ground water. Increasing reliability on river water supply for meeting various economic needs and particularly drinking water is unsustainable unless we take coping and adaptation measures. Whereas, developed countries are quickly evolved coping mechanisms to face climate change led economic implications, however, developing countries including India lag behind taking climate change very seriously to protect the river basins. Therefore, adoption of New York City Model will help protection of River Catchment Areas for lasting supply of water. There are striking similarities in dependence and impounding of water for New York and Bangalore cities. Both cities impound water away from more than 100 km and depend on critical watersheds or river catchments. New York City completely depends on Catskill and Delaware Watersheds for water supply and Bangalore depends entirely on the River Cauvery which has watershed in Tala-Cauvery and Bhagamandala in Western Ghats in Kodagu. When New York City faced severe drought conditions in 1980s, protection of Catskill and Delaware water bodies was taken up. The New York City Corporation made one-time huge investment to protect both forest and agricultural lands by compensating farming community, taking afforestation and also imposing restrictions on using chemical fertilizers and pesticides by promoting organic farming. This includes practices of sustainable farming, limiting use of fertilizers and preventing of dumping waste products. All these efforts have ensured high water quality with the strong partnership with local stakeholders and communities. This has led to increasing availability of clean water which serves a population of 8 million in New York even without the cost of water treatment. These challenging efforts to mitigate climate change led water shortage in catchment areas has reduced the huge cost of water treatment and ensured reliability of water supply. Whereas, in case of Bangalore city, drinking water needs of 8.5 million people rest with water drawn from the river Cauvery. Failure to protect the watershed of Western Ghats, unabated deforestation in the river catchments have largely impacted on the raining pattern which caused lasting catastrophe to end abundance of Cauvery Water. The reduced the flow of the water in the riparian states of the river Cauvery River rarely appreciate this fact and value the water and watershed of Western Ghats. Creating Cauvery River Watershed Protection Fund by the river riparian states particularly Karnataka and Tamil Nadu will help addressing climate change or droughts, helps afforestation efforts, compensates the farming community to protect the forests and ensures water availability for all the states. The creation of Payment for Ecosystem Services (PES) in Kodagu districts on the lines of New York City Model for conservation of forests in Kodagu district is very important for the sustainability of the river Cauvery river basin for meeting water demands of riparian states.

New York City has effectively adopted both supply-side (water enhancement) management through catchment area conservation and demand-side management by efficiently managing water by reducing the demand (See Figure 2). Both supply enhancement and demand reduction policies have effectively addressed climate change led water scarcity in New York City. The demand for water has come down from 1,500 million gallons daily to 1,000 MGD despite growth of population from 7.5 million in 1980s to 8.25 million in 2010 (Figure 2).

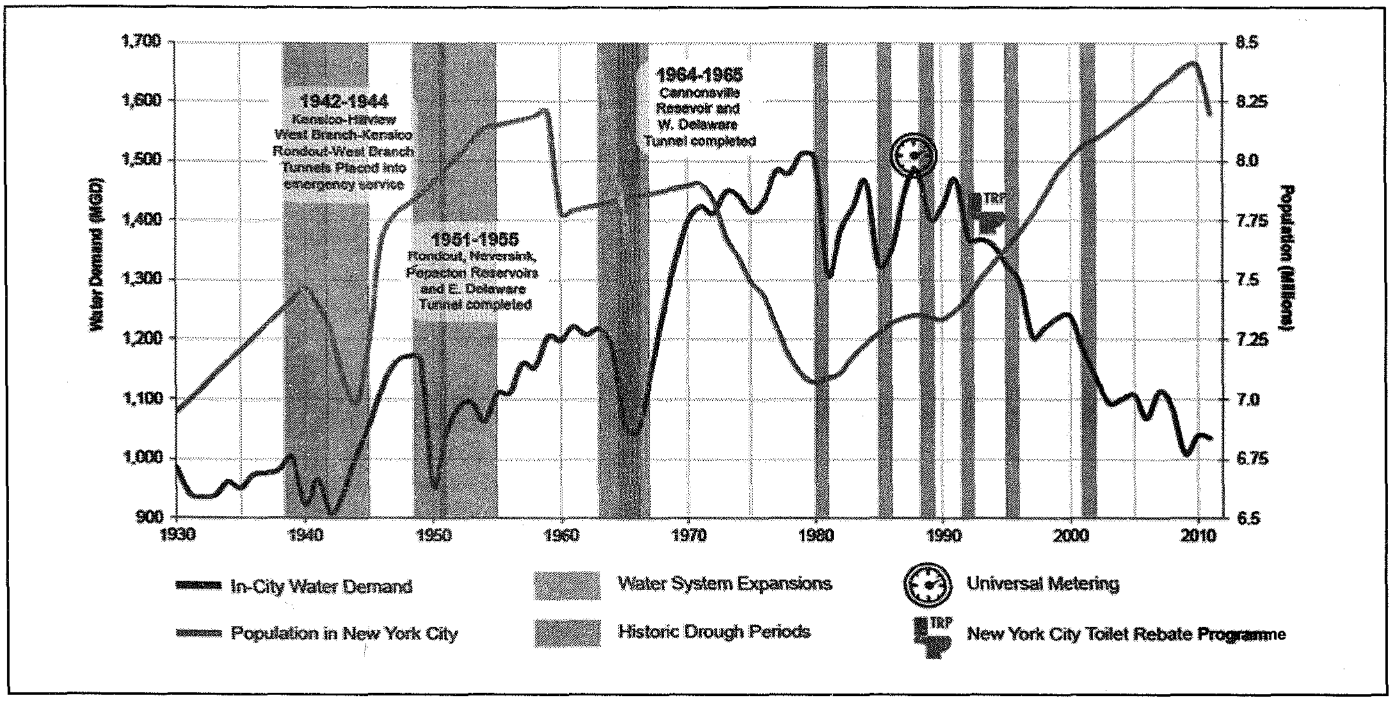


Figure 2: Supply and Demand Side Management of New York City Water

Whereas, Bangalore city regardless of climate change and water scarcity continues to depend on supply enhancement strategy which is leading to high rate of non-revenue water or UFW and revenue loss. The present status of water supply in Bangalore city shows that the city is excessively relying on surface water sources from the river Cauvery for meeting drinking water necessities with the unprecedented fall in the ground water table due to over exploitation and pollution of lakes in and around the city. The city is also constantly searching new water sources for meeting drinking water needs in future. Bangalore city currently receives 1,350 million litres Daily water meet the drinking water needs of 8.5 million people which is sufficient. However, water is supplied in alternate days with limited to 3–4 hours and water available at 50 LPCD which reflects growing water scarcity not due to non-availability of water but due to an increasing share (48 per cent) of Unaccounted for Water (UFW) in total water production (Figure 3). The shortage or inadequate provision of water in the city is mainly due to lack of demand side management including reducing the loss of water due to leakages and theft. The 48 per cent of UFW is very high compare to the optimum level of UFW in well managed urban water utility (5–10 per cent) in the world cities (Krishna Raj, 2013). This implies that the problem of water is not associated with economics or scarcity but politics (poor governance).

Cauvery Catchment area is 81,155 sqkm with average water yield of 21.4 billion cubic metre and all India average yield is 1,869 BCM whereas Brahma Putra is 537. The Ganges is 525 which represents low yield in Cauvery basin but high demand for water among riparian states for various agricultural, industrial and drinking water needs. Cauvery river basin with relatively higher degree of urbanization is also characterized by arid or semiarid climate with extremely low renewable water availability, and therefore cannot support high degree of urbanization unless water is efficiently managed or drawn from sources outside the basin. This reflects stark reality of water stress in the Cauvery Basin and calls for demand-side management of water including save the water at both utility and consumer level.

Today, even though water is becoming scarce commodity, due to obligation to people and their entitlement to right to water, governments are willingly not favouring markets to dominate water supply in many cities of the world despite cash crunch, inefficiency or institutional failures, etc. Under the globalization, markets tend to pose themselves with animal spirit (confidence) to manage water efficiently, but equity issues concern governments. Globalization has impacted on the growing stress of water resources with increasing corporate siphoning off of water for surplus production of various goods and services without treating and reusing wastewater this 'free-riding' approach systematically undermines societal drinking water needs. But there are international benchmarks in urban water management which show that without leaving water supply to market mechanism, government agencies have efficiently managed water in large metropolitan cities like New York. Therefore, India's ethos towards conservation of water and environment is just euphoria as people worship the rivers but hardly respect, value and conserve them including the most revered rivers, the Ganges and the Cauvery. The payment for ecosystem approach makes riparian states more economically and environmentally responsible in equitable sharing of water and avoid interstate water disputes.

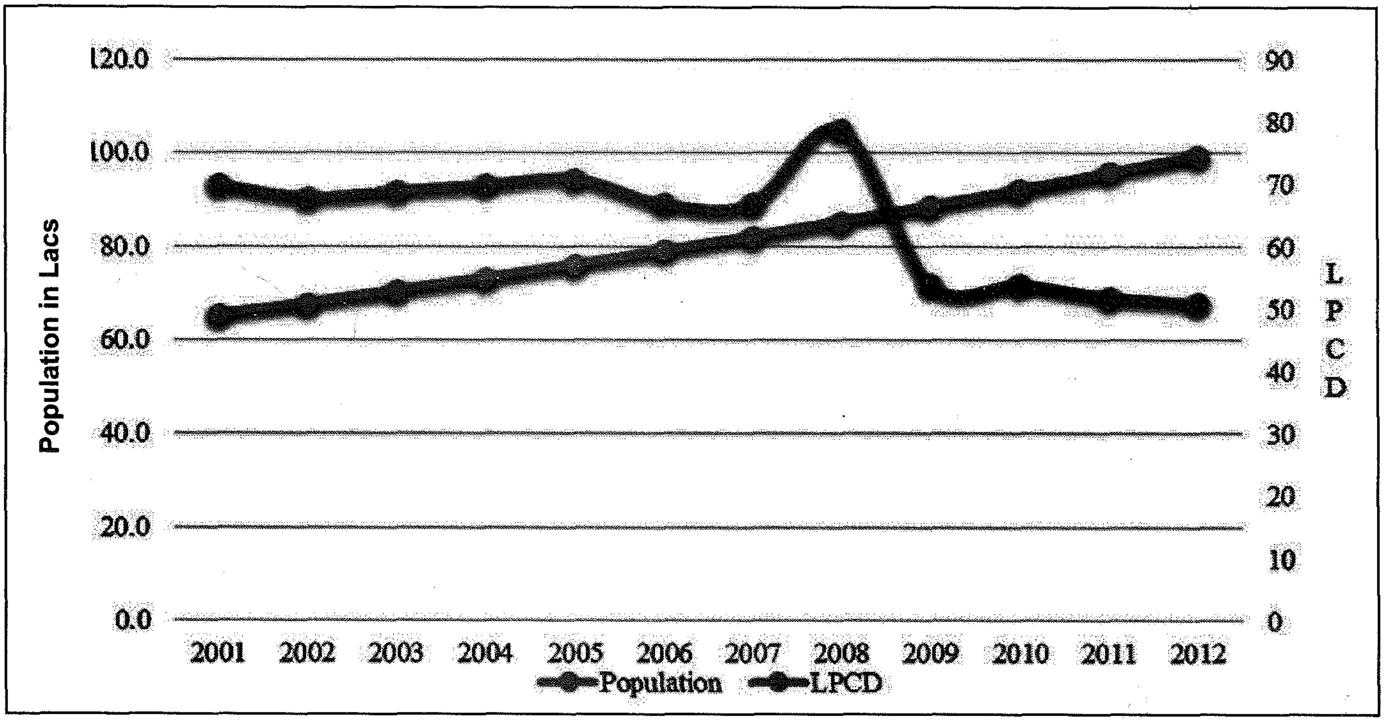


Figure 3: Reduction in per capita Availability of Water in Bangalore City

3. Understanding India's Growing Water Scarcity

Water crisis is increasingly being viewed in terms of increasing imbalance between water supply and demand; however, it's economic, ecological, social and health causes and consequences are pervasive in nature. The world water resources (both surface and ground) are unequally distributed among countries of the world. The world statistics on wealth of nations and water resources or availability suggest that countries with high GNP have also high per capita water availability. The paradox is that the Western developed countries abundantly endowed with water but largely export less water intensive industrial goods, whereas, developing countries scarcely endowed still export water intensive agricultural goods like rice and sugarcane. India with 2.4 per cent of the world's total area supporting 16 per cent of the world's population endows only 4 per cent of the total available fresh water. The international standard suggests that if per-capita water availability is less than 1,700 m^3 and 1,000 m^3 per year then the country is categorized as water stressed and water scarce, respectively. India is in threshold of reaching these stages as per capita surface water availability in the years 1991 and 2001 were 2,309 and 1,902 m^3. It is estimated that by 2017, India will be 'water stressed' with the decline in per capita availability to 1,600 m^3 (Biswas et al., 2010). Projections for the years 2025 and 2050 also show that per capita water availability will be further drastically reduced to 1,401 and 1,191 m^3 respectively (Kumar et al., 2005). The scarcity of water has been estimated based on per capita availability of water. Water scarcity is growing with increasing population and growing demand for water from all sectors of the economy; consequently, the per capita availability of water in parts of India is very low and it also varies in time and season. This clearly gives stark diagnosis of dwindling water resources in India with imminent realisms like growing population, sprawling utilization and ever expanding economic activities. Water demand for consumptive (drinking, health and sanitation needs) and productive uses (agricultural, industrial production, power generation, mining operations and navigation and recreational activities) has increased tremendously while water supply has declined with depletion and degradation of water resources causing water distress or scarcity. The progressive water shortage and competitive demand with mounting population and economic growth has posed a challenge to water management particularly in the context of equitable access to water and its benefits. This will largely alter economic activities and limit productive capability of the economy. The declining trend in the economic contribution of water resources has occurred due to physical and economic water scarcity which results in insufficient use, poor management, declining water productivity, and increasing environmental and economic costs (Figure 4). Obviously, the outcome is growing imbalance between water needs and supply augmentation capability in the country. Inefficiency in water use and management mainly caused by market failure, poor property rights and improper allocation has further complicated operationalizing water policies.

Further, water demand and supply are particularly sensitive to variations in climate change. Alteration in water levels in river basins or stream flows, watersheds and ground water have already impacted on the performance of different sectors of the economy which results in search for alternate sources of water to ensure reliability of drinking water needs. For instance, residents over depend on ground water and water markets when water sources from piped water supply developed into irregular and insufficient. This situation is aggravated the ground water depletion in India causing water quality to deteriorate with the depth of extraction which directly imposes health cost on the society and limits system's resilience. The climate condition makes water scarce and expensive. Recent estimates indicate that 20 per cent of global water scarcity is directly induced by climate change. The climate change can also exacerbate water scarcity which can cost 6 per of India's GDP. Besides, depletion of quantity and degradation of quality of water has restricted the availability of water for consumptive and productive uses and consequently caused 'negative externality' which imposes high economic and social cost on the society. India faces serious water problems throughout the year (8 to 12 months) as per the World Bank study (Figure 5) which has a serious implication on production and consumption behaviour of economic agents. The detailed inter-linkages of drivers, pressures and economic impacts of water resources are discussed in the Figure 6.

3.1 Water Poverty and Growing Water Market

Water poverty is already ubiquitous in many parts of rural and urban areas where water access is limited due to deficit in supply exceeding demand. Water scarcity, water use inefficiency and inequity in water distribution have already resulted in prevalence of water poverty all over India. In many villages and cities water availability both surface and ground water is limited, access to drinking water is reduced, water use efficiency is low. Water poverty Index estimates the water stress due to water scarcity and availability of water among socio-economic groups. This shows that poor households often suffer from insufficiency, unsafe, inaccessible, unaffordability of water which result in economic loss of labour and time. Majority of the Indian cities despite growing scarcity of water have achieved neither equity nor efficiency in water supply and sufficiency (Krishna Raj, 2015). The details of slab-wise water connections and consumption (2013) in Bangalore city (Table 3) shows that about 68 per cent of water connections at less than 25000 water slabs in the city consume 32 per cent of water or (127 million litres daily), whereas, 32 per cent connections above 25,000 water slabs consume high quantity of water at 68 per cent water or 273 MLD. This shows high water inequality in water consumption of rich and poor households. Further, 32 per cent of connections or households consume or get 28 litres per capita daily

Table 3: Water Inequity in Bangalore City

Slabs	No. of Connections	Consumption in MLD	Consumption per HH or connection	Per capita Water Consumption	Water Rates Per 1000 litres (Rs.)
0–8000	1,87,055 (32.2)	21 (5.2)	111.3	28	6
8001–25000	2,05,863 (35.4)	106 (26.5)	514.2	129	9
25001–50000	1,43,990 (24.8)	165 (41.3)	1148.6	287	15
50001–75000	34,457 (5.9)	68 (17.0)	1969.0	492	30
75001–100000	7,275 (1.3)	21 (5.2)	2853.9	713	36
>100001	2,701 (0.5)	19 (4.8)	7154.4	1789	36
Total	5,81,341 (100)	400 (100)	688.0	172	-

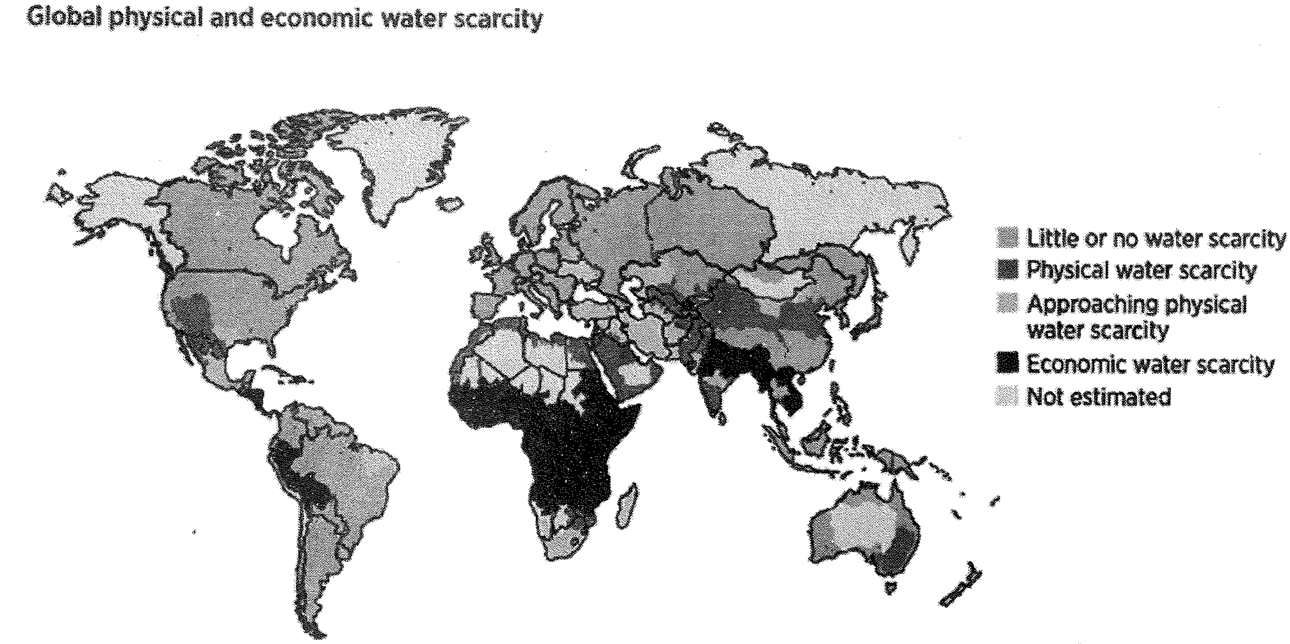
Source: Author's Estimation using BWSSB Data (2013).

which is highly insufficient whereas the remaining 68 per cent households consume from 129 to 1,789 LPCD. The water consumption differentials cause water inefficiency and households depend more on water market to meet the insufficiency in water availability.

The inequitable distribution of water among various socio-economic groups and inefficient use of water with high theft of water without legal connection, leakages, wastage of water have clearly reflected in intermittent supply of water which imposed high costs on the society or economy as water market emerged as alternative to the public water scarcity. Increasing inaccessibility to potable water supply, people are increasingly depending on market for meeting their drinking water needs particularly from private water suppliers such as bolted or packaged water industry. The demand for packaged water is in increase due to health concerns among the people with increasing pollution of water bodies particularly ground water and also poor quality water supply by public water supply authorities. The Karnataka state, as per the Bureau of Indian Standards, has 200 bottled water manufacturing industries. Private appropriation of water bodies has resulted in absolute loot of ground water in the absence of ground water regulation authority. Augmentation of drinking water supply through an integrated approach of accessing water from rivers, tank rehabilitation, rain water harvest and conservation and appropriate valuation of drinking water is a rational option. Bottling plants industries have been proliferated all over the cities making use of both surface and ground water indiscriminately for quick profiting. If they are not controlled ground water is siphoned off indiscriminately imposing high costs on the neighbours who depend on ground water for drinking. The unregulated ground water exploitation has resulted in water table has reached on an average 822 feet to get the water which clearly reflects the quantum of water extracted over replenishment. Bangalore and surrounding areas have 408 (Bangalore urban 283, Bangalore Rural 57 and surround districts), 64 (Kolar, Tumkuru, Chikkaballpur and Ramanagaram) comprising 57 per cent of the total bottling units of 708 in the entire state with an extraction of 1,500 litres to 25,000 litres. The scarcity of drinking water also reflected in the omnipresence of water tankers in many areas particularly where the water is intermittently supplied and newly added villages of BBMP. The water price for each tank varies from Rs 600 to 1,500 but water quality is not assured. The water poverty among lower income groups is highly prevalent in all the major cities of India.

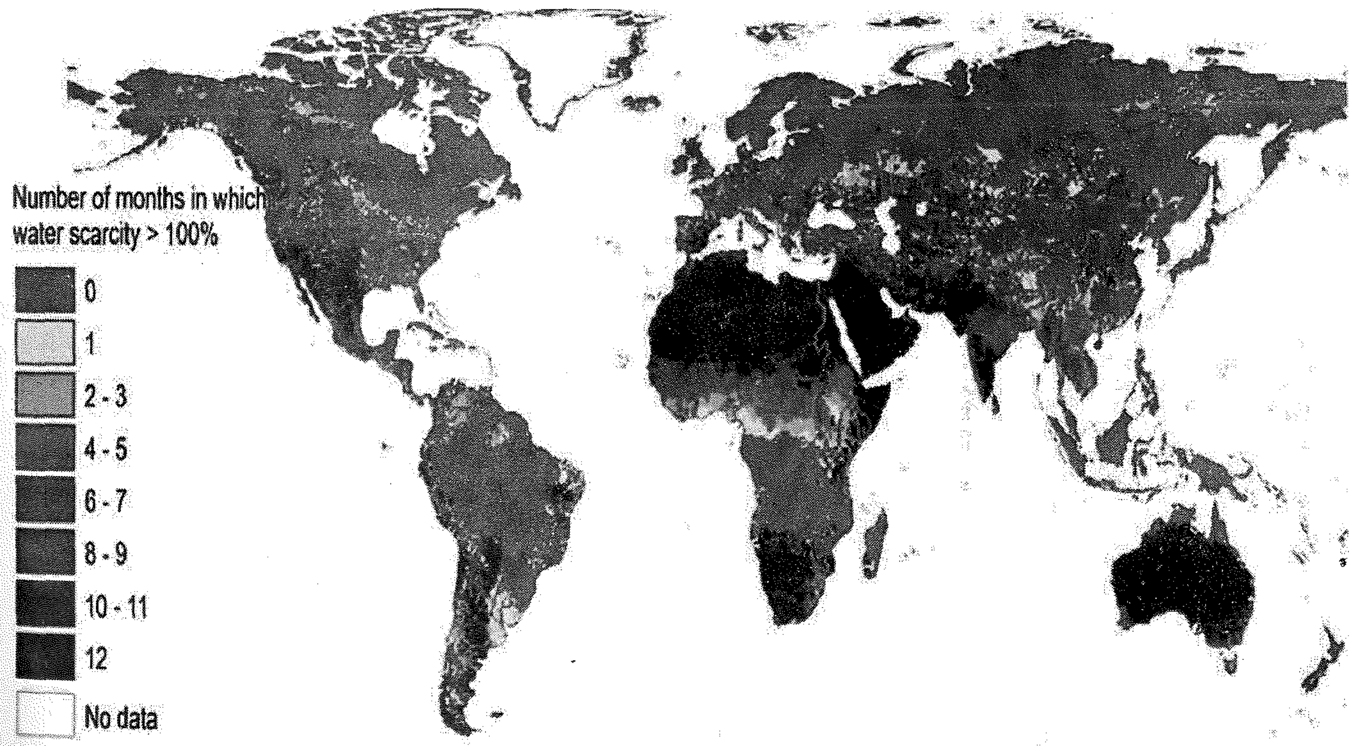
3.2 How to Achieve Water Efficiency

Water is an economic good and capital resources, the end of surplus or abundance gives the stark reality of the water economy. Therefore, the production and consumption behaviours of industry and consumers should be on the path of sustainable development practices. Drinking water is supplied at free of cost in major Indian cities which is cost high operation and maintenance cost. Universal water



Source: Adopted from the 4th World Water Development Report (2012).

Figure 4: India's Economic and Physical Water Scarcity



Source: World Resources Report (2011).

Figure 5: Climate Change-lead Water Scarcity in the World

metering and rationing can effectively reduce water theft as well as water leakage which are alarming high in many metropolitan cities of India. Water utilities need to change flat rate to meter billing to improve in the system performance and ensure water reliability and reduce consumption of water by 50 per cent. Further, all India campaign in support of production of water saving fixtures or taps, water tubs, and their replacement in all the households as government measure will reduce the water wastage or slow the flow of water, this policy measure which will save nearly 70 per cent of the drinking water. Replacement of high water flush toilets with low water consuming toilets will result in significant water saving. Waste water recycle and reuse is made compulsory for the industries, commercial establishment, apartments, malls, hospitals, institutes and large buildings. The city corporations should also prohibit sale of high flow showerhead, faucets, and toilets. Consumer awareness programme and computerization of water billing are more effective in water saving as proved in New York City where consumers receive text message for excess consumption of water may be due to actual use or wastage of water. New buildings should have rainwater harvesting provision which will reduce water consumption for gardening and other activities. Restriction on vanity projects like water recreation and swimming pools help reduce water or should be encourage to use recycled water rather using fresh or drinking water. Improvement of economic efficiency depends on evolving an effective water pricing mechanism considering the economic status and ability to pay by the households. Economic status influences the peoples' willingness to pay for improvement in access and quality of water supply. Policy of water pricing, therefore, needs to achieve two objectives simultaneously: recovery of the full cost of production from supply of water, and provision of efficient and reliable water supply service to the consumers. Without any provision for better water supply services, mere increase in water tariffs are doomed to fail in this objective as observed in many research studies.

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Since natural resources are finite, increased consumption must inevitably lead to depletion and scarcity.

–Paul Ehrlich