International Journal of Financial Management and Economics

P-ISSN: 2617-9210
E-ISSN: 2617-9229
IJFME 2018; 1(1): 64-69
Received: 15-05-2018
Accepted: 19-06-2018

Dr. SM Athar Hussain
PGT Accountancy,
Bhagalpur, Bihar, India

Correspondence
Dr. SM Athar Hussain
PGT Accountancy,
Bhagalpur, Bihar, India

A critical study on availability of water resources and its management in India

Dr. SM Athar Hussain

Abstract

Water is the most important in shaping the land and regulating the climate. It is one of the most important compounds that profoundly influence life. Groundwater is used for domestic and industrial water supply and also for irrigation purposes in all over the world. Water is a prime natural stockpile, a basic human need and a treasured national asset. Planning, development and management of water maneuver need to be governed by national perspectives. We are all too familiar with the problems of water on earth in both qualitative and quantitative aspects. India receives annual precipitation of about 4000 km, including snowfall. Out of this, monsoon rainfall is of the order of 3000km. Rainfall in India is relying on the south west and northeast monsoons, on shallow cyclonic depressions and disturbances and on local storms. The latest estimate of total water resources of India as assessed by NCIWRDP is 1952.87 BCM. The (NCIWRD) estimated the total basin wise average annual flow in Indian River systems as 1953 km. The annual potential nature of ground water recharge from rainfall in India is about 342.43 km. The total utilizable water resources of India, according to the CWC are 1110 BCM. According to NCIWRD, the population of India is expected to be 1333 million and 1581 million in high growth scenario by the year 2025 and 2050 respectively. This eventually would be major cause of water crisis and water quality deterioration. An ideal water management technique and awareness of people could help to save the life on earth. Index Terms- Water resources, Groundwater, degraded water, surface water, water management.

Keywords: Water resources, groundwater, degraded water, surface water, water management

1. Introduction

Water bedaubs more than two-thirds of the Earth's surface. But fresh water represents less than 0.5% of the total water on Earth. The rest is either in the form of seawater or locked up in icecaps or the soil, which is why one often hears of water sparseness in many areas. There are about 97 percent of all water is in the oceans and three percent of all Earth's water that is freshwater. The majority, about 69 percent, is locked up in glaciers and icecaps, mainly in Greenland and Antarctica. It might be surprised that of the remaining freshwater is remained as ground water. No matter where on Earth you are standing, chances are that, at some depth, the ground below you is saturated with water. Of all the freshwater on Earth, only about 0.3 percent is contained in rivers and lakes-yet rivers and lakes are not only the water we are most familiar with, it is also where most of the water we use in our everyday lives exists. Water is finite in quantity, tangible in nature, and un-equally distributed throughout the world. Only 2.5% of 1386 million cubic kilometers of water available on earth is fresh water and one-third of this smaller quantity is available for human use. The per capita annual water resource (AWR) has been used to classify countries with respect to the water scarcity.

According to international norms, countries with an AWR per capita of 1700 cu m and above have been termed as countries where shortage will be rare; if per capita water availability is less than 1700 cu m per year then the country is categorized as water stressed, if it is less than 1000 cu m per capita per year, then the country is classified as water-scarce; and those with an AWR per capita of 500 cu m and below as countries where availability of water is a primary constraint to life. Water is essential for sustaining all forms of life, food production, economic development and for general well-being. It is impossible to substitutes for most of its uses, difficult to de-pollute, expensive to transport and it is truly a unique gift to mankind from nature. In India, per capita surface water availability in 1991 and 2001 was 2309 and 1902m^3 respectively and these are projected to reduce further to 1401 and 1191m^3 by the years 2025 and 2050 respectively.

India receives annual precipitation of about 4000 km, including snowfall. Out of this, monsoon rainfall is of the order of 3000km^3. Rainfall in India is reliant on the south west and north- east monsoons, on shallow cyclonic depressions and disturbances and on local storms.

2. Literature Review

Shweta Tyagi, Bhavtosh Sharma, Prashant Singh, Rajendra Dobhal carried out Water quality assessment in terms of Water Quality Index at Uttarakhand (India). The study states that Water quality index (WQI) is valuable and unique rating to depict the overall water quality status in a single term that is helpful for the selection of appropriate treatment technique to meet the concerned issues. However, WQI depicts the composite influence of different water quality parameters and communicates water quality information to the public and legislative decision makers. In spite of absence of a globally accepted composite index of water quality, some countries have used and are using aggregated water quality data in the development of water quality indices. Attempts have been made to review the WQI criteria for the appropriateness of drinking water sources.

Manjesh Kumar and Ramesh Kumar Carried out experimental work on Physico-Chemical Properties of Ground Water of U.P., (India). The study deals with evaluation of granite mines situated in jhansi (Goramachia) for their status about physicochemical contamination of ground water. Six different sites are selected for sample testing collected from mines and urban area. Three samples have been taken at various distances on the site. This location is 10Km above from Jhansi city. The physic-chemical parameters such as pH, D.O., E.C., T.D.S., alkalinity, turbidity, Ca (calcium) and Mg (magnesium) hardness, total hardness, NO3 (nitrate), F (fluoride), Fe+3 (iron) and Cl- (chloride) have been tested. It has been found that parameters are not in limit when compared with W.H.O. standards.

Ramkrishna carried out studies on ground water status by water quality index at Visakhapattanam (India) Commensurate with the growth of industrial and allied activities in and around Visakhapatnam city; its area grew from 30 km2 in 1960 to over 80 km2 to date. The city's population according to 2001 census is about 1.33 million. Water supply has always been inadequate in this city with the crisis growing along with the cities progress. Today's water requirement is 360 million gallons per day. The existing Thatipudi, Gossthani, Meghadrigadda and Mudasarlova can hardly meet 50% of the need. Rajwada water scheme can add a little more, therefore the supply capacity needs to be augmented. The only viable solution is to transport water from Godavari.

Sriniwas Kushtagi and Padaki Sriniwas (2011) carried out studies on water quality index of Groundwater of Aland taluka, Gulbarga (INDIA)states that main aim of the current work is to evaluate the quality of well water for rural and urban population based on W.Q.I. results, groundwater characteristics and quality assessment .Ten villages of Aland taluka are selected and at each village water samples at three places were collected using standard procedural methods and analyzed for pH, TH, Ca, Mg, CL, TDS, Fe, F, NO3,SO4 . BIS-10500-1991 standards were adopted for calculation of water quality index.

Cristina Rosu, Ioana Pistea, Mihaela Calugar, Ildiko Martonos, A.Ozunu, carried out work on quality of ground water by W.Q.I. method in Tureni Village, Cluj County. The rural population from Romania is dealing even today with the absence of access to a sure drinking water source. Therefore in 2002 only 65% of the Romanian population had access to drinking water, distributed in 90% from the urban environment and 33% from the rural one. This work presents a case study referring to a 3-month monitoring of weekly samples of the quality of well water (10 samples) from Tureni village, Cluj County. A portable multi parameter model WTW 720 Germany was used to measure the pH, total dissolved solids (TDS), electrical conductivity (EC), temperature, oxidation-reduction potential and salinity of the collected water samples (these tests were done on site). In laboratory, using the photometric method (RQ Flex instrument, Merck) we determined: Ca2+, Mg2+, SO42-, Cl- and NO3-.

Dr. N.C. Gupta, Ms. Shikha Bisht and Mr. B.A. Patra carried out Physico-Chemical analysis of drinking water quality from 32 locations in Delhi. Delhi is an old town, which has gradually grown into a popular city. It is one of the important business centers of India and thickly populated as well. Since the last decade, drinking water problem has created havoc in the city. In this study, we collected 32 drinking water samples throughout Delhi. Different parameters were examined using Indian Standards to find out their suitability for drinking purposes. During this examination mainly the physic chemical parameters were taken into consideration.

4. Objectives of the Study

- To Study the various water sources available in India
- To analyze water management in India
- To review various precautions from managerial perspective

5. Water Availability and Water Demand in India

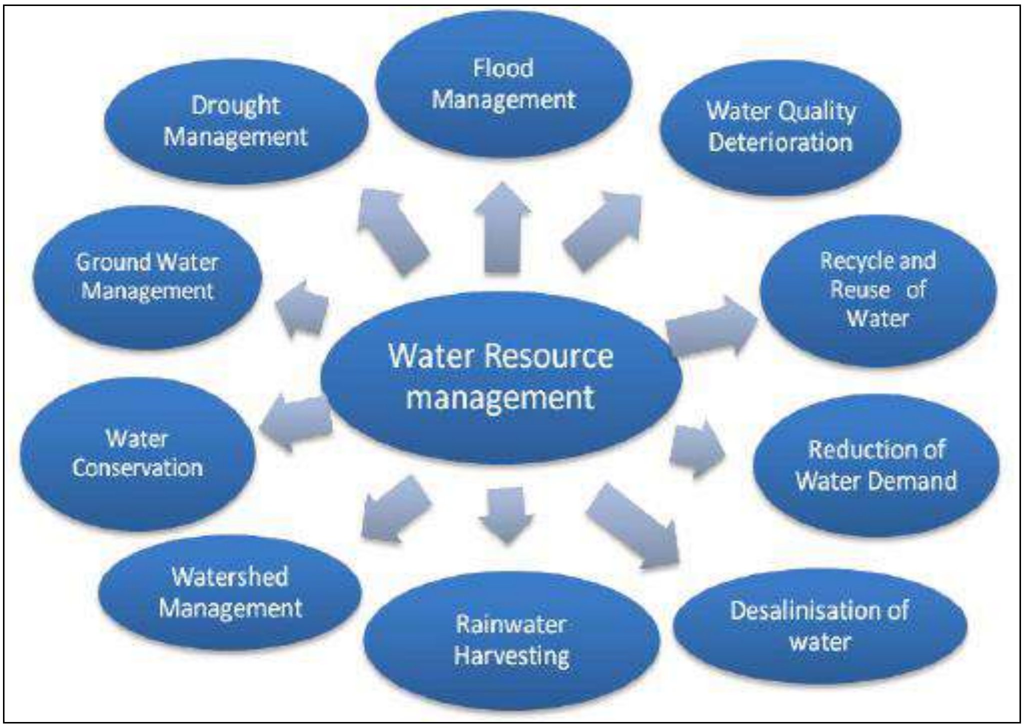
According to the National Water Policy of India [7]. "Out of the total precipitation, including snowfall, of around 4000 billion cubic meters (BCM) from surface water and replenishable ground water is put at 1869 billion cubic meters. Because of topographical and other constraints, about 60% of this, i.e. 690 billion cubic meter from surface water and 432 billion cubic meters from ground water, can be put to beneficial use." The latest estimate of total water resources of India as assessed by NCIWRDP is 1952.87 BCM, but this cannot be fully put to beneficial use because of topographical and other constraints.

There are four main sources of water:

i. Surface water
ii. Underground water
iii. Atmospheric water, and
iv. Oceanic water.

In our daily life we use only surface water and underground water. Let us study them in detail.

i) Surface Water: India's average annual surface run-off generated by rainfall and snowmelt is estimated to be about 1869 billion cubic meters (BCM). However, it is estimated that only about 690 BCM or 37 per cent of the surface water resources can actually be mobilized. This is because (i) over 90 per cent of the annual flow of the Himalayas rivers occur over a four-month period and (ii) potential to capture such resources is complicated by limited suitable storage reservoir sites. The average annual precipitation over the entire surface of the earth is estimated to be about 100 cm. amounting to a total volume of about 5x105km³. This is about 39 times the total quantity of all water in the atmosphere, implying that the average residence time of water in the atmosphere is about 9.4 days. Yet, this atmospheric circulation is dynamically linked to the much larger time scales of circulation of surface water and ground water and has influenced the earth's evolution over billions of years.



Source: Compiled by the Researcher

Fig 1: Water Resource Management and Procurement Methods

Average water yield per unit area of the Himalayan rivers is almost double that of south peninsular river systems, which indicates the importance of snow and glacier melt contribution from high mountains. Average intensity of mountain glaciations varies from 3. 4% for Indus to 3.2% for Ganges and 1.3 for Brahmaputra. The tributaries of these river system show maximum intensity of glaciations. It is estimated that the Himalayan Mountains cover a surface area of permanent snow and ice in the region which is about 97,020 km2 with 12930 km2 volume. In these mountains,10 to 20% of the total surface area is covered by glaciers, while an area ranging from 30 to 40% has seasonal snow cover. These glaciers provide snow and the glacial melt waters keep the Himalayan rivers perennial.

ii) Underground Water: The term underground water refers to all water below the water table to great depths. In the soil, both water and air coexist in the pore spaces. A profound consequence is that the capillary water in the soil can only be extracted by plant roots, within certain range of conditions. Ground water, on the other hand can be extracted by humans through wells. Ground water and soil water together constitute the lower part of the hydrological cycle. The annual potential natural of ground water recharge from rainfall in India is about 342.43 km, which is 8.56% of total annual rainfall of the country. The annual potential ground water recharge augmentation from canal irrigation system is about 89.46 km.

Table 1: Ground water resources of India (in km^3 /year).

SL. No	Groundwater sources	Amount (Km^3/yr)
1.	Total replenishable groundwater resource	432
2.	Provision for domestic. industrial and other uses	71
3.	Available groundwater resource for irrigation	361
4.	Utilizable groundwater resource for irrigation (90% of s1.3	325
5.	Total Utilizable groundwater resource (sum of sl.nos 2&3	396
	Total	1575

Thus, total replenishable ground water resource of the country is assessed as 431.89%. After allotting 15% of this quantity for drinking and 6 km3 for industrial purposes, and the remaining can be utilized for irrigation purposes. Thus the available ground water resource for irrigation in India is 361km3, of which utilizable quantity (90%) is 325km³.The estimates by the central Groundwater Board (CGWB) of total replenishable groundwater resource, provision for domestic, industrial and irrigation uses and utilizable ground water resources for future use are given in India's rechargeable annual groundwater potential has been assessed at around 431 BCM in aggregate terms. On an all-India basis it is estimated that about 30 per cent of the groundwater potential has been tapped for irrigation and domestic use. The regional situation is very much different and large parts of India have already exploited almost all of their dynamic recharge. Haryana and Punjab have exploited about 94 per cent of their groundwater resources. Areas with depleting groundwater tables are found in Rajasthan, Gujarat, most of western Uttar Pradesh and in all of the Deccan states. Occurrence of water availability at about 1000 cubic meters per capita per annum is a commonly threshold for water indicating scarcity (UNDP). Investment to capture additional surface run-off will become increasingly more difficult and expensive in the future. Over time, both for surface and groundwater resources, a situation where resources were substantially underutilized and where considerable development potential existed, has transformed in little more than a generation to a situation of water scarcity and limited development options

iii) Atmospheric Water: The Earth is a truly unique in its abundance of water. Water is necessary to sustaining life on the Earth, and helps tie together the Earth's lands, oceans, and atmosphere into an integrated system. Precipitation, evaporation, freezing and melting and condensation are all part of the hydrological cycle - a never-ending global process of water circulation from clouds to land, to the ocean, and back to the clouds. This cycling of water is intimately linked with energy exchanges among the atmosphere, ocean, and land that determine the Earth's climate and cause much of natural climate variability. The impacts of climate change and variability on the quality of human life occur primarily through changes in the water cycle. The hydrological cycle is largely driven by solar energy. Of the total solar energy received on the Earth's surface, about 40% is returned to the atmosphere as latent heat of evaporation, and another 18% as sensible heat. Within the atmosphere, water plays a significant role in the redistribution of energy through meridional or longitudinal convection cells, as well as through zonal or latitudinal circulation patterns. The average annual precipitation over the entire surface of the Earth is estimated to be about 100 cm, amounting to a total volume of about 5, 105 km3.
This is about 39 times the total quantity of all water in the atmosphere, implying that the average residence time of water in the atmosphere is about 9.4 days. Yet, this atmospheric circulation is dynamically linked to the much larger time-scales of circulation of surface water (years to decades) and groundwater (decades to centuries), and has influenced the Earth's evolution over billions of years.

iv) The Oceanic Water: The Ocean plays a key role in this vital cycle of water. The ocean holds 97% of the total water on the planet; 78% of global precipitation occurs over the ocean, and it is the source of 86% of global evaporation. Besides affecting the amount of atmospheric water vapor and hence rainfall, evaporation from the sea surface is important in the movement of heat in the climate system. Water evaporates from the surface of the ocean, mostly in warm, cloud-free subtropical seas. This cools the surface of the ocean, and the large amount of heat absorbed the ocean partially buffers the greenhouse effect from increasing carbon dioxide and other gases. Water vapor carried by the atmosphere condenses as clouds and falls as rain, mostly in the ITCZ, far from where it evaporated, Condensing water vapor releases latent heat and this drives much of the atmospheric circulation in the tropics. This latent heat release is an important part of the Earth's heat balance, and it couples the planet's energy and water cycles.

5. Water Quality Deterioration

Groundwater accounts for more than 80% of the rural domestic water supply in India [24]. Data collected in 1998 for the 54th round of the National Sample Survey showed that 50% of rural households were served by a tube well, 26% by a well, and 19% tap. In most parts of the country, however, the water supplied through groundwater is beset with problems of quality. The over dependency on groundwater has led to 66 million people in 22 states at risk due to excessive fluoride and around 10 million at risk due to arsenic in six states.

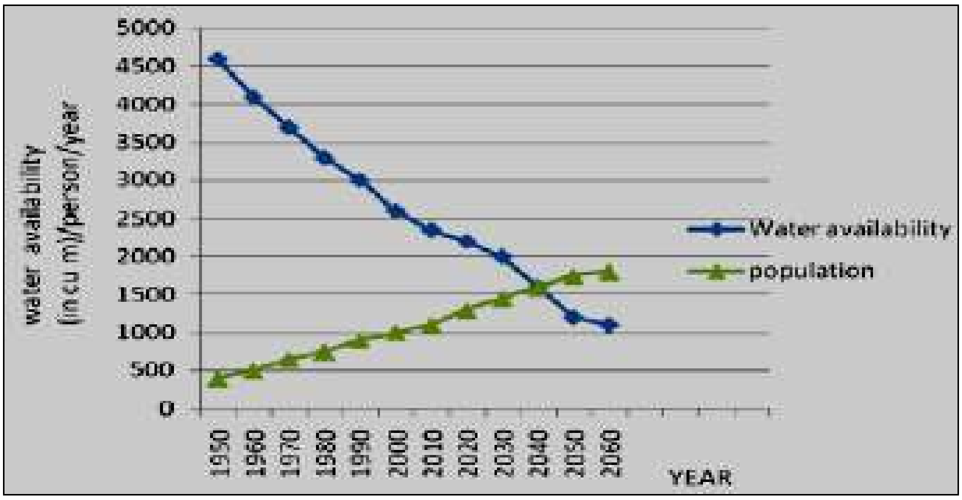


Fig 2: Clearly denotes that the availability of water per person/year is reducing with the rapid increase of population in our country

India's Tenth Five Year Plan lists excess fluoride concentration as one of the major hurdles to the sustainable supply of safe water for domestic use. Twenty Indian states have excess fluorides in the ground water. Nearly six million children below the age of 14 suffer from dental, skeletal and non-skeletal fluorosis.

Figure-2: Clearly denotes that the availability of water per person/year is reducing with the rapid increase of population in our country. It is very much alarming for our future production, development and prosperity. The presence of arsenic in water is geogenic. The entire gangetic delta plain, which consists of alluvial soil, contains arsenic in the deeper aquifers. Bacteriological contamination, especially fecal coliform, is the most widespread groundwater problem in India. Groundwater itself doesn't inherently contain fecal coliform. Most of the ground water coli forms come from the leaching of solid (human and animal) and liquid waste. In addition, there are problems due to excessive salinity, especially in coastal areas, iron, nitrates and others. Around 195,813 habitations are affected by poor water quality due to chemical parameters.

Table 2: Water quality problem in rural areas

Nature of problem	No of habitation affected
Excess fluoride	36988
Excess arsenic	3553
Excess salinity	32597
Excess iron	138670
Excess nitrate	40003
Other reasons	1400
Total	217221

6. Management of Ground Water Resources

Management of ground water resources in the Indian context is an extremely complex proposition as it deals with the interactions between the human society and the physical environment. The highly uneven distribution of ground water availability and its utilization indicates that no single management strategy can be adopted for the country as a whole. On the other hand, each situation demands a solution which takes into account the geomorphic set-up, climatic, hydrologic and hydrogeologic settings, ground water availability, water utilization pattern for various sectors and the socio-economic set-up of the region. Any strategy for scientific management of ground water resources involves a combination of A) Supply side measures aimed at increasing extraction of ground water depending on its availability and B) Demand side measures aimed at controlling, protecting and conserving available resources. Various options falling under these categories are described in detail in the following sections

A) Supply Side Measures: As already mentioned, these measures are aimed at increasing the ground water availability, taking the environmental, social and economic factors into consideration. These are also known as 'structural measures', which involves scientific development and augmentation of ground water resource. Development of additional ground water resources through suitable means and augmentation of the ground water resources through artificial recharge and rainwater harvesting fall under this category. For an effective supply-side management, it is imperative to have full knowledge of the hydrologic and hydrogeologic controls that govern the yields of aquifers and behavior of ground water levels under abstraction stress. Interaction of surface and ground water and changes in flow and recharge rates are also important considerations in this regard.

i) Scientific Development of Ground Water Resources

a) Ground Water Development in Alluvial Plains:
b) Ground Water Development in Coastal Areas:
c) Ground Water Development in Hard Rock Area
d) Ground Water Development in Water-logged Areas
e) Development of Flood Plain Aquifers

ii) Rainwater Harvesting and Artificial Recharge

B) Demand Side Measures Apart from scientific development of available resources, proper ground water resources management requires to focus attention on the judicious utilization of the resources for ensuring their long-term sustainability. Ownership of ground water, need-based allocation pricing of resources, involvement of stake holders in various aspects of planning, execution and monitoring of projects and effective implementation of regulatory measures wherever necessary are the important considerations with regard to demand side ground water management. 5. Groundwater Development Prospects in India: The analysis of available data indicates that contribution made by ground water to the agricultural economy of India has grown steadily since early 1970's. In just last two decades, the ground water irrigated lands in India has increased by nearly 105%, this change was most striking in northern India, the heart of the Green Revolution. A close examination of the ground water resource availability in different geomorphological terrains of the country and its utilization as presented in Table 1, indicates that out of the total of 433 BCM of annual replenishable ground water resources available in the country, the share of alluvial areas covering Eastern Plain states of Bihar, Orissa (part), Eastern Uttar Pradesh and West Bengal; and North Western plain states of Delhi, Haryana, Punjab, Western Uttar Pradesh, Chandigarh; is about 192 BCM which is works out to be 44% of the total available resource. The enigma is in the eastern plain states the overall stage of ground water development is about 43%, whereas the overall stage of ground water development in North Western Plain states covering Punjab, Delhi and Haryana is 98%. Except Western part of Uttar Pradesh, a major part of the area is overexploited.

B. Demand Side Measures Apart from scientific development of available resources, proper ground water resources management requires to focus attention on the judicious utilization of the resources for ensuring their long-term sustainability. Ownership of ground water, need-based allocation and pricing of resources, involvement of stake holders in various aspects of planning, execution and monitoring of projects and effective implementation of regulatory measures wherever necessary are the important considerations with regard to demand side ground water management.

7. Managerial Precautions

There should be proper organizational arrangements at the national and state levels for ensuring the safety of storage dams and other water-related structures consisting of specialists in investigation, design, construction, hydrology, geology, etc. For effective and economical management of our water resources, the frontiers of knowledge need to be pushed forward in several directions by intensifying research efforts in various areas, including the following.

- Better water management practices and improvements in operational technology
- Surface and ground water hydrology
- River morphology and hydraulics
- Assessment of water resources
- water conservation
- Hydrometeorology
- Snow and lake hydrology

- Water harvesting and ground water recharge
- Water quality
- Evaporation and seepage losses
- Recycling and re-use
- Crops and cropping systems
- Soils and material research
- Use of sea water resources
- Prevention of salinity ingress
- Risk analysis and disaster management
- Use of remote sensing techniques in development and management
- Environmental impact
- Regional equity
- Use of static ground water resource as a crisis management measure
- Sedimentation of reservoirs
- Seismology and seismic design of structures
- The safety and longevity of water-related structures
- Economical designs for water resource projects
- Prevention of water logging and soil salinity
- Reclamation of water logged and saline lands

8. Conclusion
Water is life on earth. It is one of the most essential natural resources for sustaining life and it is likely to become critically scarce in the coming decades, due to continuous increase in its demands, rapid increase in population and expanding economy of the country. Variations in climatic characteristics both in space and time are responsible for uneven distribution of precipitation in India. It is posing a challenge to the existing water resources and to those who are responsible for the management of water resources. Hydrological studies are required to be taken up for assessment of water resources under changing climatic scenarios. For safe drinking water it is essential to generate reliable and accurate information about water quality. To sustain life on earth in all its totality, water should be carefully managed in its natural habitats.

9. References

1. Kumar R, Singh RD, Sharma KD. Water resources of India; Curr. Sci. 2005;89:794-811.
2. Jain SK, Agarwal PK, Singh VP. Hydrology and water resources of India (Dordrecht, Netherlands: Springer), 2007, 1258.
3. Postel SL, Daily GC, Ehrlich PR. Human appropriation of renewable freshwater. Science. 1996;271:785-788.
4. Gosain AK, Rao S, Basuroy D. Climate change Impact assessment on hydrology of Indian River basin. Curr. Sci. 2006;90(3):346-353.
5. Lal M. Climate change-Implications for Indias water resources. J India Water Res. Soc. 2001;21:101-119.
6. Kumar R, Singh RD, Sharma KD. Water resources of India, Curr. Sci. 2005;89(5):794-811.