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Freshwater: Resources and Pollution

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Abstract

Today with the rapid increase in the population, the gap between demand and supply of resources has been doubled. To overcome this gap increase in industrial revolution came into existence causing the severe damage to nature and its resources. Today our aim is not only to overcome the gap between demand and supply but also to manage these resources so that our future generations can also use them. Water, everyone's need is the major resource which is severely affected and being polluted enormously. In context of India if we look towards our biggest river basin *i.e.* River Ganga, nourishing the agricultural fields, providing water for domestic and commercial purposes is majorly polluted due to industrial effluents and chemicals. We still have our resources plenty in amount but only if we manage them properly with new management techniques. We are the caretakers of these resources, not owners; all these resources belong to our future generations.

Keywords: *Water*, *Management*, *Resources*, *Pollution*

Introduction

Water, like other primordial elements was revered and worshipped since Vedic times. The Rig Veda says: "Agni and water are givers and sustainers of life, they are affectionate mothers, givers of all givers of life, they have healing powers". If it was true then, it is truer now as never before.

Through our history water has been a natural resource critical to human survival. Water a substance which is flowing, swirling and seeping, constantly moving from sea to land and back again. It not only shape's the earth but moderate our climate also. If we see our body composition, we found 60% of our body is water. Water dissolve nutrients and distributes them to cells, regulates body temperature, support body structure and removes waste products. Water is the only medium in which all living processes occur.

The great rivers, like mothers, nourished civilizations such as Indus Valley, the Sumerian or the Nile, in fact, evolution of human cultures and civilization has revolved around river systems, in other words human history can generally be considered to be water-centered. The main reason of the development of civilization and habitats along the banks of rivers was easy availability of water for drinking, farming, and transportation was an important requirement for survival. In other words human history can, in fact, be written in terms of interactions and interrelations between humans and water.

World's water resources consist of fresh water found on and under the Earth's surface, and the immense salt-water reserves of the oceans. Since fresh water is used to meet most of our current needs it has become the focus of immediate concern. With population growth and industrial development on the increase, demand on limited supplies is likely to intensify still further. Both the Millennium Development Goals and the Johannesburg Summit on Sustainable Development recognize the need to provide greater access to clean fresh water, to improve

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sanitation, and to produce integrated plans for the development of this universal resource.

Fortune magazine stated that, in a world fleeing the vagaries of technology stocks, the water industry is the best investment for the century. The World Bank places the value of the current water market at close to $1 trillion. With only 5 percent of the world's population currently getting its water from corporations, the profit potential is unlimited. Water from a fundamental right and necessity for survival has become a product of profit in the market.

The total amount of water available on earth has been estimated at 1.4 billion cubic kilometers, enough to cover the planet with a layer of about 3 km deep. About 95% of the earth's water is in the oceans, which is unfit for human consumption and other use because of its high salt content; about 4% is locked in the polar ice caps; and the remaining 1% constituents all the freshwater in hydrological cycle including ground water reserves. Only 0.1% is available in as fresh water in rivers, lakes and streams, which is suitable for human consumption. This shows that at what level we need the water for the survival of life on earth.

The above statistics of availability are devoid of the influences of contamination, pollution and other human contributions shrinking the supply of drinkable water further.

The decreasing supply of water arises from the meager absolute natural endowments of water the earth is blessed with as well as from the meager natural endowments relative to increasing growth of population, and their increasing demands for use and misuse. During the last fifty years, human population has increased by 240 percent to 6 billion people. By 2050, human population is estimated to be at 9 billion people. India with 1 billion people at present is projected to become the most populace country before the middle of next century. Global consumption of water is doubling every 20 years, more than twice the rate of human population growth. According to the United Nations, more than one billion people on earth already lack access to fresh drinking water. By 2025, if the current trends persist, the demand for freshwater is expected to rise to 56 percent above the amount currently available.

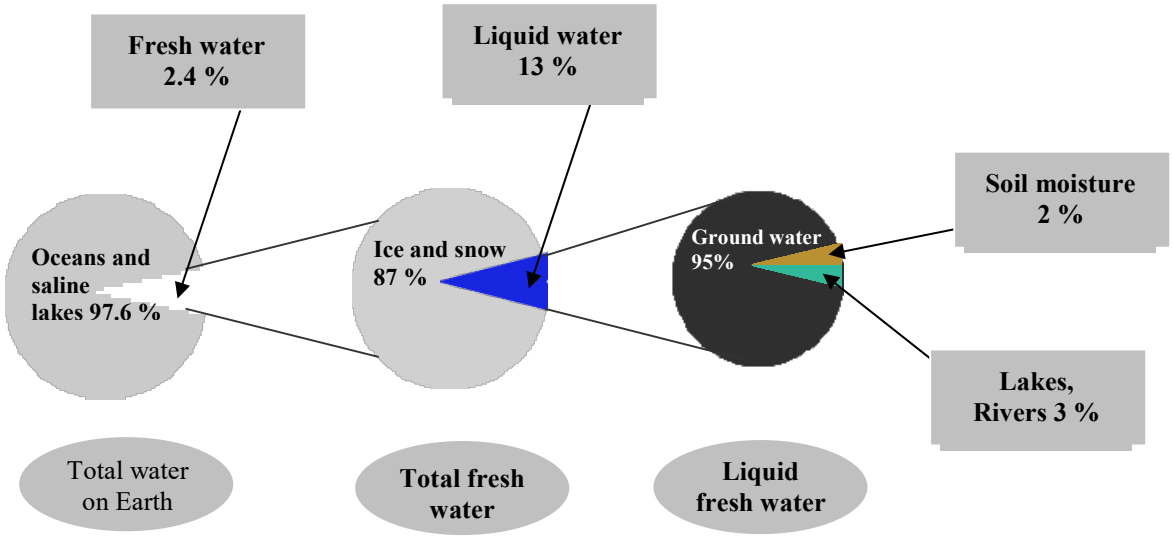

Figure 1: Distribution of water in different forms

According to National Water Policy, 2002 "Water is a prime natural resource, a basic human need and a precious national asset. Planning development and management of water resources need to be governed by national perspectives". A combined study conducted by United Nations International Children Education Fund (UNICEF) and the World Wide Fund (WWF) for Nature revealed the alarming situation of fresh water depletion in the country. The main cause was found of the decline of the quality and quantity of the presently available water resources is due to: (1) increase in the population (2) improper resource management (3) pollution in water sources (4) Shortcomings in the design and implementation of legislation and regulations, which address these problems.

The demand for water needed for the mere purposes of survival is compounded by the need of water for industries, agriculture, livestock maintenance and other activities. Thus, with water being the essence for human survival and a necessity for carrying out all human activities, there can be no decrease in the demand for water, not even a slump but only an ever-increasing demand. This holds sadly true with the running down of its finite supply. In other words, scarcity of water is continuously increasing. 'Scarcity' is a term often associated with the developing world, be it food, medicines, schools *etc*. But when it is a matter of water scarcity, the developed world and the developing world equally suffer. North America (New Jersey, Carolinas, Texas) is facing the problems of water shortages just as the people of Asia, Africa and Latin America. The scarcity arises in both the developed and the developing world, not just because of decreasing water availability from the sources of water supply, but also due to the inefficient working of the water supply system. The water distribution system remains inefficient, more so in the developing world. Further with intensive urbanization, deforestation, water diversion and industrial farming, water available in cities and villages suffer from lack of quality and irregular supply. Continuously increasing scarcity, defines the status of the global water situation. In short, water is becoming globally scarce in availability and where available, further scarce through misuse, poor water management and inefficient distribution system.

According to latest census, India's population is about 1020 million, which is projected to go up to 1333 million by A.D. 2025 and further to 1640 million by A.D. 2050 for feeding a population of 1.64 billion, nearly 450 million tones of food grains would be required by the year 2050, production of which would be a gigantic task considering the constraints being faced in the irrigation sector, including irrigation water resources. If we see the situation in India as regards availability of water is paradox. The country accounts for 2.45 per cent of the total land area and 4 per cent of the water resources of the world. Nevertheless, water is a scarce national resource with demands on it increasing on account of a growing population of over one billion. Much of the available surface water and ground water estimated at 1869 billion cubic metre is presently unable to be harnessed for use on account of topographical and other constraints. India is at the 133rd position among 180 countries and as regards the quality of the water available, it is 120th among 122 countries. Of the present water usage in India, 92 per cent is devoted to agriculture; around 3 per cent is used by industries and only 5 per cent for domestic purposes like drinking water and sanitation. The picture gets complicated by the other constraints. 40 million hectare of land in the country is flood prone and an average, floods affect an area of around 7.5 million hectare per year. One-sixth area of the country is drought prone. Water pollution is a serious problem with 70 per cent of India's surface water resources and an increasing number of its ground water reserves standing contaminated by biological, toxic organic and inorganic pollutants. The National Water Policy advocates a participatory approach to management of water resources and non-conventional methods for utilization of water like

artificial recharge of ground water and traditional water conservation practices like rain water harvesting. With water being a scarce resource, its sharing and distribution requires a regulatory framework which is brought about through not only written laws but also traditional and customary practices. At this stage it's too important to develop the educational level of water management, sustainable use of water resources.

Major water resources

Distribution of water compartments in which water is present are in different forms. Nearly all the world's water is in the oceans. Oceans play a crucial role in moderating the earth's temperature, and over 90 percent of the world's living biomass is contained in the oceans. What we mainly need though is fresh water. Of the 2.4 % which is locked up in ground water and huge glaciers in various parts of the earth. Accessible water for human beings and to other organism is 0.1% of the total freshwater present on earth.

Ground water resources

In India ground water contributes 70-80% of agricultural produce in India, about four fifth of the domestic water supply in rural areas and about 50% of urban and industrial uses. In the most developing countries as ours, most of the water sources of freshwater, especially in outskirts of large cities and villages are polluted. Continuous flow of industrial effluents and sewage in the ground the water has become the store house of various kinds of bacteria's and viruses also.

Assessment of ground water resources has been made at 431.9 BCM by the Central Ground Water Board through a large volume of hydrologic and related data. This is the sum total of potential due to natural recharge from rainfall and due to recharge contributions from canal irrigation. The utilizable ground water resources have been assessed at 395.6 BCM (70.0 BCM for domestic and industrial uses and 325.6 BCM for irrigation).

A management approach is said to be perfect, if the demand side of the elements of interest balance with its supply-side inputs. In case of groundwater management, the elements are: (i) hydrogeologic and socio-economic conditions of the system (ii) regulatory provisions (iii) regulatory interventions; (iv) costs and benefits of management activities and interventions. Some of the issues which will emerge in groundwater development and management are: (i) the protection of ground water against pollution and aquifer remediation (ii) the ground water depletion requiring practicing of artificial recharge using different methods to utilize monsoon runoff and wastewater from different sources; (iii) the management of trans boundary aquifers; (iv) regulate the ground water development and formulation of an exclusive National Groundwater Policy defining the custodianship of natural and recharge groundwater; (v) the management of water logged and inland Salinity areas; (vi) updating the technologies of tackling the groundwater quality problems of fluoride, arsenic, nitrate and selenium.With stimulated models and optimization methods as the new methods for the management of ground water management which finally produces a single programme that optimizes management objective while meeting physical and technical constraints on ground water behaviour, we can not only prejudge the results of our management techniques used but also save the time and money, which leads to sustainable development.

Table 1: Earth's Major Water Compartments

Compartments	Volume (1,000 km^3)	% of total water
Total	1,386,000	100
Oceans	1,338,000	96.5
Ice and snow	24,364	1.76
Saline groundwater	12,870	0.93
Freshwater	10,530	0.76
Fresh lakes	91	0.007
Saline lakes	85	0.006
Soil moisture	16.5	0.001
Atmosphere	12.9	0.001
Marshes, wetlands	11.5	0.001
Rivers, streams	2.12	0.0002
Living organisms	1.12	0.0001
Source: UNEP, 2002		

Surface water

Fresh, flowing surface water is one of our most precious resources. Rivers, lakes, wetlands are the main sources of surface water. Rivers flowing from various mountain ranges having a minute amount of water level of water in rivers depends upon the precipitation and on the icecaps which melts in summer thus increasing the water level in the rivers. The sixteen largest rivers in the world carry nearly half of all surface runoff on the earth, and a large fraction of that occurs in a single river, the Amazon, which carries ten times as much water as the Mississippi.

The main river systems of the country are the Indus and the Ganga-Brahmaputra-Meghna (Barak) system. The Ganga rising from the snow capped Himalayan mountains, flows through the great indo-gangetic plains. The Brahmaputra rises in Tibet where it is known as the Tsangpo and runs a long distance until it crosses over into India in Arunachal Pradesh under the name of Siang or Dihang. The Ganges and the Brahmaputra join inside Bangladesh and continue to flow under the name Padma forming the Sunderban delta.

Holy River Ganga, along with its tributaries forms the largest river basin of India is a symbol of purity. But with rapid growth in population and pollution is severely polluted, that is in utter disregard to its sanctity. Not only River Ganga other river of the country also facing the same problem at different level. Many cities of the country like Kanpur situated near River Ganga and Delhi situated near Yamuna are facing drinking problems. People living near to these water bodies are found to be affected by many diseases like malaria, cholera *etc*.

Inspite of being the life line of the country, and having much dependency of peoples from industries to domestic use these major fresh water bodies are severely being polluted. The rapid pace of industrialization and urbanization has posed a serious threat to these vast varieties of water resources. Effluents from various industries with having excessive concentration of nitrates and phosphates causes well known lake eutrophication, disrupting the whole aquatic environment.

Water is an indispensable need of life. It is necessary to develop a suitable and sustainable technique to protect and manage the quality and resources not only from biological and biodegradable pollutants but also from toxic inorganic compounds and non-biodegradable wastes. Hence the whole water system should be examined and proper management methods should be developed with latest technologies like models to preserve and maintain the water quality of the surface water.

Table 2: World's ten largest river

River	Location	Annual Discharge (m^3/ Second)*
Amazon	Brazil, Peru	175,000
Orinoco	Venezuela, Colombia	45,300
Congo	Congo	39,200
Yangtze	Tibet, China	28,000
Brahmaputra	India	19,000
Mississippi	United states	18,400
Mekong	Southeast Asia	18,300
Parana	Paraguay, Agerntina	18,000
Yenisey	Russia	17,200
Lena	Russia	16,000

* 1 m^3 = 264 gal.
Source: Data from World Resource Institute.

Water pollution

Today human activities are constantly adding industrial, domestic and agricultural wastes to water bodies at an alarming rate. The main sources of pollution in Indian freshwater bodies are through effluent discharge from industries, pesticide leaching from agricultural fields, oil spills from oil tankers and boats, sewage and waste disposal and retting of coconut husk along estuaries and backwaters.

According to reports more than 90% of the industries in India do not have adequate facilities to treat the effluents and as a result huge quantities of untreated effluents containing chemicals and wastes are discharged into the aquatic environment leading to serious consequences in the environment.

The availability of water, both in quality and quantity, is one of the prime factors in deciding the growth of towns and cities as well as industries. For industries, the available of water must be as near as possible to the factory site and should also be soft otherwise the manufacturing cost will increase.

Pollution from factories, power plants, sewage treatment plants, underground coal mines and oil wells are classified as point sources of pollution, being discharged from specific locations. With this kind of pollution sources it is possible to treat the effluents before they enter into the water bodies. Pollution from soil erosion, chemical runoff, and animal waste pollution are all examples of non-point source pollution. Non-point source pollution refers to pollutants that come from a widespread area and cannot be tracked to a single point or source. Non-point source pollution is major water quality problem by sheer volume and in terms of current and future economic costs because it not only affects the surface water quality but also decline the productivity of agriculture fields also.

During the past two decades, the public has become increasingly concerned with hazardous and toxic materials discharged into the aquatic environment. Due to the development of more industries, increased urbanization and reclamation of areas, the environment is under severe stress and these create an unfavourable situation for aquatic organisms to live. The pollutants can weaken the organisms making it susceptible to disease or they cause disease directly. Toxicants or other stressful situations may enhance the disease.

A proper monitoring of water resources pollution and enforcement of strict measures to control pollution would help enhancing the productivity of the aquatic environment.

Water management

According to World Bank report today, about 700 million people live in countries experiencing water stress or scarcity. By 2035, it is projected that 3 billion people will be living in conditions of severe water stress. Many countries with limited water availability depend on shared water resources, increasing the risk of conflict over these scarce resources.

Water resource management is the integrating concept for a number of water sub-sectors. Use of an integrated water resources perspective ensures that social, economic, environmental, and technical dimensions are taken into account in the management and development of surface waters (rivers, lakes, and wetlands) and groundwater.

The lack of water resources experienced in different parts of the world has now been recognized and analyzed by different international organizations such as WHO, the World Bank *etc*. Recently published documents from the UN Environment Programme confirms that severe water shortage affects 400 million people today and will affect 4 billion people by 2050 (Thomas and Durham, 2003).

IWRM was previously mentioned in the Millennium Development Declaration of the UN, (Nations, 2000) article 23 “To stop the unsustainable exploitation of water resources by developing water management strategies at the regional, national and local levels, which promote both equitable access and adequate supplies.” This approach includes the:

- Development of alternative water resource;
- Protection of water resource to stabilize and improve its quality and quantity;
- Demand management implemented at the level of each river basin.

If we are agreeing to consume water despite the recognition that there is a growing crisis of scarcity then we have to decide *who* gets to make decisions about that process? Is it the role of government, in which case we should discuss mechanisms and bureaucratic modalities for water governance or, is it up to the individual as

regulated by civil society? Writers considering sustainable development (Chambers,1997; World Bank, 2003), common pool resource management (Korten, 1986; Berkes, 1989; Poffenberger, 1990; Western and Wright 1994; Ostrom, *et al.* 2002; Deitz, *et al.* 2003), and global norms in water management policy (WMO, 1992; OECD, 1998; Kemper, *et al.* 2003) all have come to point in the same direction: (1) all resources, especially water resources, need to be managed, (2) decision making across multiple levels fosters sustainability, and (3) communities, especially rural communities, have a greater interest in managing resources sustainably than state or corporate managers. Communities are more aware of local environmental processes, and thus can be mobilized to manage the resource within multi-level natural resource use regimes. In the water sector, these assumptions codified in the Dublin Accords are reflected in attempts at complementing centralized physical infrastructure with lower cost community-scale systems, decentralized and open decision making, water markets and equitable pricing, application of efficient technology, and environmental protection (Gleick 2003). The four 'Dublin Principles' read :

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.

Unfortunately, the development path that countries in Southeast Asia have taken is one that is highly disruptive to the hydrological cycles. Aquifers, which store precious ground water, have lost their water holding capacities due to massive deforestation such as those experienced in Indonesia and the Philippines. Over-exploitation of water sources for industrial and domestic purposes has contributed to the rapid depletion of already limited freshwater resources. These disruptions have severely compromised the ability of the forests to "catch" and then "shed" the water into streams, rivers and reservoirs, as well as the capacity of aquifers to recharge.

The extremely rich biodiversity of Southeast Asia is a testament to the abundance of freshwater systems and high rainfall that support life. The Ganga river of India, Mekong River of Mainland Southeast Asia, Chao Phraya of Thailand, and the other rivers and lakes of the region are important sources of food, water for various uses, medicines, energy, minerals, *etc*. More importantly, these surface waters as well as the underground aquifers provide communities with drinking water.

Water management and conservation are also economically and environmentally sound ways to prevent and over come the problems like floods and drought damages and store water for future use than building huge dams and reservoirs. A series of small dams on tributary streams can hold back water before it becomes a flood. Ponds formed by these dams provide useful wildlife habitat and stock-watering facilities. They also catch soil where it could be returned to the fields. Small dams can be built with simple equipment and local labour, eliminating the need for massive construction projects and huge dams.

Another important tool is the development of country water resources assistance strategies (listed on the left), which describe what the Bank can and will do to help improve water resources management in a country. These strategies can improve the strategic focus of water-related activities, stimulate coordination across water-related sectors within the Bank and the country, and engage regional and global water knowledge.

To mitigate the adverse impacts of water pollution, suitable measures are to be evolved through comprehensive water management studies. The change in human attitude towards water resources

is also important as the resources are not unlimited and moreover they must be preserved for future generations. Steps like interlinking of the flowing rivers flowing within the Indian Territory. States with flowing rivers must behave with a level of maturity and the Centre should act as a mediator. In this way water could reach through out the country and droughts can be prevented.

Water management or conservation is not a single handed process nor fulfilled without the participation of local people, it's a collective effort of the community and legal system. Community should initiate the resource management in every part of the micro-watershed or even at the macro-watershed level this will increase the public awareness, conducting research, providing basic infrastructure (waste disposal systems), technical assistance whenever needed and last but not least they can help us to predict more accurately what will the output of our techniques as the local people are more aware of the past and present condition.

Conclusion

Water is needed in all aspects of life. The general objective is to make certain that adequate supplies of water of good quality are maintained for the entire population of this planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and combating vectors of water-related diseases. Innovative technologies, including the improvement of indigenous technologies, are needed to fully utilize limited water resources and to safeguard those resources against pollution.

Looking at the Water Framework Directive from India's perspective, it is particularly relevant to note that this philosophy of water management, despite its roots in a society that pre-dates modern society by over fifteen centuries, is based on science and technology. Modern water law and policy cannot exist without active participation from science. Yet, science cannot make judicial and policy decisions. In the larger scheme of democratic governance, science, scientists, and scientific institutions have an obligation to see that the best available scientific knowledge is brought to bear on the creation of water laws and policies, as well as their implementation. Science has to learn to address a different type of knowledge that lies outside its traditional boundaries.

As scientific knowledge grows, there comes the need for social responsibility. Further, such knowledge growth becomes available for adaptation in differing situations. There is an immediate need of nationwide consensus to adapt to river and water resources management. We believe that this is achievable through pursuance of scientific studies, 'correct' perception of scientific outputs and, through persuasion of planners and policy makers to develop suitable policies. With reference to coastal systems management in India, bridging natural sciences, social sciences and policies is imperative to further endorse the truism that 'coasts protect those who protect coasts'.

If we are to protect our valuable water resources, changes have to be made in the way we see and treat our environment. The real solutions to protect water quality must begin at the sources of pollution. One such effective and lasting measure is the implementation of clean production processes. By eliminating the use of toxics from the very first step of production by which pollution of water sources can be effectively prevented.

Our constant exposure to polluted fresh water sources—clogged, or foul smelling river and lakes, as well as contaminated groundwater—have made water pollution a reality which we have learned to accept. Thus, we focussed on technology meant to 'clean up' pollution rather than to prevent it, and drafted laws that merely regulate the extent of toxicity in water, rather than prohibit it completely.

We must learn to unlearn this 'reality.' Clean water is the given we must protect if we are to ensure that our water will continue to sustain life well into the future.

Beau
Baconguis,Toxics
Campaigner, Greenpeace
Southeast

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