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GLOBAL WATER SCENARIO: THE CHANGING STATISTICS

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ABSTRACT

A detailed analysis of how population interacts with renewable water at local levels would demand data on regional supply and quality that are currently not available. However, comparing current and projected population trends with national data on renewable water supplies in various countries could bring into focus the impact of population growth on this essential natural resource. An analysis, based on the data available on about 149 nations' water availability and the population growth projected by UN, has been presented herewith to find out the changes in water statistics and the likely availability of water for the best uses. The per capita availability of water based on 1990 data has been taken for the analysis.

A classification of the water shortage, water stress and water scare nations has been done considering its present and future requirements. Over 28 countries as on 1990, experienced water stress or scarcity. With world population growing by 1.6 percent a year, it is predicted that by 2025, about 46 to 52 countries will fall into these categories. Besides, human being, coastal and marine ecosystem will be facing major threats from water. It will also lead to the increase in international conflicts particularly among the water-dependent countries. An approach to conservation and sustainable use of water for safe future should be the guiding policy for solving the ever-growing water problem.

Key Words: Hydrologic cycle, Runoff, Aquifer, Groundwater, Water withdrawal, Water consumption, Renewable water, Ecosystem, Desalination, Water shortage, Water stress, Water scarcity, Sanitation.

INTRODUCTION

Water, the most vital element for the survival on earth, has become one of the emerging environmental issues our ecosystems are facing today. Issues of water quantity, quality and availability are the three major concerns and are vital to the quality of the life on earth. The assessment of the global water resources can alarm us for its future consequences. Water crises are the challenges to the global environment communities, as water issues have been included under the agenda 21 of the United Nations Environment Program (UNEP).

Freshwater resources are being depleted very fast. The available freshwater resources are unevenly distributed, with much of the water located far from human population. There are an estimated 263 major international river basins in the world, covering about 45% of the earth's land surface area[1]. Among the available freshwater, 90% is available through groundwater resources serving the drinking water requirement of about 1.5 billion people. Agriculture sector is the largest consumer of the available water accounting to 75% of the available global water followed by industrial activities to 20% and remaining 5% is for domestic sector. An estimate shows that two third people of world will be forced to live under

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water stressed conditions by the end of the next two decades. In Africa alone, 25 countries will be water stressed (< 1,000 cubic meters per capita per year) by the year 2025. At present, about 450 million people in 29 countries are facing water scarcity. Safe drinking water supply and sanitation remain the major problem across the world with about 20% of the global population lacking access to safe water. Water pollution is also another matter of the major concern in the developing countries, which is affecting about 1.2 billion people and costing the lives of nearly 15 million children annually.

Besides human life, coastal and marine ecosystems are also facing great threats from a variety of human activities. About 50% of the world's coasts are threatened by haphazard developmental activities. Land based activities amount to 80% marine pollution leading to severe eutrophication in several seas. Increasing marine pollution is resulting in the decrease in yield of marine fisheries, which can be seen as inland and marine aquaculture production contributes 30% of the total global fish yield. Rise in atmospheric pollution is leading to climate change causing the rise in the sea level and the submergence of low-lying coastal areas. This, in turn, will increase human vulnerability in other areas, as they are highly dependent upon marine resources.

CURRENT STATISTICS

An estimate shows that total amount of water on earth is 1.4 billion cubic kilometers of which total 41,000 cubic kilometers of renewable water is falling on continents and islands each year. Against this water availability, the world's total population to be satisfied was 5.3 billion in 1990 and is likely to touch 9.1 billion in 2025 (projected on high growth rate).

Understanding the limits of renewable fresh water supply requires an appreciation of how little of the planet's 1.4 billion cubic kilometers of water actually fits into that category. Only 2.5% is fresh i.e. fit for drinking, growing crops and meeting industrial uses. Moreover, 69% of that is locked in polar ice caps and mountain glaciers or stored in underground aquifers too deep to tap under current and foreseeable technology[2].

In calculating how much fresh water is available for human use, what counts is not the sum total of global fresh water supplies, but the rate at which fresh water resources are renewed or replenished by the global hydrologic cycle. Powered by the sun, this cycle each year deposits about 113,000 cubic kilometers of water on the world's continents and islands as rain and snow. Of that, about 72,000 cubic kilometers evaporates back into the atmosphere. That leaves 41,000 cubic kilometers a year to replenish aquifers or to return by river or other runoff to the oceans[2]. If the entire world's water were to fill into a bathtub, the portion of it that could be used sustainably in any given year would barely fill a teaspoon[3].

Moreover, not all of these 41,000 cubic kilometers can be captured for human use. More than half flows unused to the sea in floodwaters and as much as an eighth falls in areas too far from human habitation to be captured for use. Some water experts suggest the practical upper limit of the world's available renewable fresh water to be between 9,000 and 14,000 cubic kilometers per year. Also, a substantial proportion of this amount is needed to sustain natural ecosystems, in and around rivers, wetlands and coastal waters, and the millions of living species, they contain.

As per the present scenario more than 28 nations are water scarce where the quantity of renewable fresh water is less than 1000 cubic meters. Developing countries are heading the list of water scarce countries as more than 15 countries are from developing countries. An assessment indicates that this number will be double by year 2025 as about 20 more

countries will be added to this list. Rapid population growth rate is the basis for these projections and depending on the actual population growth rate, these numbers can very.

With the population already crossing the 1 billion mark, India's annual per capita water availability is just enough to satisfy per capita requirements. Water scarcity is already plaguing many regions in the country. India is among the countries projected to fall into the *water shortage* category before 2025.

In case of China, it will just miss the water shortage benchmark in 2025 with per capita availability of 1,818 cubic meters. In spite of this, people in North China are facing acute water scarcity.

With population growing to double every two to three decades, oil rich Area states are facing acute scarcity. Most of the Arab states are among the states having least water per capita. Many countries rely heavily on desalination and nonrenewable groundwater supplies to augment their little renewable fresh water supply.

Israel and Jordan are high on the list of water scarce nations. Israel is projected to grow to about 8 million in 2025. Israel probably uses water more efficiently than any other country, yet its demand has exceeded the sustainable annual yield of its available sources since the mid 1970s.

For Jordan, whose population has more than doubled from 1.5 million in 1955 to 4 million in 1990, increasing scarcity means deteriorating water quality and growing reliance on groundwater as a result the water tables are dropping rapidly. Jordan, with annual per capita water availability of about 300 cubic meters, already exploits all its available water resources, and its population is projected to double again before 2015.

African nations are also struggling to balance declining per capita water supplies with the demands of rapidly rising populations. Of 20 African countries that have faced food emergencies in recent years, half are either already stressed by severe water shortage or are projected to fall into the water stress category by 2025. Lacking the financial resources and technology to improve the management of scarce water or to gain access to more renewable supplies, these countries are in desperate need of improvement in the development and management of renewable fresh water resources.

Certain countries currently enjoy adequate per capita renewable fresh water resources but will encounter water scarcity by 2025. Iran, for example, has about 2,000 cubic meters per capita a year at present; by 2025, the figure is projected to be between 776 and 860. Haiti, with nearly 1,500 cubic meters at present, could have anywhere from 761 to 981 cubic meters per person in 2025, depending on population growth. Libya, close to scarcity already with 1,000 cubic meters per capita, is projected to have between 329 and 377 cubic meters in 2025.

Fresh water from sea could, theoretically, be a sustainable source. However, this is limited within the reach of the affluent countries. An estimate shows that about 13 million cubic meters of fresh water were being produced per day from 7500 facilities around the world through desalination process, which represents a 13 fold increase in the global capacity over last two decades. Yet desalinated water still supplies barely 1000^{th} of the fresh water used worldwide[1]. So it falls far from the sustainability even today. Because of the high capital and energy requirements, desalinated water costs several times more than water supplied by conventional means[1]. With world population growing by 1.6 percent a year, it is hard to

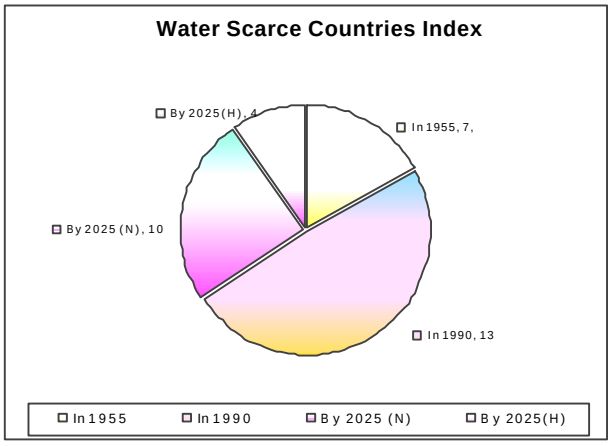
imagine this technology expand fast enough to make a major contribution in meeting water needs around the world.

The key point, however, is that wealthy countries as well as poor ones are whether now using water unsustainably, eventually they will have to face the consequences and place their water management on a sustainable path.

WATER STRESS

A country, whose renewable fresh water availability on an annual per capita basis exceeds about 1,700 cubic meters, will suffer only occasional or local water problems. Below this threshold, countries begin to experience periodic or regular water shortage. When fresh water availability falls below 1,000 cubic meters per person per year, countries experience chronic water stress, in which the lack of water begins to hamper economic development and human health and well being. When renewable fresh water supplies fall below 500 cubic meters per person, countries experience water scarcity[2]. The 1,000 cubic meter benchmark has been accepted as a general index of water scarcity by World Bank and other analysts[4]. Table below gives the list of water scarce countries where availability is less than 1000 cubic meter / capita / year.

Expected time for countries to reach scarcity level	Countries facing water scarcity / likely to cross the water scarcity index
In 1955	Malta, Djibouti, Barbados, Singapore, Bahrain, Kuwait, Jordan (7)
In 1990	Qatar, Saudi Arabia, United Arab Emirates, Yemen, Israel, Tunisia, Cape Verde, Kenya, Burundi, Algeria, Rwanda, Malawi, Somalia (13)
By 2025 under normal population growth as per UN	Libya, Oman, Morocco, Egypt, Comoros, South Africa, Syria, Iran, Ethiopia, Haiti (10)
By 2025 under high population growth as per UN	Cyprus, Zimbabwe, Tanzania, Peru (4)



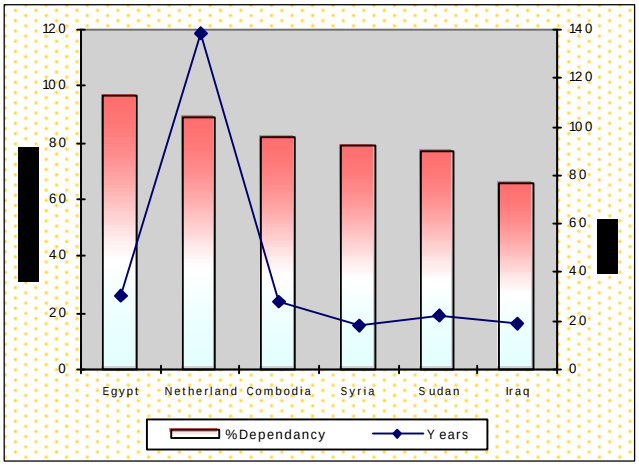
The water scarcity index (shown in pie diagram) makes it clear that water is or likely to become a major constraint on development for more than a third of the countries under the study in four of the five major continents. In 1990, 28 countries with populations totaling 335 million experienced water stress or scarcity. By 2025, from 46 to 52 countries will fall into these categories and the number of people in such countries could be as low as 2.78 billion or as high as 3.29 billion, *depending on rates of population growth over the next three decades.* The difference between these two numbers is one and a half times the number of people living in such conditions in 1990. As

early as in the first quarter of the 21st century, achievable reductions in population growth might cut by half a billion, the number of people who might live in countries that are frequently or chronically short of water.

Following table shows the percentage dependency of the various countries from other countries. The time in years required to double the population of these countries and its percentage dependency are shown in graph separately.

The water scarcity might fuel the increase in international conflicts particularly among such heavily water dependent countries.

Country	Percentage of renewable water supplies originating outside borders	Years required for population to double at current rate
Egypt	97%	30.1
Netherlands	89%	138.6
Cambodia	82%	27.7
Syria	79%	18.2
Sudan	77%	22.4
Iraq	66%	18.7



GROUND WATER

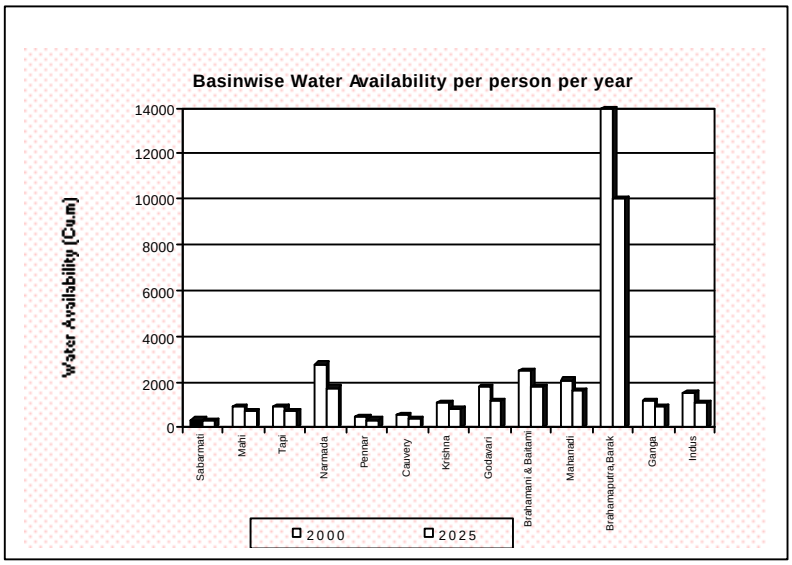
The pressures of modern agriculture, industry and urban lifestyles, multiplied by growing populations and rising standards of living, are causing water tables and river levels to fall and the contamination to spread.

The results of the overuse of groundwater are visible throughout the world. In China's northern provinces, where 10 large cities rely on water from underground, water tables have been dropping as much as one meter a year in wells serving Beijing, Xian and Tianjin. Over exploitation of groundwater in Bangkok is causing the city to sink by 2 to 4 inches a year, leading to cracked pavements, broken sewer and water pipes, sea water intrusion and flooding. In the early 1980s, water tables in Texas were falling by as much as six inches a year, although that rate has since moderated.

Lakes and rivers have also proven vulnerable to unsustainable use. The level of Lake Naivasha in Kenya is dropping as farmers tap its waters to irrigate their fields. The diversion of the rivers for irrigation that feed the Aral Sea in Central Asia has reduced it to 40 percent of its earlier surface area. Once seriously polluted, groundwater reserves and lakes are essentially lost to their potential use as drinking water.

INDIAN CONTEXT

The water resources of India are very unevenly distributed within the basins. National Commission for Integrated Water Development has shown that the per capita availability of water varies widely from around 300 cubic meters per person per year in basins like Sabarmati to very large quantities in the Brahmaputra, with a National average of about 2,000 cubic meters per person per year[5]. The basin wise availability of water per person per year in Indian context is shown below.



Source: Water Management Forum, 2003[5]

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Even the region of Cheerapunji in Meghalaya, the wettest place in the world, is now facing frequent droughts. Because of intense seasonal rainfall and the fact that the area's forests

have been cleared in the past few decades to meet growing demands for agricultural land and housing, much of the runoff cannot be captured. As a result, the region now suffers from excessive flooding for three to four months and frequent droughts for the rest of the year. With a rapidly growing population of 1.8 million, Cheerapunji's water shortages and desertification is likely to worsen[6].

USES

Worldwide, agriculture is the single biggest drain on water supplies, accounting for about 69 percent of all use. About 23 percent of water withdrawals go to meet the demands of industry and energy, and just 8 percent to domestic or household use. Patterns of use vary greatly from country to country depending on levels of economic development, climate and population size. African countries, for instance, devote 88 percent of the water to agriculture, mostly irrigation, while highly industrialized European countries allocate more than half their water to industry and hydroelectric energy production.

The changes in land use patterns brought about by urbanization also affect renewable water supply, by altering and accelerating natural patterns of runoff, eroding soils and speeding evaporation. Urban runoff, collecting toxic compounds from sewage, vehicle exhaust and industrial pollution, severely degrades water quality.

ECOSYSTEMS

Among the casualties of the expanding human use and abuse of water resources are fresh water ecosystems and the plant and animal species they sustain. Freshwater ecosystems are disappearing as rivers and coastlands are being developed around the world. In the United States, Florida Bay, most of which lies within the boundaries of Everglades National Park, has undergone dramatic changes since a rapid influx of people into South Florida began in the 1940s. The bay has been transformed from a healthy estuary and sports fishing paradise to a nearly lifeless and hyper saline lagoon.

Looming over questions of future water supply and use is the likelihood that human beings are inadvertently changing climate worldwide through the heat trapping greenhouse gases increasingly being released into the air through their development activities. Although the impact of the predicted global warming on renewable water supplies and water demands is unknown, it is likely to change the rainfall and the storm patterns and also the sea levels.

The risk of substantial changes in climate over the coming decades, coupled with the other threats posed by growing human pressures, underlines the uncertainty about future water supply and the need for cautious, flexible and innovative planning.

CONFLICTS

With over 200 river and lake basins bordered by two or more countries and aquifers crossing international borders, the potential for increased regional tensions over shared water resources as the population pressures escalate is substantial, particularly in arid and semi-arid regions where water is already scarce[4]. A few countries voluntarily consider the impact of their water usages on their neighboring countries. To date, countries have forged more than 300 treaties to deal with specific international water issues and about 2,000 treaties have water provisions. Yet coordinated management of international river basins is still the exception rather than the rule.

Fresh water scarcity has been a particular source of conflict in the Middle East in recent decades, with relations between most of the countries in the Jordan River basin marked by military conflict over its waters. During the 1967 war, the Israelis attacked a joint Jordanian-Syrian dam site on the Yarmuk River, a tributary of the Jordan. Since the war, Israel has controlled most of the Jordan River's headwaters and basin, leaving insufficient water for Jordan's growing needs.

Tensions over the control and the use of water resources are mounting around the globe. After heavy flooding killed more than 2,000 people in South Asia in the summer of 1993, the Government of Bangladesh has renewed its demand that India and Nepal build dams to control the Ganges and Brahmaputra rivers upstream from Bangladesh. In arid Central Asia, shared waters could quickly become the catalyst for conflicts between the newly independent nations of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. Unfortunately, International water law offers little guidance for resolving these conflicts. As the demands of growing populations approach the limits of renewable resources, water could provide the flash point for conflict in regions with longstanding ethnic and political rivalries. Indeed, some analysts have suggested that within a decade, water could overshadow oil as a scarce and precious commodity as the center of conflict and peacemaking.

THE STRATEGIES

The effective management of the available water lies in the accurate assessment of the water resources. The steps being used by the world water community for better assessment of the world's water resources leading to formalization of suitable strategies are described below:

Scoping and Scaling i.e. identification of the issues causing changes to the environment and the socio-economic conditions of a particular region.

Detailed Impact Assessment i.e. assessing the situations by analyzing the relationships between activity and environmental component in terms of Environmental Impact Assessment and Socio-economic Impact Assessment.

Analyzing the Causes i.e. constructing the causal chain to discover the roots of the problem by following the most significant successive causes of environmental degradation.

Policy Analysis i.e. evaluation of alternative scenarios following various projections developed on the basis of actions to address the societal root causes of environmental degradation. These analyses consider methods for evaluating the environmental impacts of various options for the water use, before weighing the cost of measures designed to modify unsustainable development.

Better Implementation in Field i.e. stringent control and enforcement with quality control in the field actions to implement the designed measures in sustainable way.

CONCLUSIONS

New sources of fresh water will be developed, and no doubt water will be used with increasing efficiency. Water conservation and reuse should be adopted as rule for sustainable future use. Solutions that work over time, however, must respect the limits imposed by the global water cycle. At least, until renewable energy can be coupled inexpensively with desalination technologies, sustainable development of water resources

means working with the limited 41,000 cubic kilometers of water that the water cycle provides each year. After allowing for flooding and for meeting the nature's needs, a quarter to a third of that amount may be considered as the upper limit of water available for sustainable human use.

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