Reason - A Technical Magazine
ISSN 2277–1654
Vol - X ● 2011

General Article

WATER IN THE PERSPECTIVE OF GLOBAL ECONOMIC SCENARIO

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Abstract: From the dawn of civilization water and man are related to each other. Man lives on water but, unfortunately, cares little for it. Time has come to understand the importance of water on the earth and stop indiscriminate use of the same. Conservation of water is the need of the hour. Human Development Index and use of water are inter-related. India has different rates of precipitation in different parts of it. For example, Rajasthan with 8% of the country's population has only 1% of the total water resources of the country whereas Bihar with 10% of the country's population has 5% of water resources. A large amount of area in this country is affected by drought. The role of major dams has also been discussed.

Keywords: *Water resource, economy, utilization, scarcity*

1. Introduction

Every human being on earth is a stakeholder in water resources management. Man needs to protect other living things not for any altruistic reasons, but in his own self-interest. He should realize that that his well-being is inseparable from the well-being of the ecosystem. If frogs are dying, he should surely be the next in the line!

The international Conference on Water and Environment, Dublin 1992, enunciated crucially important guiding principles [1]. These are:

Dublin Principles

Principle No. 1 – Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment,

Principle No. 2 – Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels,

Principle No. 3 – Women play a central part in the provision, management and safeguarding of water,

Principle No. 4 – Water has an economic value in all its competing uses and should be recognized as an economic good.

Over all these years, therefore, the message has remained the same: water is a precious resource that must be assessed and managed with care for the benefit of mankind and the natural environment.

With the threat of global warming due to increasing greenhouse gas concentrations in the atmosphere, the need for measurements and data exchange on the hydrological cycle on a global scale is evident. The data are required to understand both the world's climate system and the potential impacts on water resources of climate change and sea level rise. All countries must participate and, wherever necessary, be assisted to take part in the global monitoring, the study of the effects and the development of appropriate response strategies.

In his keynote address to the UNESCO-organized World Conference on Science, Budapest, Hungary, June 26 – July 1, 1999, Dr M. S. Swaminathan of India gave his vision of hunger-free world. He envisaged three approaches:

1. Improving food production through the optimization of various inputs, via people-participatory technologies in an ecologically-sustainable manner,

2. Increasing access to food by promoting job-led economic growth, and

3. Facilitating the availability of safe drinking water and environmental hygiene, in order to ensure the biological absorption of food in the human body. It may be noted that water resources management happens to be at the core of all the three approaches. Plants need tremendous amounts of water to grow – about 30-40 cm of water is needed to produce a food crop, such as wheat. Thus irrigation will continue to be the principal user of water, and also the key input to enhance agricultural productivity. Water-related activities (e.g. rainwater harvesting, storage, distribution, use

and reuse, etc.) have considerable potential to create jobs. About 5000 children (mostly in the Developing countries) die every day due to water-related diseases. These deaths are entirely preventable if only adequate quantity of clean water is available for drinking and sanitation.

2. Water, Civilization and Quality of life

Furthermore, adequate water and sanitation are becoming increasingly critical in urban areas, as rapid urbanization and industrialization strain have already limited the resources. This is of particular concern in Asia, which holds more than 50% of the world's population and is home to number of the world's mega cities. But such explosive growth is a global problem. Well over 300 cities have populations over 1 million, double the total in 1975. By 2025, 60% of the global population will live in urban areas, a daunting number given the health hazards already present in many of the cities.

It is not easy to define, let alone quantify, the quality of life of a community or a family. There is, however, little doubt that quality of life is closely linked to the quality of water available for drinking, cooking, washing, bathing, sanitation, gardening, etc. The rate of consumption of water for domestic purposes (in terms of cubic meters per capita per annum) bears a general direct relationship to the quality of life. One way to quantify the quality of life is the Human Development Index (HDI is a parameter developed by UNDP, based on life expectancy, adult literacy, and standard of living, as measured by Real GDP in terms of Purchasing Power Parity dollars or PPP. [Sources: 'Human Development Report' 1997; 'World Development Report' 1992) (Table 1)]

3. Dimensions of Water Resources Management

The United Nations Report entitled, "Comprehensive Assessment of the Fresh water Resources of the World" (1997), draws a sombre picture of how water shortages in the 21st century could constrain economic and social development, and become sources of conflict between countries. Water use has been increasing twice as fast as population during this century. Population has made the matters worse. Total water use in the world rose from 1000 $km^3 yr^{-1}$ in 1940 to 4130 $km^3 yr^{-1}$ in 1990. At least one-fifth of the world's people lack access to safe drinking water. About 80 countries in the world, making up 40% of the world's population, are already suffering from serious water shortage, which had become a limiting factor in their economic and social development. The Report forecasts that by 2025, as much as two-third of the world's population will be affected by moderate to severe water scarcity, unless appropriate mitigation measures are taken.

Presently, agricultural irrigation accounts for 70-80% of total water use. Increasing population would need more food and hence more water would be needed for irrigation. The report argues that water must be perceived as a marketable commodity, with its use being subjected to the market laws of supply and demand. It has been estimated that in USA, one acre-foot of water would yield an income of US$ 400 when used in agriculture, and US$ 400,000 when used in manufacturing. So in the American context, when water is scarce, it would be used for drinking and manufacturing purposes. Food is to be grown in areas where water is plentiful.

A complication factor is the global trend towards urbanization – urban population as a percentage of total population, varies from 100% in city-states like Singapore, 80-90% in several countries of Western Europe (e.g. UK: 89%) and South America (e.g. Argentina: 86%), 20-30% in most African countries (e.g. Mozambique: 30%), with Bhutan having the lowest percentage (5%). Globally, urban populations are increasing at a faster rate than the general population growth, and this is particularly evident in the developing countries where this differential can be as high as three to four. This has serious implication for water resources planning. Cities cannot be shifted to places where resources like water and fertile soil are available. On the other hand, services like drinking water; habitation, sanitation, roads, etc. have to be organized keeping in mind the existing location of towns.

97.25% of water available on the earth lies in seas and oceans and 2.1% is in the form of polar ice caps, glaciers and snow (Table 2). Of the 0.62% of the total water which is available as fresh water about half is below a depth of 800 m and so is not available for men's use. This means that the stock of the earth's fresh water which is obtainable in one way or the other for men's use is about 4 million km^3. Management of this resource is a challenging task. Despite significant improvements of water resources management in recent years, over one billion people still lack access to safe water, and nearly two billion lack safe sanitation. An estimated 10,000 people die every day from water and sanitation related diseases, and thousands more suffer from a range of debilitating illnesses.

Water undergoes a permanent cycle (hydrological cycle) under the influence of moving force of the sun's radiant energy. Because water continually evaporates, condenses, and precipitates, with evaporation on a global basis approximately equalling global precipitation, the total amount of water vapour in the atmosphere remains approximately the same over time. This movement of water, in a continuous circulation from the ocean to the atmosphere to the land and back again to the ocean is termed the global water cycle, and is at the heart of the Earth's climate system, affecting every physical, chemical, and ecological component.

Every year about 566000 km^3 evaporates from the earth's surface, 80% of it over the sea. The same amount falls back onto the earth as precipitation, but only 110000 km^3 over the land masses, of which 71000 km^3 evaporates directly again. Thus, the average amount of water running off the land masses each year as a renewable resource is about 39000 km^3. Of the 39000 km^3 runoff described above as a renewable resource 64%, 25000 km^3 flows off very quickly. This part is known as the "unstable runoff". The remaining one third, in other words about 14000 km^3, seeps into the ground and becomes ground water, which later forms the "stable runoff". The later is also known as fair weather or groundwater runoff. Table 3 shows the renewable water supply continent by continent. Looking at the relationship to area, it becomes clear that South America, with an average of 583 mm, has the largest amounts of fresh water available, while Africa has an average of only 139 mm.

4. Challenges

Fresh water requirement by the human being is expected to increase significantly in the coming decades. A substantial amount, 70%, of the water currently withdrawn from all freshwater resources is used for agriculture. With the world's population set to increase by 65% (3.7 billion) by 2050, the additional food required to feed future generations will put further enormous pressure on fresh water resources. According to recent global water assessments, around 70% of the future world population will face water shortages and 16% will have insufficient water to grow their basic food requirement by 2050. The guaranteed sustainable supply of water with good quality is a tremendous challenge.

5. Water Crisis in India

India receives an average rainfall of 1170 mm which is the highest in the world among countries of comparable size, and should be sufficient enough to satisfy its ever-increasing demand. It has more water per head than Korea and South Africa. It grows enough food to feed itself even when the monsoon disappoints. The trouble is that India gets most of its water during the four monsoon months. Some areas receive far less rainfall than others and also it is unevenly distributed both in space and time. About 60% of the area of our country receives below average rainfall. Table 4 presents the average precipitation ranges with approximate areas [2].

In India, the availability of water (both surface and groundwater) varies tremendously in various regions of the country. Rajasthan with 8% of the country's population has only 1% of the total water resources of the country whereas Bihar with 10% of the country's population is endowed with 5% of water resources. A large amount of area of our country is affected by drought. As many as 30 of the country's total 35 meteorological sub-divisions suffered from drought in 2001. On the other hand ground water is being non-sustainably exploited particularly in Andhra Pradesh, Gujarat, Haryana, Karnataka, Punjab, Rajasthan, Tamil Nadu and Utter Pradesh. In areas with extensive monocropping, such as Punjab and Haryana, this exploitation has reached 100% in some districts. In Mehsana, Gujarat, the rate of ground water exploitation has increased by 145% between 1984 and 1992.

Urbanisation has now become a global phenomenon, but its consequences are more pronounced in developing countries. The massive increase in urban population has brought us to a stage where the balance of water supply and demand is close to being destabilised in many places. As far as the present status of water supply in various cities and towns is concerned, there is a good deal of variation. In Mumbai it is 296 litres per capita per day, in Bhopal 271 litres per capita per day, in Lucknow 253 litres per capita per day, in Kolkata 226 litres per capita per day, in Madras 115 litres per capita per day and in Delhi 244 litres per capita per day.

6. Augmentation and Conservation of Water Resources

Any method that saves water is a conservation method. Since ancient times, farmers and herders living in areas of limited rainfall practised a variety of water conservation measures.

6.1 Some traditional methods for water conservation

- ❖ Rain Water Harvesting
- ❖ Harvesting of Surface Runoff
- ❖ Ground Water Recharging
- ❖ Tapping of Groundwater Inflow into The Sea

Also there may be methods like

- ❖ Amelioration of Mine Water
- ❖ Desalinization of Salt Water

6.1.1 Rain water harvesting

❖ Making better use of rainfall by minimizing runoff losses (in combination with increased infiltration), collection and storage of rainfall, minimizing evapotranspiration,

❖ Collection of fog drip and dew, and

❖ Making use of groundwater without water lifting, through artesian wells and horizontal wells. These water conservation measures are low-cost, labour-intensive operations and, hence, particularly suitable for the developing countries.

6.1.2 Harvesting of surface runoff

❖ Collection, storage and distribution of storm runoff have been practiced by ancient cultures from time immemorial. In South India, thousands of irrigation tanks were built by the ancient kingdoms, several of which continue to be in use to this day.

❖ Currently, minor irrigation tanks in India have a storage capacity of 14.3 M ha m.

❖ Rehabilitation of the 50-100 years old irrigation tanks/spread across Rajasthan, South Bihar, Madhya Pradesh, Tamilnadu, Karnataka, Andhra Pradesh and other locations solely from an irrigation perspective is not proper. In addition to storing water for crop irrigation, tanks provide services such as recharge of ground water used by adjacent communities, fertile silted soil that allows cultivation of additional crops, fishing and aqua culture, water for raising livestock and sand and soil used by small industries.

Ways and Means of Increasing the Runoff from an Area

❖ Development of a V-shaped contour in the slopping surfaces

- ❖ Vegetation Management
- ❖ Mechanical Treatment
- ❖ Chemical Application to Reduce Soil Permeability
- ❖ Surface Binding Treatment
- ❖ Rigid Surface Covering
- ❖ Flexible Surface Covering

6.1.3 Groundwater recharging

The total volume of the world's surface reservoir is about 6000 km^3. L'vovich (1979) had the vision to propose the artificial conversion of surface runoff of the order of 3000 to 5000 km^3 per year [1].

Advantages in Storing Water in Underground Reservoir

❖ Better protected against pollution than water in the surface reservoirs

❖ Do not interface with the land use.

❖ No loss due to evaporation.

❖ Though the recovery rate of the water stored is less than unity because of effluent seepage of groundwater, that is beneficial as it will feed the rivers and makes for an increase in stable runoff.

❖ The operation of large canal irrigation systems in the Indo-Gangetic Plain and similar hydro-geological areas can be modified to recharge groundwater on a vast scale. This reduces the need for new dams and other storage structures.

Artificial Recharging

The usual practice the artificial injection of water into the aquifers by means of drilled wells. Normally water is drawn from a well – in case of artificial recharge, water is pumped into the well. An issue to be borne in mind that there is a possibility that it may trigger low magnitude earthquakes. In 1962 when toxic fluid wastes were pumped under pressure into a borehole in the Denver Basin in USA, low magnitude earthquakes got triggered.

Storage and Utilization of Rainwater from Groundwater

Rainwater storage ponds are best located when there is

- ❖ A natural saucer-shaped depression, or
- ❖ A shallow ravine with a small flowing stream which can be impounded
- ❖ The ground has high water retention capacity

If the soil porosity is high, the bottom and the sides of tank have to be sealed with a suitable sealant such as an embedded membrane of plastic sheeting or bentonite.

6.1.4 Tapping of groundwater inflow into the sea

The direct groundwater runoff to the ocean in about 21000 km^3 per year amounting to about 5% of the total runoff of the Earth's rivers (42,700 km^3 per year) [1].

Two aspects about the groundwater inflow into the sea need special mention:

It is quite substantial and very little of it is being presently tapped.

7. Big Dam Controversy in India

It is now universally agreed that economic growth initiates disequilibria to break the low-level equilibrium trap of the low income economies. This is urgent for economic development the primary aim of which is to uplift the living standard of the huge mass of the weaker sections of the population in those countries. To achieve the target, development economics in the decade of fifties relied mainly on rapid income generation through capital formation in the form of heavy machineries (in large-scale capital-intensive industries), irrigation infrastructures (like big dams and multipurpose river valley projects), power (hydro, thermal and nuclear) and transport (highways) believing in the theory of trickle-down of benefits.

Despite all the achievements made so far in water resources development sectors since independence, there cannot be complacency, as yet, in the matter of further development as only 37% of cultivable land stands irrigated and 15% of the hydropower potential is harnessed. It is true that there are several arguments in favour of and against the dams. Some of the established facts are mere myths and can be avoided by taking precautions. It is difficult for an economy like India to have sustainable development without acknowledging the social and economic implication of major dams. However, the smaller dams may be promoted because of their advantages, the bigger ones may be planned with great care to avoid delay in completion and cost escalation. Social issues and demerits can be avoided if proper planning for displacement, rehabilitation and employment opportunities is made. Table 5 shows regional distribution some of the major dams in India.

8. Conclusion

Water is, directly or indirectly, related to macro-economic scenario in a country. Water improves life of people. India being a heterogeneous state needs to look upon the policy very carefully. However, keeping the global economy in mind it can be said that India cannot go alone. A comprehensive global policy on water and its distribution may scale down all anomalies and controversies related to water.

References

[1] Mazumdar, A. (2004). "Management Through Conservation of Water Resources." *UGC-Refresher Course on Water Resources Management, Jadavpur University*.

[2] Goel, N. K. and Lohani, A. K. (2004). "Hydrological Aspects Of Water Resources Management – Recent Trends." *UGC-Refresher Course on Water Resources Management, Jadavpur University*.

Table 1: Relationship between HDI and Water Consumption

Country	Domestic consumption of water (m3/capita/annum)	Human development index (HDI)
Canada	193	0.960
Brazil	91	0.783
South Africa	65	0.761
China	28	0.626
Mozambique	13	0.281
Ethiopia	5	0.244

Table 2: Estimated Water Inventory of the Earth

Location	Volume 1000 of km^3	Percentage
Fresh Water Lakes	125	0.62
Rivers	1.25	
Soil moisture	65	
Ground Water	8,250	
Saline lakes and in land seas	105	0.008
Atmosphere	13	0.001
Polar in caps, glaciers and snow	29,200	2.1
Seas and oceans	1,320,000	97.25
Total	**1,360,000 = 1.36 x 10^9 km^3**	**100**

Table 3: Renewable Water Supply of the Earth

Region	km^3	mm
Europe	3110	319
Asia	13190	293
Africa	4225	139
North America	5960	287
South America	10380	583
Australia	1965	225
Total	**38830**	**294**

Table 4: Average Precipitation Ranges with Approximate Areas (%) of Indian Territory

Sl. No.	Range of Annual Precipitation	Area (%)
1	0-750	30
2	750-1250	42
3	1250-2000	20
4	>2000	8

Table 5: Regional Distribution of Major Dams in India

No. of Dams	No. of States	States where located
Upto 50	09	Bihar, H.P., J&K, Kerala, Meghalaya, Orissa, Punjab, West Bengal, Goa,Daman and Diu
50-100	04	AP, Karnataka, Tamilnadu, U.P.
50-150	01	MP.
50 and above	02	Gujarat, Maharashtra