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Drinking Water Scarcity: Some Issues

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Abstract:
Environment, in general, is a broad-based concept encompassing the whole range of diverse surrounding in which one perceives and reacts of various events and change. it includes the land, water, vegetation, air and the whole gamut of the social order, including the physical and ecological systems. it also concerns man's ability to adapt both physically and mentally to the continuing changes in environment. Environment is not static, it is dynamic and changes occur, even if there is no human interference. In its natural uninterfered conditions, the environment of any region is in a continuous state of dynamic equilibrium. This state of equilibrium is called the balance of nature. it is when human-beings, driven by their greed or superego attempt to conquer nature for higher and still higher standards of material life for ever expanding population and try to over-exploit and interfere with nature, this equilibrium gets disturbed and in most of the cases, the results are to the detriment of all forms of life. Ultimately, it is the conditions of air available for breathing, quality of water for drinking and that of the soil for growing crops, which determine the wealth of a nation in true sense.

Keywords: River, Pollution, Aquatic e life & Bottle water

1. PROLOGUE

Water is vital for all forms of life on this planet and clean water is necessary for healthy living. The main source of water is precipitation (rainfall), which is roughly of the order of 400 million hectare meter per year in India. Nearly 50% of it percolates into the soil, about 30% of it runs as surface run-off and another 20% evaporates into the atmosphere. in a well-managed agricultural land and in a dense forest with significant humus cover, the percolation is relatively high. Similar is the case with a well-managed pasture land. but in a barren, over-grazed, poorly managed agriculture or forest, most of the precipitation escapes as surface run-off and is lost through rivers into ocean or sea, causing floods and devastation (including loss of life) on the way. Wastage of our valuable water resources through faulty land and water management practices has become unaffordable at present.

Water has earlier been so easily and abundantly available that only a very few people consider its bountiful presence a miracle. A general misunderstanding still exists that water is a free commodity having no economic value. Growing water shortage has made it inevitable that water must now be assigned as economic value, even in the eyes of the common public. the "Dublin Declaration" in 1992 stipulated: "Water has an economic value in all its competing uses and should be recognized as an economic commodity and it is vital to recognize first, the basic right of all human beings to have an access to clean water and sanitation at an affordable price" (WMO, 1992). More than 2.7billion people will face severe shortage of freshwater by 2025, if the world keeps consuming water at the present rates, the United Nations warned in its recent

Report released on the World Water Day. Already an estimates 1.1 billion people have no access to safe drinking water, 2.5 billion lack proper sanitation facilities and more than 5 million people die after suffering from waterborne diseases every year. This number is about 10 times of that killed in various wars around the globe (HT, 2002).

Over the decade 1981-1990, the United Nations emphasized the importance of this problem and called this period as "International Water Supply and Sanitation Decade", which had the prescribed goals to attain access to clean drinking water and accepted level of sanitation for all. Even after thios, about two billion inhabitants of the developing world lacked safe drinking water and have no adequate sanitation facilities. partly because of the rising population pressure, more people were expected to manage with lack of access to these basic amenities in the year 2000 than those living like that in 1990(Lindh and Gilbrich, 1996). Even higher than the cost incurred due to air pollution is the cost attributable to pollution of water in India, both for the surface water and groundwater resources. the overwhelming majority of diseases prevalent in india arise due to ingestion of contaminated and increasingly polluted water. Diseases such as diarrhea, trachoma, hepatitis and many others are the result of extremely high levels of water pollution, which is also the cause of high infant mortality (Pachauri, 1997).

1.1 Emerging Packaged Water Market

Presently, an aroused level of consciousness has emerged in India, particularly related to the quality of drinking water, as can be seen from publications and news appearing in public media on this issue. high level of quality consciousness has provided a treated-water market for a number of domestic/multinational companies. Sale of drinking water, packaged in the name of mineral water, by these companies has goneup very high even in this cities having government agencies responsible for treatment and supply of water for public consumption. The figure for the consumption of bottled water touched Rs 1,000 crores in the year 2001-2002 in India (The Hindu, 2002). Irony is that bottled water consumption is continuously growing despite the price advantage on treated water supplied by municipal agencies of course, the physical and chemical water quality parameters of the bottled water were found to be satisfactory in most of the cases,
but presence of pathogens (as shown by the indicator organisms) has been detected in a significant number of cases (Coulston and Mrak, 1977; Singh et., 2003; IS: 14543, 1998), which is an alarming situation.

2. GLOBAL WATER DISTIBUTION

if the total volume of world's water supply were supposed to be equivalent to one litre, fresh water would make about 31.05 milliters or about 3% of the total volume and the readily accessible fresh water would make less than one drop (Miller, 1998). Human being already put approximately 54% of all accessible surface water to various uses, which is expected to increase to 70% by 2025 (postel, Daily and Ehrlich, 1996). The total quantity of fresh water on earth can satisfy all needs of human population, if it would have been evenly distributed and was easily accessible out of the world's fresh water resources, about 75% is held within ice sheet and glaciers, nearly 24.5% in groundwater and remainder occur in rivers (0.03%), lakes (0.3%) and in the atmosphere (0.06%) (Parivesh Newsletter, 1995).

India is enviably endowed in respect of the availability of water resources. the country is literally crisscrossed with rivers and blessed with quit high precipitation, mainly due to the southwestern monsoon, which accounts for about 75% of the annual rainfall. The major river basins along with the medium and minor river basins account for almost 91% of the country's entire drainage area. Even after the nature's bounty, paucity of potable water has emerged as an issue of high concern at national level. the decline in quantity and deterioration of water quality are directly attributable to unabated competing demands by various sectors of water users and indiscriminate disposal of sewage from different sources including small and large human settlements, various industries and agricultural activities. Due to increased human activities over the recent years and also, on account of unplanned growth of industries until the early eighties, the rivers in India have been subjected to intense environmental stress, resulting in their pollution of various types.

Availability of water supply adequate in terms of both quanity is essential for human existence. quality control has become prime objective now and it lends support to Pindar's words (460 B.C), "Best of all things is water". Availability of fresh water on earth is a very small fraction of the total quantity of water on the globe. According to an estimate (Todd, 1970), the distribution of word water can be given as shown in the Table 1.

Table 1: Global Distribution of Water.

Location	Volume, 10^{12} m^3	% of total
Fresh water lakes	125	0.009
Saline lakes and inland seas	104	0.008
River (Average instantaneous volume)	1.25	0.0001
Soil Moisture	67	0.005
Groundwater (Above depth of 4000m)	8.350	0.61
Ice caps and glaciers	29,200	2.14
Total – Land Area	**37,800**	**2.6990**
Atmosphere (Water Vapour)	13	0.001
Oceans	1,320,000	97.3
Total – All locations	**13,60,000**	**100**

3. DEGRADATION IN WATER QUALITY

In Asia, approximately 86% of total fresh water is used for agriculture, 8% for industry and 6 % for domestic purposes (ES, 1994). Unfortunately Asia's rivers, on an average, have about 20times more lead than the rivers in the industrialized world and approximately 50 times more pathogens from human faerces than the number permitted by World Health Oragnisation (WHO) guidelines. about 5,00,000 Asian die every year from diseases caused by ingestion of contaminated water and due to poor sanitation facilities (Kristof, 1997). Manila, the capital city of Philippines, has been served by piped-water supply from surface sources like five heavily polluted rivers and reservoirs, where untreated wastewaters from the industries have been discharged and to which, the domestic sewage contributed to more than half the pollution load. due to heavy pumping-out of the groundwater, water table has gone down upto 200m below the sea level in certain areas, resulting in very serious problem of salt-water intrusion at regional level.

Statistics covering urban areas in Bangladesh over the period 1980-1985 indicated that about 76% of the population did not have access to safe drinking water and proper sanitation servies (Lindh and Gilbrich, 1996). Many rivers or streams in developing countries are heavily polluted due to anthropogenic activities such as industrial and domestic sewage discharges (Jonnalagadda et al., 1991; Mathuthu, zaranyika and Jonnalagadda, 1993: Jonnalagadda and Nenzou, 1996). Nriagu (1994) highlighted the problem of mercury-pollution coming from abandoned gold and silver mines in south America.

A part from the shortage of water in the country in spite of heavy rainfall, whatever existing water bodies are there in India, about 70% of them are polluted. Pollution of water may be due to different sources. soil erosion in the catchments of the rivers, streams and ponds leads to excessive sediment load and thus, pollutes the aquatic eco-system. Streams and other aquatic eco-system are also polluted by discharges of municipal sewage and industrial effluents. responsibility for maintaining proper civic amenties like water supply, drainage, slum clearance, open spaces and the streets in cities lies with municipal agencies. Unfortunately, there has been a dismal failure on the part of all our municipal agencies in keeping the cities and nearby streams clean. Similarly, industries have taken up antipollution measures very unwillingly and thus, causing practically unabated severe pollution to the water bodies.

3.1 Deterioration in the Quality: Caustive Factors Industrialization has made rapid strides since independence in india and brought economic gains to the country, but on the other hand has also led to severe pollution of the environment, including contamination of water sources, resulting in various harmful effects to human health, plant life micro-flora and fauna in water bodies and aquatic life as a whole. thus, industrialization and pollution may be termed as the two facts of the same coin. Defining in a very broad perspective, "Pollution means such contamination of water or such alteration of the physical, chemical or biological properties of water or such discharges of domestic sewage or effluents or of any other liquid, gaseous or soild substances into water (whether directly or indirectly) as may, or safety, or to domestic, commercial, industrial, agricultural or other legitimate uses, or to life and health of animals or plants or of aquatic organisms (Government of India, 1974).

Pollution is as old as human-beings. in prehistoric times, the population was very small. Man used to move from place to place in search of food and better living, leaving behind the filth, which was easily degraded and the environment could be purified by natural agencies. Gradually, with the increase in population, urbanization and industrialization, the pollution of the environment started going up. Nowadays, the problem of pollution has assumed vast magbitutes, because of increasingly high population densities, continuous rise in the acquired needs and rapid growth in size and number of various types of industrial plants and human habitations.

Rapid growth in global population leads to rapid urbanization and related problem, amongst which the scarcity of drinking water of right quality lies at the forefront. At the start of the twentieth century, the world was largely a rural place and less than one person in seven lived in urban areas. by the end of the twenty-first century, about half of the global population is expected to become urban. in many developing countries, cities are expanding at even faster rates than their rates of population growth rate more than 4% compared to the corresponding population growth rate of about 3%

Total number of large cities is also increasing. At the start of the twentieth century, there were eleven big cities, mostly in Europe and North America, having more than one million inhabitants. By the end of the twentieth century, it was estimated that out of 24 megacities with population in excess of ten million people, eighteen would be in developing counties (Lindh and Gilbrich, 1996). Like many other developing countries, India too is passing through the phase of massive urbanization. In India, the proportion of urbanization in the first forty years of the twentieth century was less than 12% and it has risen to 25.72% in the 1991census (Biswas, 1997). Besides urbanization, the 1991 census also indicated rapid growth of industrial townships as a very conspicuous and alarming feature. with rapid increase in population and urbanization alongwith associated economic and other activities, water is becoming a very scarce resource with the passage of time.

Ground water pollution by agriculture practices has been widely reported in the recent past from many regions all over the globs. This kind of pollution is usually indicated by high nitrate concentrations in groundwater, which can be related to indiscriminate use of fertilizers on croplands, forming the recharge area of the polluted aquifers. other nutrients applied to croplands, such as phosphate and potassium, and various organic compoundsa such as pesticides, herbiciders, weedicides, algaecides, nematicides etc, can be partially or largely dissolved and / or mobilized from the surface, downwards to the groundwater table through the vadose zone. However, the nitrate molecule is very mobile due to its solubility and plays a major role in groundwater pollution resulting from the agricultural activates (Guimera, 1998)

In many fresh water bodies (on surface) such as lakes, ponds or rivers and groundwater sources, heavy metal contents may be quite high due to industrial discharges and also on account of those coming from the geochemical origin, which arises from the gradual solubilization of heavy metals from the soil, rich in such metals. This process can be accelerated by lower pH values. Air pollutants such as particulate matter settling on surface water bodies, acis rain dissolving metallic dust and runoff from polluted soil also contribute to heavy metal load of different water bodies. application of phosphate-bearing fertilizer on crop-lands has been shown to enhance leaching of cadmium from soil. However, bulk of the heavy metals reaches surface water bodies through domestic and industrial effluents. mining and mineral processing industries including smelters, foundries and electroplating industry; chemical laboratories and accidents; industries employing metal castings; municipal and industrial solid waste dumps; transportation of ores, use of metal catalysts in various industries; corrosion of pipelines and joints and metallic-salts used for vector and pest control are other important sources of heavy metal pollution.

Steady fall in groundwater table in and around megacities is seriously impairing the original productive power of nature. Result of over exploitation of groundwater is hazardous even to public health. In Kolkata and the rest of the state of West Bengal, over exploitation of groundwater has disturbed the geochemical balance, with the consequence of arsenic from the bedrock flowing into the groundwater. In case of about one-third of the districts in state of West Bengal in India, the Government of India has admitted in Parliament in early 1996 that the drinking water had more arsenic than the maximum permissible limit prescribed by the WHO. The affected area has been growing in geographical extent by approximately, a study has reported that it has stood on the threshold of an arsenic bomb and the problems caused by excessive use of groundwater have been visible everywhere.

Even in Delhi, the levels of fluorides in the groundwater, which have the crippling effect after consumption over long time, has been found to be much higher than the permissible limit in a number of localities. some megacities on coastal region have been facing increasingly severe problems due to salinity, while some have other types of contamination/pollution and certain other places have been reported to a facing a mix of all these problems (Sharma, 1997) with certain other water-related difficulties.

4. POLLUTION OF INDIAN RIVERS: A CASE OF THE GANGA

There are 14 major rivers in India, most of which suffer from pollution in their one stretch or the other. River Ganga and its tributaries constitute the most extensive riverine system of India. Emerging from the mountainous glaciers in the Himalayas, it travels a long stretch of about 8, 047km, covering the major part of northern India. In its journey from the Himalayas to the Bay of Bengal, it recives huge volumes of domestic, agricultural and industrial wastewater-discharges making it highly polluted. Due to all these factors, the Ganga, considered to be the most sacred amongst all Indian rivers, has been found to be one of the most polluted rivers. The Ganga basin covers over 12,500 km^2 in northern India. its basin occupies 34.39% area amongst the total basin area of the all the major river systems. With regard to average annual discharge, it is second only to Brahmaputra.

More than 45 million people have been residing in the Ganga basin. The Ganga passes alongside 29 cities with population above 1,00,000, 23 cities with population between 50,000 and 1,00,000 and 48 towns with population less than 50,000. In many stretches of the river, due to very small flow in lean season (summer) and excessive discharge of pollutants, its water has been severely polluted. According to an estimate, 29 major cities situated along the bank of Ganga have been discharging about 1,200 million litres of wastewater every day into the river.

Industrial sewage has been discharged in huge volumes by a number of industries situated in this riparian zone. In 1995, the CPCB listed 191 grossly polluting industries in the state of Uttar Pradesh, 6 in the state of Bihar and 67 in the state of West Bengal. These industries were discharging toxic substances into their effluents with Biochemical Oxygen Demand (BOD) concentrations of more than 100mg/liter and each unit was generating more than one million litres of wasterwater every day. The industries present in this river basin have been sugar and paper mills, woolen, cotton and rayon mills, tanneries, ordinance factories, battery-manufacturing industries, thermal power plants, chemical industries of various types, metal processing and steel factories, distilleries and fertilizer manufacturing units etc.. Consequently, the river water does not conform to even bathing standards at many places. Heavy metals such as cadmium, zinc, nickel, lead, chromium and copper have been found in the river water and the sediments.

The Central Polluted Control Board (CPCB), Delhi has reported quite high levels of zinc and nickel in the sediment of Yamuna River (an important tributary of River Ganga) in downstream side of the capital city of Delhi. The main problem with Indian River is not the industrial effluents because it has been responsible for only about 20% of the total pollution-load in the rivers. Remaining 80% of the pollution load has been contributed by domestic and municipal sources (Parivesh Newsletter, 1995). A study conduxted by the CPCB in 1984 has indicated that nearly 75% pollution load of the river was on account of the discharge of untreated municipal sewage into the river from large and medium size cities and towns located along it bank. the remaining 25% pollution was caused by the discharge of partly treated/untreated industrial effluents. the CPCB report had also identified some of the non-point sources of pollution such as surface-runoff from areas used for open defaecation, garbage dumps and agricultural fields, discharge of unburnt/partly burnt dead bodies, animal carecasses and cattle wallowing etc. in the river. Quantification of total pollution from such sources is, however, difficult.

A large number of the dead bodies or the ashes produced after their cremation have also been regularly discharged in Ganga throughout its length. The quantities of these pollutants are so huge that self purification capacity of the river is exceeded and it has been facing a great ecological threat. Mythologically, a holy dip in the Ganga may salvage the soul but scientifically, the dip may be injurious to health. "Cleaning the Ganga" Programme launched by Central Ganga Authority (C.G.A.) is an endeavour to preserve the sanctity of the river water.

Rapid deterioration in the river water quality has very adversely affected the aquatic flora and fauna of the Ganga ecosystem and the impacts have been visible many times. Mass deaths of fishes at various locations have been reported quite frequently. Toxic chemicals have also adversely affected the spawning and breeding grounds of important fishes and other aquatic organism. Destruction of the spawn fingerling and fishes means a significant loss of the sources of various types of protein. Indiscriminate killing of aquatic life of river Ganga has led to shrinkage in genetic, species and ecosystem diversities. Many important species have already become extinct and many other reached the endangered list.

4.1 Biological Pollution and Its Effects

Pollution of river Ganga can be put under two major groups, i.e., biological and chemical. Biological pollution originates due to discharge of untreated or partially treated municipal sewage, throwing of the unburnt or partially burnt dead bodies and ashes of corpses and also, due to mass bathing, washing of cattle and other such activities. Huge volumes of sewage have come from a large number of cities, situated along the banks of the Ganga, as described earlier.

Onslaught on Ganga ecosystem by pollution become more severe, when the river touches the sacred cities of Rishikesh and Haridwar and the wastewater discharges affect very adversely the quality of Ganga water, particularly for drinking purpose. According to a report by CPCB, the river in Kanpur is highly polluted as indicated by maximum BOD, i.e., 12.45 – 18.60 ppm in comparison to that found in other localities. About 80% of the diseases in India are water-borne and the Ganga-water (consumed without proper treatment) is supposed to be one of the important contributor s to prevalence of such diseases in localities on its bank. At about 69 points along the 6km long stretch in Varanasi city, many open drains carrying raw sewage flow uninterrupted into the river.

According to a report, it is mentioned that three persons die every minute in Ganga basin due to diaeehoea and the related problems. It has been observed (Bilgrami and Datta Munshi, 1958) that the maximum most probable number (MPN) of total Coliforms was 3,20,000 per 100ml at the bathing Ghats of Sultanganj during August-September (Sawan Mela), followed by the counts at Rajapur Ghat (Patna) and Adampur Ghat (Bhagalpur). It was to be about 2,40,000 per 100 ml at both the places near the municipal sewage discharge sites.

Due to discharge of domestic wastewater into the river, the physic-chemical composition of the abiotic components of the ecosystem undergoes drastic changes in this region. Turbidity, conductivity, total dissolved solids, free CO_2, total hardness as well as concentrations of nitrate-nitrogen, phosphate-phosphorus, calcium, magnesium, sodium, potassium and chloride increase substantially, while dissolved oxygen, pH and planktonic biodiversity falls down drastically, Escherichia coli, Aerobactor aerogenes, A. cloacae, Staphylococcus aureus, Streptococcus faecalis, proteus vulgaris and Salmonella species have been some of the common forms of microorganisms, which could be encountered in excess in the sewage-mixing zones of Patna, Bhagalpur and other major cities situated on the river-bank.

4.2 Chemical Pollution and Its Impacts

It is other form of pollution, which originates mainly from industrial wastes and surface run-off from agricultural fields. In a report, it has been mentioned that out of 132 major industries located along the river bank, 68 were under planning stage and remaining 64 were on the way to install sewage treatment plants (Chaudhuri, 1986). 50% of these industries were located on the bank of the river at Kanpur alone. A scientific investigation undertaken by CPCB has revealed that the water quality at upstream of Kanpur was satisfactory, but it deteriorated drastically after receiving volumes of domestic sewage and industrial effluents, mainly from tanneries and textile mills. Adverse effect of tannery wastes persisted up to 10kms downstream from Kanpur. At Phoolpur near Allahabad, the fertilizer complex used to discharge its toxic effluents in river Ganga without adequate treatment. Consequently, the fish mortality was found to be quite high in the 16km stretch downstream of outfall-site.

An opium factory is located in Ghazipur, which produces morphine. The effluent adversely affects the gishes and cattle wealth in this region. In Bihar, Maximum industrial pollution of river Ganga takes place in Mokama-Barauni industrial area. Bata Indian Limited and McDowell distillery at Mokama have been reported to discharge about 25,000 litres of unprocessed chemical waste every day, which had very adverse impact on river water quality. The chemical were highly toxic to the fishes, which could survive only for a few hours in Mokama Ranga (Bilgrami and Datta Munshi, 1979). The liquid effluents were brownish in colour. Due to suspended materials, there was an enormous increase in the aesthetic pollution of the water, drastic fall in dissolved oxygen level and sudden enhancement in ionic concentrations. Consequently, species diversity of phyto- and zooplanktons declined alarmingly.

After Farakka, one stream of the river Ganga passes over to Bangladesh and joins the river Brahmaputra. The river Hooghly, a tributary of the Ganga bifurcates westwards, passes through west Bengal and finally, flows into the Bay of Bengal. The industries located on the banks of Hooghly in Kolkata Metroplitan Development Authority boundaries are one of the biggest sources of various types of pollution. This has been one of the most extensive industrial area in the entire Gangetic Plain. A large number of jute mills, textile mills, tanneries, paper mills, distilleries and metal processing factories have poured untreated or partially treated liquid effluents through 361 outfalls in the region. The discharge increased the BOD value and acidity in the receiving water. Industrial wastewaters from tanneries and metal processing units are hazardous and include heavy toxic metals.

Pollution due to industrial effluents (in the region) has accounted for about fifteen percent of the total river pollution-load, but it is extremely hazardous due to presence of toxic substances. Lethal chemicals like lead, nikel, chromium, mercury and other heavy metals and certain nonbiodegradable materials have posed a quite high risk to human and biotic health. These toxic materials enter into the food chain through the water and ultimately, reach the consumer level, causing severe disorders of various types due to the process of biomagnifications. it has been scientifically proved that the ganga water had the ability to kill 75 percent of pathogens within 24 hours. This has been due to the activity of bacteriophages, which were percent in a large concentration in the river water. But at present, the regenerative power of the Ganga has been largely overpowered.

5. ENVIRONMENTAL CONDITIONS IN MEGACITIES: SOME BURNING EXAMPLES

Asian continent has some of the most heavily populated countries in the world. the urban population in aisa is growing at a very fast rate. With the ever increasing population, the cities are becoming heavily over crowded. According to a report of Asian Development Bank (ADB), an additional 1.5 billion people will be added to Asia's urban centres by the year 2020 (ADB, 2001). The population of India is a whopping more than 100 crores and rising steadily. According to certain studies, 50% of the population is expected to live in urban areas by the begining of the twenty-first century (Chandrasekhar, 1994). With the increase in population in the cities, problems of poverty and unemployment are intensifying. The number of slum dwellers in mega cities of Asia like Delhi and Kolkata are increasing steadily everyday.

Socio-economic changes such as large increases in population, agriculture output, industrial production and capital inflow, and advances in science and technology have transformed the Asia's natural resource base, which has become a source of material inputs and as a sink for pollution of all types. Environmental degradation in Asian megacities is widely pervasive, accelerating and unabated (ADB, 2001). These socio-economic factors are playing a vital role in making the growth of such megacities unsustainable.

In most of the magacities, basic amenities like electricity, housing and water supply are often poor and intermittent or altogether absent in some parts. Sanitation facilities are inadequate or altogether lacking. To quote an example, Varanasi city in India is a major centre for religious activities and is quickly developing into a huge commercial centre of Northern India. But the city is facing the problems of intermittent electric supply and the water available is inadequate in major parts of the city both, quantitatively and qualitatively. Thus, it is evident that poor administration also accounts to an extent for the poor quality of life-sustaining resources in these megacities.

The degradation of environmental quality in the megacities may be attributed as one of the biggest reasons for their unsustainability. Economic development and poverty alleviation are increasingly constrained by environmental concerns, including degradation of fisheries and forests, scarcity of fresh water and poor human health as a result of air, water and soil pollution. Water quality has been steadily going down due to influx of domestic sewage and industrial effluents. Levels of suspended solids in Asia's rivers almost quadrupled since those of the late 1970s. In Asia;'s rivers, the median fecal coliforms level, an indicator of the health hazards due to contamination with human excreta, is about three times the world average (ADB, 2001). Access to safe drinking water is one of the most difficult problems in megacities located in south and Southeast Asia. In these regions, almost one in two Asians has no access to adequate sanitation services and only about 10% of sewage is treated at the most upto primary level (ADB, 1997).

To, quote as an example, the pollution of water bodies in Bangkok has reached extreme levels in the Bangkok Metropolitan Region (BMR). The BMR, which contains about 80% of Thailand's industrial base has an existing population of about 10 million and is expected to accommodate a projected population of almost 23 million in 2025. The major share of household, commercial and industrial wastewaters generated in the BMR is discharged into the storm water drainage system with no treatment, or with pretreatment only. the existing wastewater quanity from all sources within the BMR is about 4.5 million cubic meters per day and it is projected to increase to about 6 million cubic meters per day by the year 2015 (ADB, 1997). Chao Lake is one of the five largest fresh water lakes in China and it is the major source of potable water supply for Hefei and chaohu cities. In recent years, rapid developments of industrial and urban areas coupled with changes in agricultural practices have caused very significant environmental degradation of the lake (ADB, 1997) also.

Various health related problems are growing because of poor water quality.. More than half of the world's major rivers are either polluted or running dry. The fouling of waterways and surrounding rivers led to the total of about 25 million people being reduced to the status of refugees as a result of environmental problems in 1999. The Yellow River flowing in the Peoples' Republic of China's most important agricultural region is severly polluted and ran dry in its lower reaches for 226 days of the year in 1997. In another part of the region, the Amu Darya's and Syr Darya's flow into the Aral Sea have been reduced by three-quarters. Consequently, there has been a catastrophic regession of minus 53 feet in the water level of the Aral sea between 1962 and 1994 (ADB, 2001).

6. MEASURES ADOPTED FOR RIVER POLLUTION CONTROL

River-cleaning programme in India began with launching of the 'Ganga Action Plan' (GAP) in June 1985. It was fully funded by Ministry of Environment and Forest, Government of India. This programme has now been extended to many other polluted rivers of the country under the National River Conservation Plan (NRCP). The main objective of GAP is to improve the quality of ganga water to bring it to acceptable standards, by preventing the excessive pollution load from reaching the river. According to the Best Designated Use Criteria of CPCB for Indian Rivers, the desired designated water quality of the river Ganga is of the "Bathing Class", which stipulates, among other parameters, a biological oxygen demand (BOD) of 3 mg/L (maximum) and dissolved oxygen of 5 mg/L (minimum). Under GAP, pollution abatement works were started in 25 classes – I towns (population above 1 lakh in 1985) of which, six were in U.P., in Bihar and 15 in West Bengal (Sharma, 1997).

Results of certain common tests, which were conducted on a number of water samples collected (in the period of May – June, 2004) in the stretch of river Ganga from Assi Ghat to Bhadaini Ghat in Varanasi city, are presented in Table 2. Chernaik (1998) has also reported the total coliform count / 100 ml at various points along the river Ganga as presented in Table 3. the count varied from 180 (in some stretches in West Bengal) to 46,00,000 per 100ml in downstream side of Kanpur. In spite of the best effort made by the Central Government of India, not much improvement in water quality could be achieved even now. Reason for this insufficient participatory role played by the common people in ensuring the prevention of river water pollution.

An examination of some recent reports, prepared by various government and non-government agencies regarding water qualities of the Ganga, certain contradiction can be easily observed. certain non – Government agencies have reported that not much improvement in river water quality could be achived even after implementation of the Ganga Action Plan (GAP). On the basis of various reports, it has become evident that several varieties of aquatic animals and plants face considerable threat due to intensive engineering activities in different stretches of the river Ganga Fishery industry based on the river has been facing a serious problem due to increasing volumes of untreated or partially treated effluents flowing into the river.

Construction of massive dams and farakka barrage has very adversely affected the fishery industry of the Ganga ecosystem. Fishing of juveniles and fingerlings is another major threat to biodiversity conservation. almost total disappearance of Hilsa in the upper ranges of Farakka barrage is a clear evidence of "the adverse Barrage Effect". About three decades ago, this important species was found in abundance in the upper reaches of the Ganga at many places like Varanasi, Allahabad, Kanpur and even up up to Haridwar in U.P., but today, it has practically disappeared from larger part of the river. In an extensive zoological survey of river Ganga (Bilgrami and Datta Munshi, 1985), it has been reported that Hilsa flisha was restricted only up to 2.1% in the upstream of Farakka barrage whereas other major carps constituted up to 42.9% of the total fish catch. This obviously indicated the declining trend in the gentic diversity. It has been quite alarming (Jhingran, 1983) and there is an urgent need to rehabilitate and save this endangered fish from extinction.

The harvesting of millions of juvenile fishes from small tributaries of the river Ganga during post flood period have posed a serious threat to aqua-culture-development programme of the Government of India (Bilgrami, Datta Munshi and Singh, 1983). Majority of the fingerlings of catla catla were only 5 – 12 cm long, with the body weight of 50 – 70 g, though under normal conditions, these can attain a body weight of up to 4-5 kg in a year. Indiscriminate capture of fingerlings has significantly reduced the fish yield. It also leads to reduction in the population of the future spawners (Datta Munshi et al., 1979).

Table 2: Quality of the Ganga Water in Varanasi City: A Glimpse

Water Quality Parameter	Range of Observed Values
Acidity	06 – 15mg/L as $CaCO_3$
Alkalinity	192 – 237 mg/L as $CaCO_3$
Colour	40 – 50 TCU
Chloride	72 – 84 mg/L
Inorganic Solids	447 – 486 mg/L
Organic Solids	189 – 285 mg/L
pH	6.54 – 7.35 mg/L
Total Hardness	144 – 168 mg/L as $CaCO_3$
Total Suspended Solids	27 – 42 mg/L

Under present conditions, it has become imperative that certain other endangered fauna like Dasyatis sephan (Sting ray) and Platanista gangetica (Ganga dolphin) should not be caught and killed with immediate effect. In order to protect and conserve the faunal wealth and biodiversity of the Ganga ecosystem, it has become indispensable to stop immediately the discharge of untreated industrial and municipal effluents from different sources. other important aspects of conservation of fishes are mesh size regulation, closure of fishing season during monsoon or post – monsoon period to protect breeders, estasblishment of fish-seed farms to rear the juveniles and then, transplant the same in the river. Hossain (1997) has discussed in detail various remedial measures for protection of Ganga water quality

Table 3: Total Coliform Count at Different Location along the River Ganga

Location	State	Date of Observation	Total Coliform / 100ml
Rishikesh	Uttaranchal	17/8/98	300
Hardwar	Uttaranchal	26/8/98	1700
Kannauj D/S**	Uttar Pradesh	3/2/98	21,00,000 (2.1 million)
Allahabad	Uttar Pradesh	6/8/98	28,000
Kanpur D/S**	Uttar Pradesh	5/2/98	46,00,000 (4.6 million)
Patna	Bihar	18/2/98	24,000
Dakshineshwar	West Bengal	25/8/98	180

** D/S = Downstream side of the city

7. ENGINEERING MEASURES TO MITIGATE WATER SCARCITY

Important measures, which can be adopted for improving the present situation of water scarcity, are being outline below:

7.1 Rain Water Harvesting

Rain water Harvesting (RWH) means capturing the rainwater where it falls, or retaining the runoff in one's own village, town or city. Collection of surface runoff using minor structures is also termed as the harvesting. Experts also suggest various other ways of RWH like caturing runoff from rooftops and from local catchments, collecting seasonal floodwater from local streams and conserving water through watershed management. RWH is a simple, economical and eco-friendly method of water conservation.

In general, 'rainwater can be harvested for two main purposed, i.e., storing it for ready use in containers above or below ground level and for groundwater recharging. RWH for recharging is supposed to be an ideal solution to augment the groundwater strata. RWH can also be planned at a large scale depending upon the topography, soil, rainfall and other meteorological parameters. Factors affecting the deisgn of RWH systems are rainfall pattern and its quantity, storage capacity and vicinity of alternative water sources, etc.. The decision, whether to store or use the rainwater for recharge, depends on the rainfall pattern and the potential to do so effectively in a particular region. The sub-surface geology also plays an important role in taking this decision.

most of the domestic water needs of the country can be met successfully by adopting RWH on a large scale. a few case studies were undertaken by the United Nations Children's Fund (UNICEF) and the World Wide Fund (WWF) in certain geographical areas in India, where scarcity of water becomes a problem during the pre-momsoon months. Results of these studies showed that if the rainfall within the watersheds or sub-basins is harvested and conserved properly, the domestic water needs can be met quite satisfactorily in various parts of the country (Bandyopadhyay and Perveen 2002). This observation is completely in agreement with the results obtained from RWH practices being applied in different parts of India. Therefore, under present circumstances, immediate steps are needed to practice RWH at a large scale to mitigate the problem of drinking water scarcity.

7.2 Recycling and Reuse of Wastewater

Recycling and reuse of treated domestic wastewater can be adopted at a large scale for conservation of precious fresh water resources. Non-potable urban applications include the fire protection, air conditioning, toilet flushing, water for construction, and flushing of sanitary sewers. Potable reuse is another prospective application opportunity, which could occur either by blending in raw water supply reservoirs or, in the extreme, by direct input of properly treated and then, adequately disinfected wastewater into the water distribution network. Typically, for economic reasons, these uses are incidental and depend on proximity of the wastewater recycling facilities with the point of application. In addition, the economic advantage of urban reuses can be enhanced by coupling with other ongoing applications such as landscape irrigation (Urkiaga and Fuentes, 2004).

7.3 Application of the Principles of Industrial Ecology

Practice of 'pollute now, clean up later' has caused many environmental problems and hurdles in development initiatives (Chiu and Young, 2004). For an environmentally sustainable economic growth, a new approach towards industrialization is required. Industrial Ecology (IE) is a newly emerging approach to achieve this goal. The features of ecological system emphasize on interaction and interdependence and the stability of an ecosystem depends, to a very large extent, on the interconnectedness of the species within the system (Cote and Rosenthal, 1998).

On the basis of the principles applicable to the natural ecosystems, IE tries to determine how the group of industries could be arranged to reduce pollution and also save the natural resources including water. The three main elements involved in this concept have been identified and discussed in detail by Erkman (1997).

IE emphasizes the biophysical substratum of human activities, i.e., the complex patterns of material flows within and outside the industrial system, in contrast to current approaches, which mostly consider the economy in terms of abstract monetary units, or alternative energy flows. It considers technological dynamics, i.e., the long-term evolution of clusters of key technologies (technological trajectories) as a crucial, but not an exclusive element, for the transition from actual unsustainable industrial system to an economically viable and environmentally sustainable industrial ecosystem.

8. EPILOGUE

At present, all the countries of the world, whether industrialized or developing, rich or poor , are plagued with the problem of water scarcity in urban areas. In nearly all urban areas, population densities no longer allow for an unlimited access to safe drinking water nor permit an indiscriminate release of untreated domestic and/or industrial sewage. symptoms of stress in term of depletion and pollution of water bodies due to unregulated multiple uses of river stretches had become evident much earlier. therefore, it has become imperative that a rationale be adopted for maintaining a balance between the quality in case of various water uses. In this direction, rainwater harvesting and application of the principles of industrial ecology can play a very effective role.

Water management has so far been dealt with in a compartmentalized manner. it is necessary to evolve an integrated and institutionalized mechanism for appropriate management of water resources, both in terms of quality and quantity. Adequate financial resources need to be urgently mobilized in developing appropriate technologies to combat various water pollution problems and build more efficient sewage treatment plants. Control of pollution at source in industrial units continues to remain as one of the most effective strategies to prevent the deterioration in quality of water in the receiving water bodies. Another approach may evolve from deep rethinking on the adverse impacts of our habits, resulting in wasteful utilization of water. Necessary behavioral changes need to be brought in at individual level and collectively as a society, regarding water uses, to prevent the wastage and also abate the ever-rising pollution of very scanty fresh water resources.

Water quality can be classified broadly as physical, chemical, microbiological and radiological. Setting of water-quality standards and their regulation alone cannot help to achieve the required water quality, but what is urgently needed is a limited time regulation within which the changes envisaged for improvement in the drinking water quality must be implemented. Earlier, legislated regulations have been prevalent in India. In the present economic scenario, alternative to such regulations may the power of economic persuasion. in the intervening years, interest in the ‘fitness’ of water has gone beyond only the health factor alone and now, one is forced to decide upon its suitability for a whole spectrum of beneficial uses, involving psychological, social and physiological goals. Therefore, water policy planning has become a continuous task and it must address the questions about definition of right quality of drinking water, effective and economic treatment methodology and perfect distribution network to ensure precious water in appropriate quality to the end users.

For general livelihood and to support varied technical and agricultural activities, human-beings depend only upon the 0.62% of total water found in freshwater lakes, rivers and groundwater. This meager fraction of the total water available is under the process of continuous depletion because of rapidly growing population and industrialization and consequently, increasing pollution mainly on account of different anthropogenic activities. if the manking does not take appropriate measures to arrest the process of fast depletion of fresh water reserves by controlling the pollution activities, the polluted water around civilized society can ring the final death knell. The line of a poem, “ Water water everywhere, not even a drop to drink” may become true. Therefore, our slogan in present conditions should be “save water to save mankind”.

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