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WATER SCARCITY:A UNIVERSAL ISSUE

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Abstract

Water has an economic value in all its competing uses and should be recognized as an economic good. Water scarcity is a result of an imbalance between the supply of and demand for water sources in a geographical area. Present water deficiency is one of the major world issues according to changing climatic conditions and it will be more dangerous in future. In consideration of the fact that water availability and accessibility are the most significant restraining aspects for agriculture and proposing solutions to this problem is essential for areas affected by water scarcity. Owing to growth rate of the global population indicates that the expected increase of food demand in the future, with an immediate impact on farming water use. In this paper the significant water scarcity related issues are analyzed and valuable suggestions recommended.

Keywords:
Water Scarcity;
Climate Change;
Population;
Growth;
Agriculture;
Food Demand.

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1. Introduction

Our general public believed that the water is a free good in the form of rain, but when this free good is captured and delivered to customers by canal, pipe or other means, it becomes a water service. There is generally much less resistance to water service fees than there is to water charges. When there is not enough potable water for a given population, the threat of a water crisis is realized. The United Nations and other world organizations consider a variety of regions to have water crises of global concern. Other organizations, such as the Food and Agriculture Organization, argue that there are no water crises in such places, but steps must still be taken to avoid one. Global water use has risen dramatically in the past 50 years due to population growth and the demands of irrigated agriculture. Water is necessary for hygiene. The amount of water use varies with distance from the water source and climate.Where people must walk farther than 1 kilometer or spend more than 30 minutes for total water collection time, per capita water use drops to between 5 and 10 liters per day. At this level of service, adequate hygiene is not possible. When there is a household water connection, per capita water use for basic needs rises to between 60 and 100 liters per day or

more if used for gardening.The water is considered as most essential resource for life and it has been a fundamental issue on the international schema for several decades. At the present many areas of the world are affected by water scarcity. Present days, “scarcity” is one of the adjectives most related to the word “water”; thus, many studies and projects focusing on the assessment of global water demand and its availability have been developed. In fact, water demand has reached critical levels in many areas of the world, especially in countries with limited water availability. The misuse of water resources, the lack of infrastructures to supply water and also climate change are some of the reasons for water scarcity, despite the vast amount of water on the planet. water scarcity in wealthier countries or regions such as the United States, Europe, Australia, or the Asia-Pacific where water scarcity threatens regional food security through a number of ecological, political, and economic pathways [6],[7],[27],[14],[16],[31]. Insufficient access to water and ensuing water stress is undoubtedly a major global public health threat and challenge for our generation. Despite water being an existential need for humans, it’s also one of the most under prioritized but over abused commodity. The figure1 shows the interactions between the energy, water, land and climate.

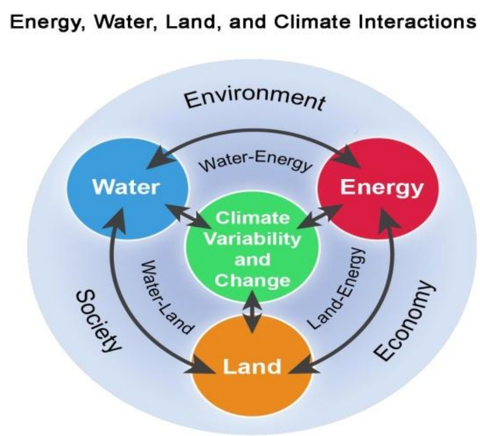

Figure 1: *Energy, Water, Land and Climate Interactions*

The World Health Organization (WHO) recommends a minimum water intake of between two and four and a half liters per person, depending on climate and activity; the WHO also suggests that two additional liters of water are needed for food preparation[10]. Current and future issues related to "water scarcity" are reviewed and highlighted the necessity of a more sustainable approach to water resource management. As a consequence of increasing water scarcity and drought, resulting from climate change, considerable water use for irrigation is expected to occur in the context of tough competition between agribusiness and other sectors of the economy. Owing to the growth of global population need of food quantity will be increased in the future and will affect the farming water use. Since a noteworthy relationship exists between the water possessions of a country and the capacity for food production, assessing the irrigation needs is indispensable for water resource planning in order to meet food needs and avoid excessive water consumption [35].

In this paper water scarcity issues and solutions are analyzed. The rest of this paper is organized as follows. Section 2 presents the related work, section 3 explains the water scarcity and various reasons for water scarcity, section 4 offers the suggested solutions for water scarcity and section 5 concludes this paper.

2. Related Work

Worldwide water demand has attained serious levels in many areas. The misuse of water resources, the lack of infrastructures to supply water and also climate change are some of the reasons for water scarcity, despite the vast amount of water on the planet. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report states that the magnitude of stress on water resources is expected to increase as a consequence of climate change, future population growth and economic and land-use change, including urbanization. According to the scenarios described in the IPCC Special Report on Emissions Scenarios, changes in precipitation and temperature may lead to changes in runoff and water availability, which, in turn, could affect crop productivity. The physical, chemical and biological properties of freshwater lakes and rivers will be affected by the increase in temperature. This change is predicted to negatively affect many freshwater species and community and habitat composition. Moreover, as a consequence of sea level rise in low-lying coastal areas, the quality of freshwater aquifers is influenced by the intrusion of saline water [20].

The normal unbalanced distribution of water sources further contributes to water scarcity. If rain fell in an even pattern, the freshwater pool covering the globe would be eighty centimeters deep [41], and would be sufficient to meet the demands of the global population [11]. Unfortunately many countries simply do not have access to the water, water importation plans have been discussed, but the costs involved limit the feasibility of any sort of large-scale implementation [26]. Unpredictable weather patterns, which often induce droughts, only worsen conditions in water-scarce countries [5]. The Water Resources Constraint Force (WRCF) have designed a conceptual framework. Conceptual models on the interactions and feedbacks between water resources and socio-economic systems in water scarce regions or river basins indicate that, if the socio-economic system always aims at sustainable development, WRCF will vary with a normal distribution curve. Rational water resources management plays an important role on this optimistic variation law. Specifically, Water Demand Management (WDM) and Integrated Water Resources Management (IWRM) are considered as an important perspective and approach to alleviate WRCF. A case study in the Hexi Corridor of NW China indicates that, water resources management has great impact on WRCF both in Zhangye and Wuwei Region, and also the river basins where they are located. The drastic transformation of water resources management pattern and the experimental project Building Water-saving Society in Zhangye Region alleviated the

WRCF to some extent. However, from a water resources management view, WRCF in Zhangye Region still belongs to the severe constraint type. It will soon step into the very severe constraint type[32]. In order to shorten the periods from the very severe constraint type finally to the slight constraint type, WDM and IWRM in the Hei River Basin should be improved as soon as possible. However, in the Shiyang River Basin, WRCF belongs to the very severe constraint type at present due to poor water resources management in the past. Though the socio-economic system adapted itself and alleviated the WRCF to some extent, the Shiyang River Basin had to transform the water supply management pattern to WDM, and seek IWRM in recent years [47].

The issue of the diminution of fresh water can be met by increased efforts in water management [50]. While water management systems are often flexible, adaptation to new hydrologic conditions may be very costly [37]. Preventative approaches are necessary to avoid high costs of inefficiency and the need for rehabilitation of water supplies [50] and innovations to decrease overall demand may be important in planning water sustainability [31]. Water supply systems, as they exist now, were based on the assumptions of the current climate, and built to accommodate existing river flows and flood frequencies. Reservoirs are operated based on past hydrologic records, and irrigation systems on historical temperature, water availability, and crop water requirements; these may not be a reliable guide to the future. Re-examining engineering designs, operations, optimizations, and planning, as well as re-evaluating legal, technical, and economic approaches to manage water resources are very important for the future of water management in response to water degradation. Another approach is water privatization; despite its economic and cultural effects, service quality and overall quality of the water can be more easily controlled and distributed. Rationality and sustainability is appropriate, and requires limits to overexploitation and pollution, and efforts in conservation [50].

In Colorado State University, a group of 37 experts met on June 13–14, 2016 to analyze stresses on global water resources and identify challenges, solutions, actions, and responsibilities for leading institutions involved in water research, education, and management. Participants included distinguished CSU alumni and faculty with expertise in water and climate and other experts with broad experience representing governments, intergovernmental organizations, academic institutions, and the private sector. Five key action areas were identified for focused attention from the academic, governmental, and private sectors to strengthen the sustainability and resiliency of natural and engineered water systems:

i). Reduce uncertainty and risk through greater understanding of climate, the environment, and institutional responses;

ii). Galvanize the power of multidisciplinary approaches using atmospheric sciences, hydrology, ecology, management, and public policy;

iii). Improve professional knowledge networks with multidisciplinary knowledge applied toward water-related and climate-related challenges;

iv). Improve water governance with objective science and implementable policies; and

v). Create robust open-access data resources to support informed decision making.

The participants identified top-priority challenges, solutions, and needs to address these key action areas with actionable items at the intersection of water and climate[30].

3. Water Scarcity

3.1. Aridity

The aridity means deficiency in moisture. All climatic classifications include arid categories, defined either by quantitative or, more usually, by mainly subjective criteria. C. W. Thornthwaite first used the term 'aridity index' and calculated it as 100 times the water deficit, divided by the potential evaporation [1].Water scarcity involves water stress, water shortage or deficits, and water crisis. This may be due to both natural and human factors. But, many reports suggest that the scarcity is more due to the human factor than anything such as industrialization, irrigation, domestic use, etc [21]. The acute water shortage prevailing in the forest areas of Tamil Nadu's districts of Madurai and Dindigul has led to the deaths of Indian gaurs found in the forest of the region, as they come in search of water are killed falling into the wells[24]. The figure2 shows the situations of aridity and figure3 shows the water scarcity in 2030 based on the Falkenmark Indicator.

Figure 2: *Aridity*

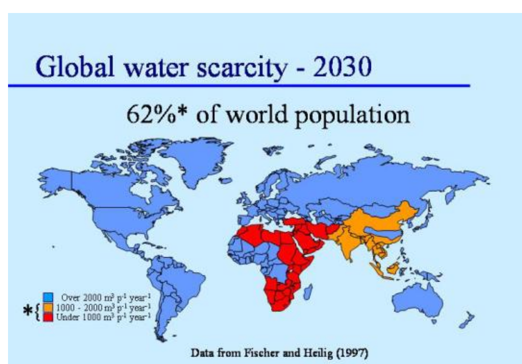

Figure 3: *Water Scarcity in 2030 based on the Falkenmark Indicator*

3.2. Climate Changes

Climate change playing vital role in creating threats to future food security, the likely impacts will differ by region, country and location and will affect different population groups according to their vulnerability. Future food security trends will also be influenced by overall socio-economic conditions, which, in turn, have implications for the vulnerability of countries and populations around the world . In a related analysis, IFPRI found that in the absence of climate change, most regions would see declining numbers of people at risk of hunger between 2010 and 2050. However, climate change will partly offset those gains. Results from IFPRI's IMPACT model suggest that, by the year 2050, under a high emissions scenario (RCP 8.5), more than 40 million more people could be at risk of undernourishment than there would be in the absence of climate change. The vulnerability of populations in sub-Saharan Africa, as well as in parts of South Asia, to food insecurity resulting from climate change also emerges in projections by the World Food Programme and the Met Office Hadley Centre (United Kingdom). Their joint work largely follows methods used by Krishnamurthy, Lewis and Choularton (2014), with vulnerability defined by a composite index based on measures of exposure, sensitivity and adaptive capacity. Projections of future levels of vulnerability were made for two time periods: 2050 and 2080. Three climate change scenarios were considered: low emissions (RCP 2.6), medium emissions (RCP 4.5) and high emissions (RCP 8.5). Each scenario was projected using twelve different climate models, and the median result was taken as the value for the respective drought and flood indicators. Scenarios of no adaptation as well as low and high adaptation were taken into consideration. The figure4 shows the situations of climate change.

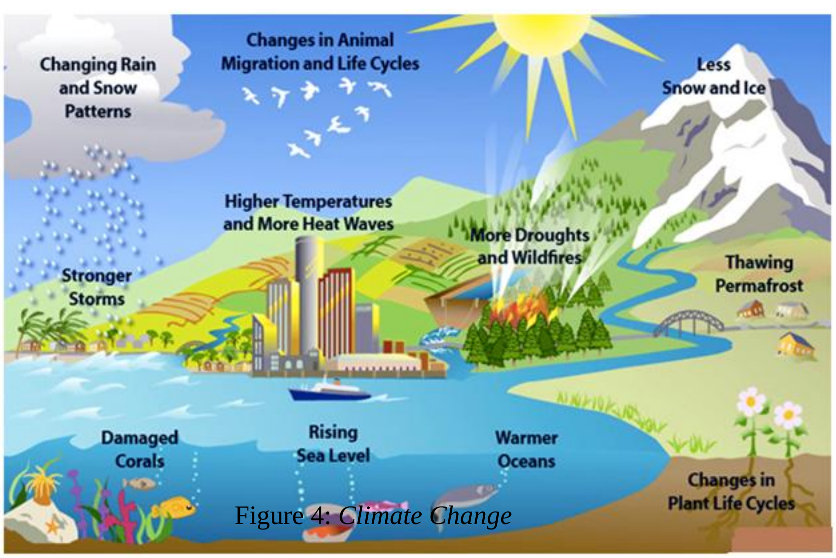

Figure 4: *Climate Change*

3.2.1.Impacts of Climate Change on Agriculture

i). Increased frequency and intensity of extreme climate events such as heat waves, droughts and floods, leading to loss of agricultural infrastructure and livelihoods

ii). Decrease in fresh water resources, leading to water scarcity in arable areas

iii). Sea-level rise and coastal flooding, leading to salinization of land and water, and risks to fisheries and aquaculture

iv). Water and food hygiene and sanitation problems

v). Changes in water flows impacting inland fisheries and aquaculture

vi). Temperature increase and water scarcity affecting plant and animal physiology and productivity

vii). Beneficial effects on crop production through carbon dioxide "fertilization"

viii). Detrimental effects of elevated tropospheric ozone on crop yields

ix). Changes in plant, livestock and fish diseases and in pest species

x). Damage to forestry, livestock, fisheries and aquaculture

xi). Acidification of the oceans, with extinction of fish species

3.3. Population Growth and Environmental Degradation

The rapid growth of human population leads to the degradation of the environment at huge levels. Humanity's desire for food is disarranging the environment's natural equilibrium. Production industries are emitting smoke and discharging chemicals that are polluting water resources. The smoke that is emitted into the atmosphere holds detrimental gases such as carbon monoxide and sulfur dioxide. The high levels of pollution in the atmosphere form layers that are eventually absorbed into the atmosphere. Organic compounds such as chlorofluorocarbons (CFC's) have generated an unwanted opening in the ozone layer, which emits higher levels of ultraviolet radiation putting the globe at large threat. The available fresh water being affected by the climate is also being stretched across an ever-increasing global population. It is estimated that almost a quarter of the global population is living in an area that is using more than 20% of their renewable water supply; water use will rise with population while the water supply is also being aggravated by decreases in stream flow and groundwater caused by climate change. Even though some areas may see an increase in freshwater supply from an uneven distribution of precipitation increase, an increased use of water supply is expected [40]. An increased population means increased withdrawals from the water supply for domestic, agricultural, and industrial uses, the largest of these being agriculture [31], believed to be the major non-climate driver of environmental change and water deterioration. The next 50 years will likely be the last period of rapid agricultural expansion, but the larger and wealthier population over this time will demand more agriculture [48]. Our ecological system constantly replenishes its water supply through its cycle of evaporation and precipitation [28], yet over eighteen percent of the world's six billion people lack access to clean freshwater [29].

Environmental degradation is the process of weakening the environment by means of resources such as air, water and soil. The damage of ecosystems means the destruction the extinction of wildlife and pollution. It is defined as any change or disturbance to the environment perceived to be deleterious or undesirable [25]. As indicated by the I=PAT equation, environmental impact (I) or degradation is caused by the combination of an already very large and increasing human population (P), continually increasing economic growth or per capita affluence (A), and the application of resource-depleting and polluting technology (T) [8],[19]. Environmental degradation is one of the ten threats officially cautioned by the High-level Panel on Threats, Challenges and Change of the United Nations. The United Nations International Strategy for Disaster Reduction defines environmental degradation as "the reduction of the capacity of the environment to meet social and ecological objectives, and needs" [23]. Environmental degradation is of many types. When natural habitats are destroyed or natural resources are depleted, the environment is degraded. Efforts to counteract this problem include environmental protection and environmental resources management.

3.4. Misuse of Water Resources

An International Conference on Water and the Environment (ICWE) conducted in January 1992 at Dublin concluded that scarcity and misuse of freshwater pose a serious and growing threat to sustainable development and protection of the environment. The conference emphasized that human health and welfare, food security, economic development and ecosystems are all at risk, unless water and land resources are managed more effectively in the future [46]. There is little doubt in the public mind of the need to do something on the constant attack by unscrupulous business interests on constricting, redirecting and filling up of public water bodies, rivers and canals for profit. In an effort to halt such malpractices, the cabinet has approved a draft bill Bangladesh Water Act, 2012 that promises to put in place a series of checks and balances aimed at halting misuse of said resources. While it is commendable to see that the government has finally taken heed of decades of outcry by affected communities, environmentalists and water experts, it will be interesting to see whether the stringent provisions proposed in the Act, such as, five years' imprisonment or a fine of Tk. 5 million will actually be enforced with due diligence in reality. Reasons for disruption of natural flow of water and pollution are well known, but we often overlook the disastrous effects such wilful trespassing have on the natural state of affairs.

Whether it is pollution or obstruction of natural flow of water, there is no denying that manmade interventions have helped bring about ecological disaster to entire communities of people who depend on these water resources for their livelihoods. The proposed piece of legislation however is not above criticism. There exist concerns whether the draft fully addresses prioritisation of consumer needs over that of commercial and industrial needs or whether there is enough clarity on the issue of licensing water distribution and so on. The concept is always operated on a zero tolerance policy when it comes to protection of the environment and water has always been and will always mean difference between life and death to people of the deltaic plains that constitute Bangladesh. The government has to take necessary steps to enact into law which if implemented, according to the letter of the proposed law, will go a long way to limit what projects public and private bodies can undertake that may undermine bio-diversity, fish sanctuary, natural drainage systems and the environment at large.

3.5. Industrial Pollution

The industries are playing vital role in contaminating the water resources in many forms. One of the most common is water pollution, caused by dumping of industrial waste into waterways, or improper containment of waste, which causes leakage into groundwater and waterways. Industrial pollution, also poses a serious threat to water supplies. As with the lack of sanitation, the effects of industrial pollution have been found to disproportionally affect those of a certain income and race [47]. Although the industrial pollution presents its own distinct set of challenges, most notably accounting for the staggering number of pollutants circulating in our water sources[17]. Commonly, the industrial pollutants are divided into three major categories (i) gas, (ii) solid and (iii) water. There are also some other pollutant forms such as noise and odor.

The table1 indicates the different type of water pollutants produced by various industries.

Table 1: Different type of water pollutants produced by various Industries

Industrial Sectors	**Water Pollutant Forms**
Iron and Steel	BOD, COD, oil, metals, acids, phenol, cyanide
Textiles and leather	BOD, solids, sulfates and chromium, dyes
Pulp and Paper	BOD, COD, solids, chlorinated organic compounds
Petrochemicals, Refineries	BOD, COD, oil, phenols and chromium
Chemicals	COD, organic chemicals, heavy metals, solids and cyanide

3.6. Water and Human Health

Maintenance of good health in the society is very important and the responsibility of individual and concern government. The supply of pure domestic water is challenging task to the government. Nearly one billion people in the world are having contaminated drinking-water. Providing easier access to safe drinking-water significantly improves health conditions. Personal hygiene increases when water availability rises above 50 litres per day. An estimated 1.7 billion persons contend with inadequate sanitation facilities. The lack of sewage collection and treatment is a major source of surface and groundwater pollution[21], [22]. The figure5 shows the relationship between the water and human health.

Health officials identify five categories of disease related to water:

i) Water-borne diseases (typhoid, cholera, dysentery, gastroenteritis and infectious hepatitis);

ii) Water-washed infections of the skin and eyes (trachoma, scabies, yaws, leprosy, conjunctivitis and ulcers);

iii) Water-based diseases (schistosomiasis and guinea-worm);

iv) Diseases from water-related insect vectors such as mosquitoes and blackflies; and

v) Infections caused by defective sanitation (hookworm).

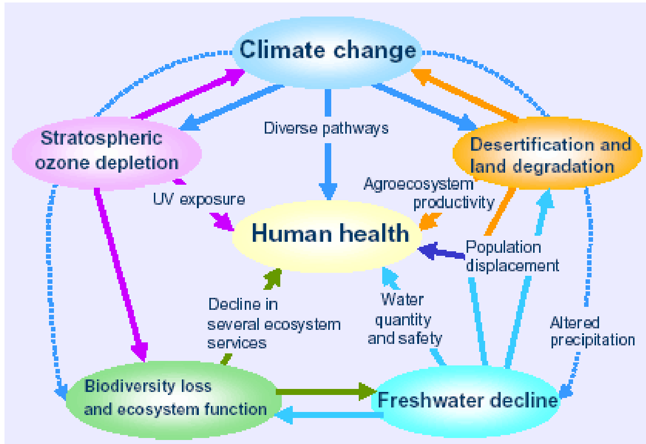

Figure 5: *Relationship between the Water and Human Health*

3.7. Reasons behind water scarcity in India

The intemperance population growth and mismanagement of water resources leads to water scarcity. The various most important causes for water scarcity are:

i). Inefficient use of water for agriculture. India is among the top growers of agricultural produce in the world and therefore the consumption of water for irrigation is amongst the highest. A traditional technique of irrigation causes maximum water loss due to evaporation, drainage, percolation, water conveyance, and excess use of groundwater. As more areas come under traditional irrigation techniques, the stress for water available for other purposes will continue. The solution lies in extensive use of micro-irrigation techniques such as drip and sprinkler irrigation.

ii). Reduction in traditional water recharging areas. Rapid construction is ignoring traditional water bodies that have also acted as ground water recharging mechanism. There is a urgent necessitate to revive traditional aquifers while implementing new ones.

iii). Sewage and wastewater drainage into traditional water bodies. Government intervention at the source is urgently required if this problem is to be tackled.

iv). Release of chemicals and effluents into rivers, streams and ponds. Strict monitoring and implementation of laws by the government, NGOs and social activists is required.

v). Lack of on-time de-silting operations in large water bodies that can enhance water storage capacity during monsoon. It is surprising that the governments at state levels have not taken this up on priority as an annual practice. This act alone can significantly add to the water storage levels.

vi). Lack of efficient water management and distribution of water between urban consumers, the agriculture sector and industry. The government needs to enhance its investment in technology and include all stakeholders at the planning level to ensure optimization of existing resources [9].

4. Solutions for Water Scarcity

4.1. Water Resources

An establishment and maintenance of water resources is the indication of welfare of the society and development of agricultural region. Subsequently, its quantitative and physical dimensions, the concept of water resources comprise also qualitative socio-economic and environmental dimensions. Water is divided in two types of resources: renewable and non-renewable water resources. Groundwater and surface water, such as the average flow of rivers on a yearly basis, are considered renewable water resources, whereas deep aquifers, which do not have a significant replenishment, rate on the human time scale, are deemed non-renewable water resources [15]. Water is also distinguished in terms of supply. Blue water is the liquid water above and below the ground (rivers, lakes, groundwater), and green water is the soil water in the unsaturated zone derived from precipitation [12]. The portion of water that is directly used and evaporated by rain fed agriculture, pastures and forests is defined as green water. Thus, green water flow has two components: The productive part, or the transpiration involved in biomass production in terrestrial ecosystems, and the non-productive part, or evaporation [13]. Blue and green water are both viewed as renewable resources in the broad sense; however, only blue water is assessed in the strict sense.The figure6 shows the water cycle system.

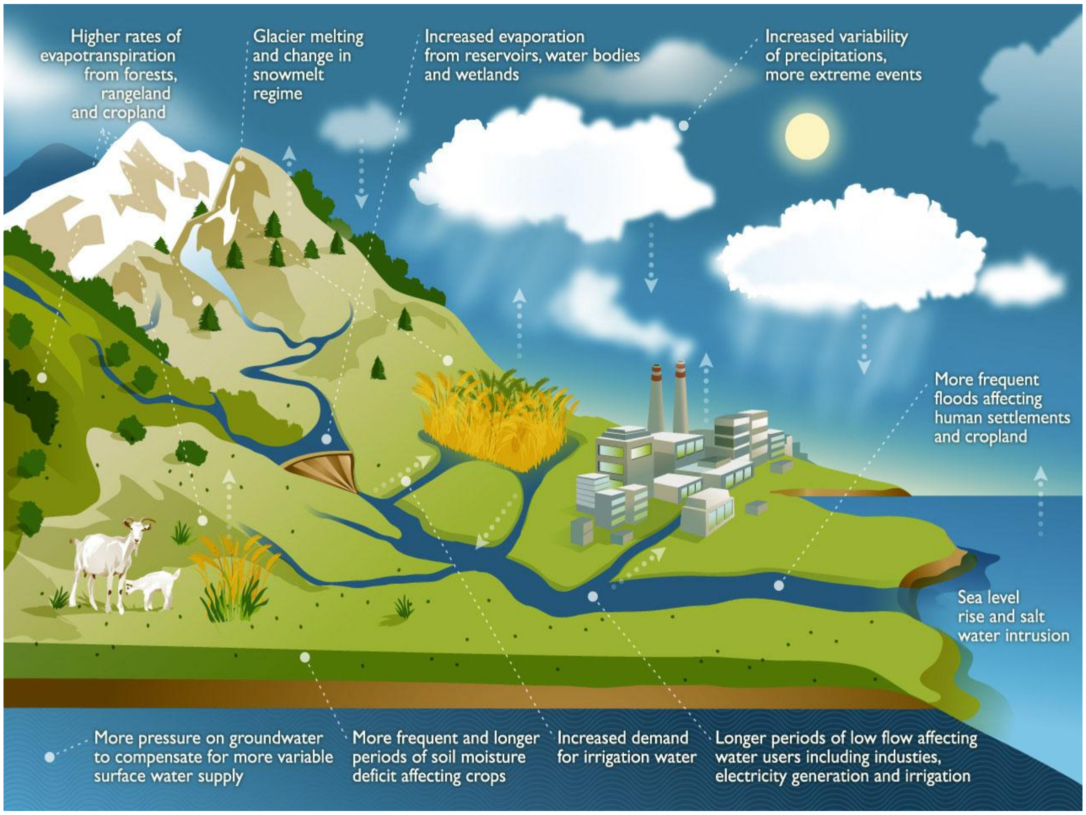

Figure 6: *Water Cycle System*

4.2. Reforming Water Resources

A more integrated and broader approach to water sector polices and issues are important because of water's special nature as a unitary resource. Rainwater, rivers, lakes, groundwater and polluted water are all part of the same resource, which means global, national, regional and local actions are highly interdependent. Water use in one part of the system alters the resource base and affects water users in other parts. The integrated approach requires water managers to understand not only the water cycle (including rainfall, distribution, ecosystem interactions and natural environment and land-use changes), but also the diverse intersectoral development needs for water resources [36].

4.3. Improving System for Water Management

A simple addition of a ‘water free’ male urinal in our homes can save well over 25,000 liters of water, per home per year. The traditional flush dispenses around six liters of water per flush. If all male members including boys of the house use the ‘water free urinal’ instead of pulling the traditional flush, the collective impact on the demand for water will reduce significantly. This must be made mandatory by law and followed up by education and awareness both at home and school. The amount of water that is wasted during dish washing at home is significant. There is a requirement to change our dish washing methods and minimize the habit of keeping the water running. A small step here can make a significant saving in water consumption. Every independent home/flat and group housing colony must have rain water harvesting facility. If efficiently designed and properly managed, this alone can reduce the water demand significantly. Waste water treatment and recycling for non-drinking purposes. Several low cost technologies are available that can be implemented in group housing areas. Generally, water leakage in residential homes, in public areas and colonies can cause a loss of 226,800 liters of water per year. The public must have aware and conscious of water wastage to avail the basic quantity of water for normal lives.

4.4. Rain Water Harvesting

Rainwater harvesting is the accumulation and deposition of rainwater for reuse on-site, rather than allowing it to run off. Rainwater can be collected from rivers or roofs, and in many places, the water collected is redirected to a deep pit (well, shaft, or borehole), a reservoir with percolation, or collected from dew or fog with nets or other tools. Its uses include water for gardens, livestock, irrigation, domestic use with proper treatment, indoor heating for houses, etc. The harvested water can also be used as drinking water, longer-term storage, and for other purposes such as groundwater recharge. Rainwater harvesting is one of the simplest and oldest methods of self-supply of water for households usually financed by the user [44]. Rainwater harvesting is possible by growing freshwater-flooded forests without losing the income from the used, submerged land [39]. The main purpose of the rainwater harvesting is to use the locally available rainwater to meet water requirements throughout the year without the need of huge capital expenditure. This would facilitate the availability of uncontaminated water for domestic, industrial, and irrigation needs.The figure7 and figure8 shows the rainwater harvesting system[34].

Figure 7: *Rainwater capture and storage system at the Monterrey Institute of Technology and Higher Education, Mexico City.*

4.4.1.

Figure 8: *Ratagul Freshwater Flooded Forest, Bangladesh*

History

Around the third century BC, the farming communities in Baluchistan (now located in Pakistan, Afghanistan, and Iran), and Kutch, India, used rainwater harvesting for agriculture and many other uses. In ancient Tamil Nadu , rainwater harvesting was done by Chola kings. Rainwater from the Brihadeeswarar temple (located in Balaganpathy Nagar, Thanjavur was collected in Shivaganga tank. During the later Chola period, the Viranam tank was built (1011 to 1037 CE) in Cuddalore district of Tamil Nadu state to store water for drinking and irrigation purposes. Viranam is a 16-km-long tank with a storage capacity of 1,465,000,000 cu ft (41,500,000 m3) [4],[38], [43].

4.4.2. Methods of rain water harvesting system:

The flooded forest plants or trees are very useful in rain water harvesting or ground water recharging anywhere such as house plots, farm lands, forest lands, open areas, river courses, etc. Rain water wherever available and needed are stored in small pits/ponds/tanks by growing 'flooded forest trees' which will earn income exceeding that of normal crops or trees.

i.) Recharging rain water in the house compounds:

Make a pit of 1.5 meters depth with sufficient storage volume to collect moderate fortnight rain fall. Plant the 'flooded forest trees' in this pond area. When there is rain, the rain water collects in this pond and slowly percolates in to the ground building up ground water. Thus trees can be grown and the ground water is recharged simultaneously for dry season drinking water purpose.

ii.) Recharging rain water in open lands of cities and rural areas:

Build a check dam to store water up to 1.5 meters depth and plant ‘flooded forest trees’ in the water stored area. The entire area becomes woody area in few years and also the groundwater is recharged.

iii.) Water harvesting in farm lands:

Generally the time gap between good rains is 15or more days. It is very useful to store the rain water in a small area of the field and use it to water the crop till the next rain. Thus the crop yield is assured even in erratic rain fall. Create a pond of depth 1.5 meters in 5% area of the field and plant the ‘flooded forest trees’. Thus the pond area land also contributes equallyfor agriculture produce and stores water for the needs of the crop.

iv.) Water harvesting in Forest lands:

On the small streams in the forest area, construct check dams of nearly 1.5 meters high and plant ‘flooded forest trees’ in water spread area. The rain water collected by the check dam will enhance water percolation in to the ground. The subsoil moisture will help the forest in preventing water stress during summer months. Thus the growth of the forest is healthy. The forest animals also get drinking water and shelter during summer months [34].

4.4.3. Advantages

The process of rainwater harvesting offers an independent water supply during regional water restrictions, and in developed countries, is often used to supplement the main supply. It provides water when a drought occurs, can help mitigate flooding of low-lying areas, and reduces demand on wells which may enable groundwater levels to be sustained. It also helps in the availability of potable water, as rainwater is substantially free of salinity and other salts. Application of rainwater harvesting in urban water system provides a substantial benefit for both water supply and wastewater subsystems by reducing the need for clean water in water distribution system, less generated storm water in sewer system [3] and a reduction in storm water runoff polluting freshwater bodies. The major part of work has concentrated on the development of lifecycle assessment and lifecycle costing methodologies to assess the level of environmental impacts and money that can be saved by implementing rainwater harvesting systems. More development and knowledge is required to understand the benefits rainwater harvesting can provide to agriculture. Many countries, especially those with arid environments, use rainwater harvesting as a cheap and reliable source of clean water [51]. To enhance irrigation in arid environments, ridges of soil are constructed to trap and prevent rainwater from running down hills and slopes. Even in periods of low rainfall, enough water is collected for crops to grow. Water can be collected from roofs, and dams and ponds can be constructed to hold large quantities of rainwater so that even on days when little to no rainfall occurs, enough is available to irrigate crops [18].

4.5. Agricultural Water Management and Food Production

Ever since a remarkable correlation exists between the water possessions of a country and the capacity for food production, assessing the irrigation needs is indispensable for water resource planning in order to meet food needs and avoid excessive water consumption. Population increase necessarily requires increased food production. To supply one person with 2800 calories per day, one thousand cubic meters of water are needed [49]. It is estimated that within thirty years, a fourteen percent increase in freshwater will be needed to supply the expected twenty percent growth in irrigated land. A total transformation of agricultural practices will also have to accompany the growth. Unmanaged agricultural systems (the earth's natural growth absent human involvement) can only feed approximately five hundred million people. The agricultural tactics implemented today feed more than six billion people: "Between 1900 and 1950, the world's irrigated land area almost doubled to 94 million hectares…[from 1950 to 1990] the area expanded by over 150 million hectares"[42]. Further adaptations will be required to feed the ten billion people expected by 2100; consequences of those adaptations will be numerous [33]. Since a noteworthy relationship exists between the water possessions of a country and the capacity for food production, assessing the irrigation needs is indispensable for water resource planning in order to meet food needs and avoid excessive water consumption.

In the agricultural segment, primarily calculate how much water is required by crops with respect to climate conditions. Some techniques, such as soil monitoring, lysimeter, eddy covariance, the Bowen ratio and surface renewal, are used to monitor and measure irrigation needs. While the monitoring approach may require delicate and expensive sensors or the assistance of experts, the application of models (e.g., soil water balance models) could provide a low-cost method for on-farm and regional systems for computing the crop water requirement and estimating the depth of water storage required to satisfy the agricultural demand. Once the crop water requirement is known, improving the efficiency of the irrigation application is a key strategy for water savings in agriculture. The term "efficiency" is commonly used to indicate "the level of performance" of a system [45].

The efficient usage of water is measured in the agricultural zone based on the relationship between crop growth development and the amount of water used. Sinclair et al. described plant water use efficiency as the ratio of biomass accumulation (expressed as carbon dioxide assimilation), total crop biomass or crop grain yield to transpiration by the crop. This plant physiology concept differs from the on-farm irrigation concept of the efficient use of irrigation water to produce a crop [35]. Globally, at least 7130 km^3 of water are needed to satisfy crop evapotranspiration losses in agriculture, considering both blue and green water (irrigation delivery and on-farm system losses excluded) [22]; however, a considerable variation between regions is noticed. Irrigation is quite important in North Africa, the Middle East, the Near East and southern Asia, where more than 75% of food is produced by means of irrigation, and blue water crop evapotranspiration is about half of the total food crop evapotranspiration. These regions, together with the Mediterranean region, Australia, the USA, Mexico, Northeastern Brazil and the west coast of South America, are considered water-stressed basins. In addition, an increase in irrigation water demand, particularly in the aforementioned areas, is projected because of climate change [2].

4.6. Recycling and Reuse of Waste Water

Wastewater treatment means enable the wastewater to be disposed safely without being a danger to public health and without polluting water resources or causing other nuisance. Progressively, wastewater treatment is used to recover energy, nutrients, water, and other valuable resources from wastewater.

4.6.1. The Composition of Wastewater

Wastewater or sewage water has contaminants include suspended solids, biodegradable dissolved organic compounds, inorganic solids, nutrients, metals and pathogenic microorganisms. The suspended solids in wastewater are primarily organic particles, composed of body wastes, food waste, and toilet paper. Inorganic solids in wastewater include surface sediments and soil as well as salts and metals. The removal of suspended solids is essential prior to discharge in order to avoid settlement in the receiving watercourse. The degree to which suspended solids must be removed from wastewater depends on the type of receiving water into which the effluent is discharged. The European Union (EU) Urban Wastewater Treatment Directive requires that effluent contains no more than 35 mg/I of suspended solids at 95% compliance, whereas the EU Freshwater Fish Directive sets a guideline level of 25 mg/I. A common target for suspended solids in the final discharged effluent in the United Kingdom is 30 mg/I, although the regulator may often choose to impose more stringent works-specific limits, called schrage consents.

4.7. Water Security

The United States Environmental Protection Agency (EPA) has suggested that “Improving the security of our nation's drinking water and wastewater infrastructures has become a top priority since the events of 9/11. Significant actions are underway to assess and reduce vulnerabilities to potential terrorist attacks; to plan for and practice response to emergencies and incidents; and to develop new security technologies to detect and monitor contaminants and prevent security breaches”. One of the most important elements of water security is early and accurate contamination detection. The EPA has offered recommended material and guidelines for contamination warning systems to be implemented in water utilities and supplies. The security challenges that utilities frequently revolve around fast detection, accuracy, and the ability to take fast action when there is a water problem. If contamination is detected early enough, it can be prevented from reaching consumers, and emergency water supplies can be put into effect. In cases where contamination might still reach consumers, fast and efficient communication systems are necessary. All these factors also point to the need for organized and practiced emergency procedures and preparedness[20].

5. Conclusion

Water is a very significant resource in daily walk of life. The availability of water supply and the unbalanced distribution of water and other resources in time are critical problems in several countries. It is observed that the two thirds of world’s population will be distressed by water scarcity in near future. In order to safeguard the financial and managerial capacity of water providers in the forthcoming decades accomplish flexible water supply for domestic, agricultural, and industrial uses and adequate systems for wastewater and flood control under climate uncertainty and increased volatility. The water distribution and management strategies, policies will be maintained strictly in worldwide to balance the water availability and distribution. Enforce the procedures for allocation of surface and ground water for different purposes, water regulations and rights which provide for equity in water distribution and allocation, legal instruments and procedures for implementing water conservation and efficient management practices. Find out the ways in which GIS can facilitate more effective and/or more efficient water resource management. Make use of GIS-based methods to resolve specific water resource challenges and problems. Give training to the next generation of water resource scientists, engineers, and policy analysts to sustain the continued evolution and appropriate use of GIS-based water resource applications.

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