Notes

Water Quality and Budgeting for Sustainable Management of Water Resources

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It is known that under extra-ordinary circumstances, equally extraordinary, aggressive measures are needed to get desired results. Water resource augmentation in our country has become such an extraordinary situation in recent years. The Union Government has indeed taken the first step towards this in May 2019 by creating a ministry named *'Jal Shakti Mantralay',* with objective to augment the resources of potable and irrigation water for daily human needs as well as balancing the ecosystem, without compromising the quantity of water. A few measures for augmentation and sustainable management of water resource in India are discussed here.

Water Scarcity, Stress and Risk

Water Scarcity

It refers to the lack of volumetric abundance of water supply against demnd, in an area. United Nations spells out that "water scarcity can mean scarcity in availability due to physical shortage, or scarcity in access due to the failure of institutions to ensure a regular supply or due to a lack of adequate infrastructure" (www.unwater.org). Water shortage is attributed worldwide as a consequence of (i) physical or absolute water scarcity, and (ii) economic water scarcity. Physical water scarcity is the result of inadequate natural water resources against a region's demand, and economic water scarcity is the result of poor management of the available water resource (www.sciencedaily.com). On the other hand, water stress is our inability to meet the demand of water for the purpose of meeting human needs and taking care of the ecological balance (www.pacinst.org). Compared to scarcity, 'water stress' is a more inclusive concept, as besides considering the aspect of water scarcity, the water stress takes into view the water quality, environmental aspects and accessibility of water.

Water Risk

It is the probability or an anticipated possibility of a vast area or region experiencing a deleterious water-related event (www.pacinst.org). Several water-related conditions like water scarcity, pollution, poor governance, inadequate infrastructure, climate change and so on create risk for different sectors. Water stress starts when the water available in a country drops below 1700 m3/year or 4600 litres/day per person (www.unwater.org/water-facts/scarcity). When the availability is below 1000 m3/year or about 2700 litres/day per person, water scarcity is experienced. Absolute water scarcity happens in countries with less 500 m3/year or roughly 1400 litres/day per person. India gets water-stressed in many parts for four to five months in summer, whereas water scarcity inflicts the rest of the part of the country for about six months. Water stress accentuated by water scarcity has relegated India with possibility of having water risk in near future, if we do not undertake emergency sustainable measures. Availability of the right or appropriate quality of water for various human, ecological, agricultural and industrial uses is the first step towards easing the water stress and avoiding occurrence of water risk in India.

Reasons for Water Stress in India

Population

Population of India has increased from 37.63-crore in 1950, to 136.88-crore in September 2019 (www.worldometers.info). India's population is 17.7% of the world population, living in mere 2.4% of global area (Fig.1). Whereas the land area and catchment area remains same, though the population

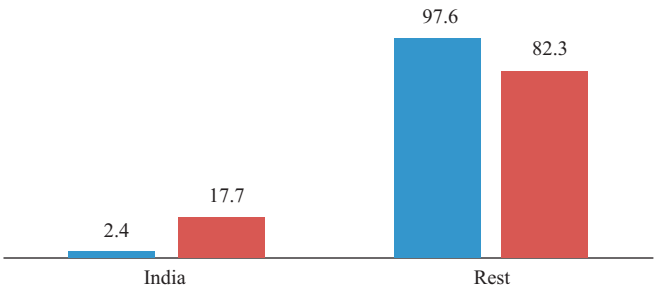

Fig.1. Histogram showing land area and population of India *vis-a-vis* rest of the world

has increased 3.64 fold, causing heavy dependence on monsoon rainfall and surface water sources. The increase in population along with the green revolution in agriculture has caused a heavy demand of groundwater for domestic use and irrigation, leading to vast depletion of aquifers.

Change in Drainage

Many of our perennial rivers systems have deplected in discharge due to the widespread changes in landuse pattern, and modification of drainage pattern which is unable to allow the precipitation to infiltrate in the soil zone to augument the groundwater basins. Rapid urbanization coupled with creation of innumerable industrial belts has led to the reclamation of most of the tanks, reservoirs, marshes, *johads* and water-bodies for anthropoginc uses. This has led to a dual malady of change in landuse pattern and lack of percolation into the aquifers. A network of national highways, urban and rural roads, flyovers, commercial malls and huge residential complexes with wall to wall concreting without facility for groundwater-recharge or structures, grossly impede recharge of the groundwater basins. Compulsory groundwater harvesting in residential buildings would benefit to large extent in groundwater augmentation.

Climate Change

During summer Significant increase in atmospheric heat with temperature upto 45- 48°C, triggers widespread evaporation and transpiration causing loss of soil moisture to the atmosphere, depleting the water in unconfined aquifers. Vast areas in Central India experience semi-aerid to aerid weather due to scanty rainfall; resulting into development of aerid zones, which would lead to large scale conversion of land to semi-desert condition, can be avoided by adopting social forestry programs.

Irrigation

India still consumes about 75% of water resource for agriculture as over 65% of our population is dependent on agriculture for livelihood and food security to the 1.3 billion population is cardinal (www.indiawaterportal.org). Any compromise on the quantity of water made available for agriculture would lead to severe food security issues. The cumulative effe ct of all the factors noted above have caused large parts of the India to be water stressed region, mostly during the peak summer. The severity of water scarcity in the summer of 2019 in several parts of Maharashtra, Madhya Pradesh, Rajasthan and Chennai city should give wakeup call to all water resource managers, executives, policymakers and administrators of the country, to initiate immediate corrective measures to ensure sufficient suppy of water of proper quality.

Water Quality for Different Uses

Understanding the quality of water for specific needs of various human activities is the first step towards an efficient and effective practice in the management of water resources (Sarvothaman, 2004). This leads us next to (i) work out the appropriate quantum of water for a most of our needs and activities; (ii) to understand the precise quality of water needed for each of those activities; and (iii) augment the water resource that is required for those specific needs. Most of the properties of water are aquired by interaction with atmosphere, rock, soil, terrain and human activity. The composition water varies from place to place, depending on type of industries, life style of people, waste disposal pattern and quantity of water available for various uses. The rain water percolates as groundwater whereas lot of water flows over as surface runoff and is used by the people with or without appropriate treatment. The quality of water required for specific purpose is same in all parts of world, with minor variations depending on the lifestyle of people. This aspect largely controls the quality of water required for different uses. The water quality required for different uses is summarised below.

The potable grade water for drinking, for cooking, washing the kitchenware and raw foodstuff before cooking needs to be uncompromisingly pathogen-free and conforming to the standards prescribed in IS-10500:1991 of BIS (2003). European Union and World Health Organization prescribe much stricter standards for potable water, but in India, the BIS (2003) standard of potable water is found to be safe. The pH of this water may be in the range of 6.5 to 8 and should be soft and free from heavy metals and ions such as Fe, Hg, Cr, As, Pb, Tl and fluoride.

For the purpose of human hygiene, such as bathing and for use in the swimming pools, the water has to be pathogen-free and devoid of toxic micro-nutrients, but the quality need not be of potable grade. The directive 76/110/EEC of European Economic Council (EEC) has fixed the quality of bathing water which is given in the Table 1.

Since India has taken up measures to encourage younger generation to participate in competitive sports like swimming, it is necessary that we maintain the quality of the water used for swimming pools in urban and rural area. That would facilitate our youth to train themselves under hygienic conditions. Creation of a large sports facility with suitable grade of water would facilitate India to host such international events.

For the purposes of agriculture and horticulture, the water has to be free from pesticides and toxic heavy metals / ions such as Hg, As, Cr, Cd, Tl, Pb, Li, Se and fluoride. These heavy metals, ions and micronutrients are absorbed by the plants and are dispersed as organic metals / ions in plant roots, fruits and shoots, which are part of food chain eventually causing serious health problems. As water supplied to agricultural causes a chain reaction, utmost caution has to be

Table1: Water quality recommended for common uses

	WHO limit	ISB limit ppm
pH	6.5 to 9.2	6.5 -8.5
Conductivity @25°C	1400	1400
CO_3 ppm	-	300-600
HCO_3	-	--
Cl	600	1000
SO_4	400	400
Ca	200	200
Mg	150	100
MPN/10 litre	Not stated	0
$CaCO_3$	500	400
F	1.78	1.5
As ppb	0.05ppm	.05
Hg	0.002ppm	0.001
TDS	1500	2000

Water quality recommended for drinking purpose (BIS: IS: 10500, 1991)

Parameter (milligram per litre except stated otherwise)	Guide limit 90 percentile	Mandatory limit 95 percentile
Cadmium	0.0025	0.0025
Mercury	0.0003	0.0003
Dissolved oxygen (DO)	80 -120% saturation	Not stated
Faecal coli MPN /100ml	100	2000
Total coli MPN/100ml	500	10000
Salmonella MPN/litre	Not stated	0
Faecal streptococci MPN/ 100ml	100	Not stated
Entero visuses		

MPN= Maximum permissible number

Water quality for bathing and swimming pool water (Prescribed in Directive 76/110/EEC)

exercised to ensure that the water used in agriculture / horticulture is free from toxic metals, heavy metals and ions.

The livestock such as cows, sheep and chicken, as also to the pets, zoo animals and the wildlife are vulnerable to various viral infections, hence, the water used for this purpose has to be pathogen-free and preferably of potable grade. Since the pathogens and organic heavy metals, pollutants are likely to be dispersed / transmitted to the humans though livestock, it is essential that the potable, pathogen-free water may be used in livestock rearing.

A huge quantity of water is used for what is known as 'marginal purposes' such as toilet flushing, house cleaning, washing of automobiles, train carriages and industrial uses like paper industry. The quality of this water is not a critical issue but needs to be pollution free. The water used for these marginal purposes is mostly from surface runoff or municipal supply for drinking and kitchen use, which amounts to gross abuse of a clean water useful for potable purpose. The water used for these marginal purposes may be from recycled sources such as recycled municipal waste water or recycled industrial waste water.

Since the consumption of water for marginal purposes is quite large, it is necessary that sewage treatment plants (STPs) and industrial effluent treatment plants (ETPs) be installed in all over urban and rural India. This matter has to be given a serious consideration by the *Jal Shakti Mantralay* because the quantity of water used for marginal use in the entire country is very large. Currently upgradable raw water is directly used for these purposes, mounting a considerable stress on the water resource that can be upgraded for potable and personal hygiene; hence, use of recycled water for marginal uses should be made mandatory all over India.

Quality of water is not an issue for watering the parks, social and urban forests, household gardens, greenbelts, sports fields such as cricket grounds and any such common greenbelts as in the convention centres, function halls etc. At present, municipal water is mostly used for these purposes, which needs to be substituted by recycled or treated water.

Water supply to industrial belts depends on the type of industry, quantity produced and the quality of water required for the production process. The Service Sector and Information Technology companies need only small quantity of potable grade water, but might need large quantity of marginal use water. This sort of budgeting of water quality should be adopted as a policy to avoid wastage. All other industrial units such as textile, tannery, automobile etc need to be instructed to use marginal use water for their industrial activities.

For the recreation, lifestyle and entertainment sector, such as water theme-parks, snow-park, fountain-parks and tourist attractions, the water used need to be pathogen-free, with pH in the range of 5.5 -7.0, which would not cause harm to skin, eyes and internal organs.

Balancing the ecology by supporting the flora and fauna characteristic to different places is an essential part of human life. Any minor variation in the water quality adversely affects the existance of the species. Any fluctuation in the water quality available to the local flora and fauna might lead to disastrous consequences in the quality of forests and forest products.

The quality of water to preserve the ecosystem varies widely, hence the concerned workers need to update themselves with information on the water and soil quality as well as the measures to improve their quality. Apart from efforts of preservation of the environment and forests, the scientific inputs for maintaining the water quality in and around forests is of utmost importance for healthy growth of flora and fauna.

Water Resource Augmentation vs Water Management

In order to enhance the Human Development Index (HDI), it is essential that adequate quantities of water of good quality is available for different daily activities. Scarcity of desired quality of water for a particular purpose causes stress on the water source of other quality, like potable water. Shortfall in water management leads to unwarranted misery like agitation or migration of population. Therefore, augmentation of the water resources of appropriate quality for different uses should precede the management of the available resource (Sarvothaman, 2004). The modern innovative technology has to be used to augument water supply for other uses by recycling waste water and purifying contaminated water. Recycling of used water will help in contolling water scarcity in non- domestic and industrial use.

The success of socially relevant government-sponsored programmes such as '*Swacch Bharat Abhiyan*' and 'Open Defecation Free India' (ODF-India) depends on the availability of adequate quantity of quality water for marginal use, since availability of adequate quantity of water is a major issue in villages which can be solved by recycled water. Since natural multi-level filtration of rain water takes place when it percolates underground, the treated water is not likely to pose great threat to the quality of the groundwater. Therefore, generation of recycled water all over India from a large network of ETPs and STPs for marginal use should be taken up on Mission-mode for *Swatchha Bharat*. For balancing ecology and improving the environment around us, significant amount of surface runoff has to be diverted for sustainance of flora and fauna, in the respective biomes (Sarvothaman, 2017). It is important to note that currently only the single and same quality of water resource which is replenished by seasonal precipitation during monsoon is used for all purposes. Several countries have worked on periodic budgeting of the water quantities vis-à-vis appropriate quality in terms of availability against requirement for various purposes, especially for the marginal use, and also take up periodic review of the budgets. Those countries which generate marginal use quality of water by recycling of effluent/municipal waste water by technological means, have reaped multiple benefits of (a) improving their HDI, (b) demonstrating their technological might, (c) enhancing the ambience and ecology of the terrain, and (d) making quality water available everyday to the citizens.

The stress mounted by India's population on the single raw water resource for all activities has taken a heavy toll on the rural and weaker section population during the water-scarce peak summers. This should be controlled by infusing water technologies to augment our water resource, year over year. Significant quantum of funds has to be allocated in the Union and State Budgets for the water resource augmentation missions and their supporting technologies.

Investments in Water Sector

Beverage industries of the country including the reverse osmosis—ultraviolet ray (RO-UV) plant operators for bottled water manufacturing are identified as the main guzzlers of Indian water resources, including the centuries-old groundwater from aquifers. Though they might be paying back in terms of taxes, royalties and revenue to the governments, their activities need to be closely watched to protect the agriculture and domestic water supply to public. The beverage manufacturing companies need to invest in large amounts for technological development such as setting up plants for effluent and sewage treatment, seawater desalination and filtration. They need to be charged a sizable percentage of their profits as corporate social responsibility (CSR) for water mamagement and quality improvement.

Sustainability in terms of managing our water resource for the living generation is required strictly with equity, concurrently without losing the sight of the future generation to avoid the water scarcity in future. To generate fund for making sustainable water resources, low-interest (say 2-3%) Water-Bonds similar to Gold –bonds, may be floated by the Union Government, which may help in installation of (a) ETPs and STPs across the country, (b) desalination and ion-exchange plants, and (c) nano-technology, resin and membrane manufacture plants for the country's Water Missions. This will also generate public awareness about the need of water conservation and sustainable water mangement for future generation.

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References

B.I.S. (2003). Bureau of Indian Standards, IS-10500:1991—'Test Characteristics for Drinking Water'.

Sarvothaman, H. (2004). Water: Resource Augmentation, Management and Policies, Asiatech Publishers Inc., Delhi, pp. 103-142.

Sarvothaman, H. (2017). Environment Science: Issues and Solutions. Asiatech Publishers Inc., Delhi, pp. 37-43.

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