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DEPARTMENT OF COMPUTER ENGINEERING

A BOOK REPORT

ON

" WATER - THE GOLD OF 21ST CENTURY "

SUBMITTED IN FULFILLMENT OF THE

REQUIREMENT OF

UNIVERSITY OF MUMBAI FOR
BUSINESS COMMUNICATION AND ETHICS

2020-2021











WATER

GOLD OF 21ST CENTURY









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Department of Computer Engineering

A Book Report On

" WATER - the Gold of 21st Century "

Submitted By,
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In Fulfilment Of The Requirement Of
University Of Mumbai For
Business Communication and Ethics

Under the Guidance Of
Prof. Tazeen Siddique

2020 -2021

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Who are bonafide students of M. H. Saboo Siddik College Of Engineering, Mumbai.
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This work has not been presented elsewhere for the award of any degree prior to this.

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Preface

"If I were called in
To construct a religion
I should make use of Water"

Water is the most every day of substances. It pours from our taps and falls from the sky. We drink it, wash with it, and couldn't live without it. Yet, on closer examination it is also a very strange substance (it is one of only a very small number of molecules which expand when cooled). Look closer again and water reveals itself as a key to a scientific story on the biggest of canvases.

Water is crucial to our survival- life depends on it- but it was also fundamental in the origins of life on Earth. The millions of gallons of water which make up our rivers, lakes and oceans, originated in outer space. How it arrived here and how those molecules, if water were formed, is a story which takes us back to the beginning of the universe. Indeed, we know more about the depths of space than we do about the furthest reaches of the oceans.

Water has also shaped the world we live in, whether it is by gently carving the Grand Canyon over millennia, or in shaping how civilizations were built; we have settled our cities along rivers and coasts. Scientific studies show how we feel calmer and more relaxed when next to water. We holiday by the seas and lakes. Yet one day soon wars may be fought over access to water.

Water -the gold of the 21st century, this book will change the way you look at water. After reading it you will be able to hold a glass of water up to the light and see within it a strange molecule that connects you to the origins of life, the birth (and the death) of the universe, and to water.

Acknowledgement

In the accomplishment of this project successfully, many people have best owned upon us their blessings and the heart pledged support, this time I am utilizing to thank all the people who have been concerned with project.

Primarily, I would like to thank my group members for being able to complete this project with success. Then I on behalf of my group member, I would like to thank **Professor Tazeen Siddique** whose valuable guidance has been the ones that helped us patch this project, also I will like to thank my **HOD Dr. Zainab Pirani** and again **Professor Tazeen Siddique** who gave us a golden opportunity to do this wonderful project on topic- **"WATER – GOLD OF THE 21ST CENTURY"** and make it full proof success. Her suggestions and her instructions has served as the major contributor towards the completion towards the completion of the project.

Then I would like to thank my parents and friends who have helped me with their valuable suggestions and guidance has been helpful in various phases of the completion of the project.

Last but not the least I would like to thank my classmates who have helped me a lot.

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Abstract

Water is a precious natural resource for sustaining life and environment. Effective and sustainable management of water resources is vital for ensuring sustainable development. Because of the vital importance of water for human and animal life, for maintaining ecological balance and for economic and developmental activities of all kinds, and considering its increasing scarcity, the planning and management of water resource and its optimal, economical and equitable use has become a matter of the utmost urgency.

The increasing demands placed on the global water supply threaten biodiversity and the supply of water for food production and other vital human needs. Water shortages already exist in many regions, with more than one billion people without adequate drinking water. Also, 90% of the infectious diseases in developing countries are transmitted from polluted water. Management of water resources in India is of paramount importance to sustain one billion-plus population.

Water management is a composite area with linkage to various sectors of Indian economy including the agricultural, industrial, domestic and household, power, environment, fisheries and transportation sector.

The water resources management practices should be based on increasing the water supply and managing the water demand under the stressed water availability conditions. For maintaining the quality of freshwater, water quality management strategies are required to be evolved and implemented. Decision support systems are required to be developed for the planning and management of the water resources project. There is an interplay of various factors that govern access and utilization of water resources and in light of the increasing water demand, it becomes important to look for holistic and people-centred approaches for water management.

Clearly, drinking water is too fundamental and serious an issue to be left to one institution alone. It needs the combined initiative and action of all if at all we are serious in socio-economic development. Safe drinking water can be assured, provided we set our mind to address it. The present article deals with the review of various options for sustainable water resource management in India. Water scarcity is a rapidly growing concern around the globe, but little is known about how it has developed over time.

As we approach the next century, more than a quarter of the world's population, or a third of the population in developing countries live in regions that will experience severe water scarcity.

Water scarcity is analysed using the fundamental concepts of and which indicate difficulties in satisfying the needs of a population and overuse of resources respectively The nature and geographic focus of growing water scarcity are identified. In the semi-arid regions of Asia and the Middle East, which include some of the major breadbaskets of the world, the groundwater table is falling at an alarming rate. There is an urgent need to focus the attention of both professionals and policymakers on the problems of groundwater depletion and pollution is seen as a major threat to food security in the coming century. Sustainability of water use in agriculture is a line of research that has gained in importance worldwide.

Introduction

"WATER - The Gold of 21st Century" .There's a dramatic reason why it's called that. Water is a precious commodity that's becoming increasingly scarce; drought is one of the main problems afflicting humanity and endangering our survival. We're the lucky ones, we take water so much for granted that we waste litres and litres every day, we spend thousands of euros a year on drinking it from plastic bottles and then we leave the faucet running while we do other things. Surely not something we actually do but an illustration to help us understand the importance of small daily gestures.

Global water use has increased by a factor of six over the past 100 years and continues to grow steadily at a rate of about 1% per year as a result of increasing population, economic development and shifting consumption patterns. Combined with a more erratic and uncertain supply, climate change aggravates the situation of currently water-stressed regions, and generates water stress in regions where water resources are still abundant today.

Climate and weather patterns are changing natural water patterns. And industrial pollution is making water a scarce commodity. For thousands of years, civilizations have waged war on each other for control over bodies of water. More recently, municipalities have enforced strict water usage limitations on residents and businesses in times of drought. Meanwhile, a lack of rainfall has contributed to uncontrollable wildfires in the western United States, and water continues to be a major source of contention in places like the Middle East.

These are just a few examples of a fact of which most people are aware — water is a big deal. In the 21st century it's a bigger deal than ever: an expanding global population means even less fresh water per capita.

When it comes to climate change, there has been a long-held belief that mitigation is mainly about energy, and that adaptation is mainly about water. Such a perspective greatly over-simplifies things. Of course, the water sector needs to adapt to climate change – from countering the effects of floods to addressing increasing water stress for agriculture and industry. But water management can also play a very important role in

climate change mitigation. Specific water management interventions such as wetland protection, conservation agriculture and other nature-based solutions can help to sequester carbon in biomass and soils, while improved wastewater treatment can help reduce greenhouse gas emissions while supplying biogas as a source of renewable energy.

No matter how you cut it, population growth means more stress on the ecosystems that support civilization. Agriculture consumes a massive amount of water, and often inefficiently. With over half the world's wetlands already gone, and climate change playing an increasingly important role in freshwater availability, water scarcity is considered one of the biggest challenges of the century. It's slated to directly affect two-thirds of the world's population during the next decade alone.

This top-down view doesn't look very promising. On the other hand, if there is a way out of the imminent freshwater crisis, it almost certainly lies with technology — and luckily for every human being on the planet, innovation is already coming to the rescue.

This report addresses the critical linkages between water contexts of sustainable development. It also serves as a guide for concrete actions to address these challenges. It outlines actions, supported by examples from across the world. Critically, measures to improve the efficiency of water use in agriculture - while at the same time ensuring water access for vulnerable groups such as smallholder farmers etc.

The Report concludes that reducing both the impacts and drivers of changing surroundings will require substantial changes in the way we use and reuse the Earth's limited water resources. The experience and expertise needed to achieve this goal are brought together in the Report.

History

Water is life – and life on earth is linked to water. Our existence is dependent on water, or the lack of it, in many ways, and one could say that our whole civilization is built on the use of water.

More than 2,000 years ago Pausanias [1], the Greek geographer who travelled throughout the ancient world, declared that no city had the right to call itself a city unless it had at its center an ornamental fountain. Fountains illustrated then – as they have done throughout the ages – an ideological and cultural notion of the triumph of civilization over nature: water, the giver and taker of life, in the fountain appears at the control of human beings. The fountain also symbolizes a more mundane [2] and direct material fact – no city and no country has been able to exist or develop without subjugating water in one form or another to the demands of human society. This universal natural and social fact alone makes water history relevant to world history. The struggle to control water is a struggle without end.

To bring water to an urban population is a ceaseless endeavor that has been, and continues to be, fought in cities worldwide, from Mohenjo-Daro, a center of the Indus Valley civilization that flourished around 2,500 BC, crisscrossed by streets with covered drains, to the enormous pipe-systems necessary to serve the water needs of the present mega-cities.

The earliest known permanent settlement, which can be classified as urban, is Jericho from 8000–7000 B.C., located near springs and other bodies of water. In Egypt there are traces of wells, and in Mesopotamia of stone rainwater channels, from 3000 B.C... From the early Bronze Age city of Mohenjo-Daro, located in modern Pakistan, archaeologists have found hundreds of ancient wells, water pipes and toilets. The first evidence of the purposeful construction of the water supply, bathrooms, toilets and drainage in Europe comes from Bronze Age Minoan (and Mycenaean) Crete in the second millennium B.C.

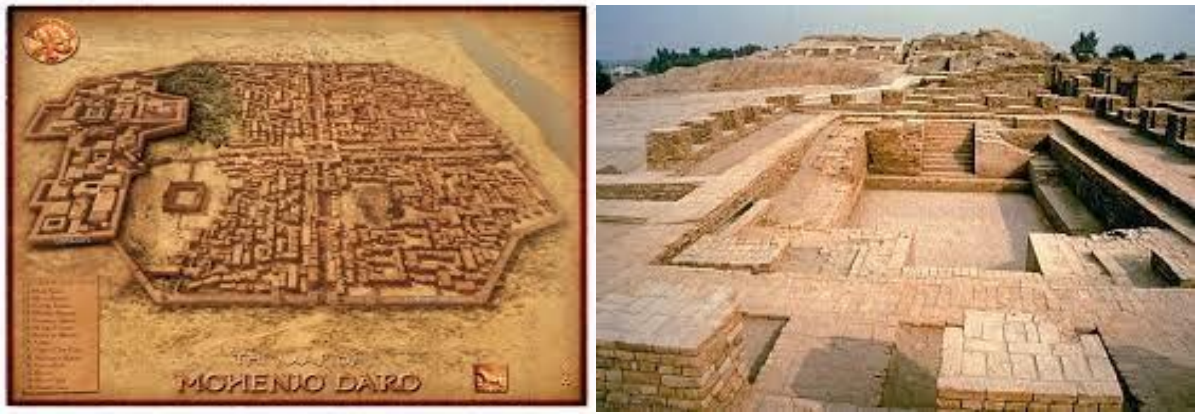


Fig2.1(a). Mohenjo-Daro water system & Great bath in Mohenjo-Daro

Mankind's continuing relation to water explains why Sextus Julius Frontinus (AD 40–103), who was responsible for providing ancient Rome with the fresh water it needed, can be so easily understood today, when he complained, almost 2,000 years ago, at the fame afforded to the beautiful but useless Egyptian pyramids and Greek temples, while the absolutely essential water structures of Rome were disregarded. The Pantheon and the Coliseum may have brought Rome fame but the city owed its existence to the water running beneath it. Impressive aqueducts, both above ground and underground, transported water from outside the city to its very center, and made Rome possible. The multiple uses and the steadily increasing demand for water – water for transport, for electricity and energy, for chemistry and industrial production, for leisure and ornament, for health and cleaning – make water planning an aspect of development itself**.**

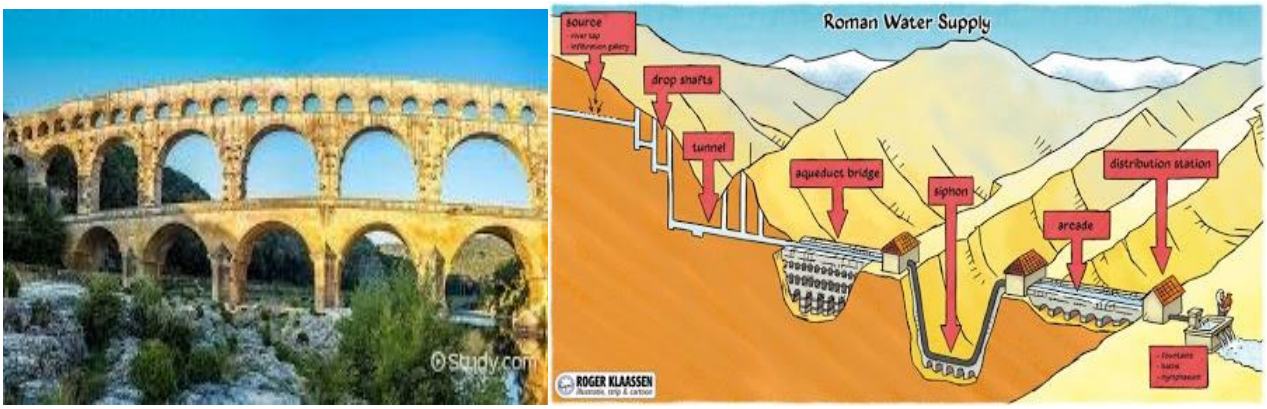


Fig2.1(b). Aqueducts in Rome

For thousands of years, water was considered to be a fixed element of the globe, like air. In a basically rural world, water had virtually no connection with commerce since water from springs, rivers and river branches, wells and cisterns was available at little or no cost, depending on whether or not it was supplied by slave labour.

Water was a gift from the gods

There was a general aversion to interfering with nature's cycle, the ancient Romans and urban-dwellers in particular being no exception. Mills turned day and night (Figure 1). The water supply goal was especially to provide water for cities: fountains and gigantic hot baths. Special amphitheatres [3], known as naumachia, were constructed for water sports (Figure 2). The historian Pierre Grimal calls Rome the 'CITY OF WATER' -by the end of the imperial epoch, eleven major aqueducts were transporting water to 'the city. Nevertheless, by around 144 BC, the inverted siphon technique had been mastered with the use of pipes made from lead, a metal in abundant supply in the area that later became Spain16. According to bibliographical sources, under the reign of Trajan (98- 117 AD) the daily amount of water supplied to each Roman was approximately 1,000 liters. This estimate does not, however allow for leaks and enormous water losses from the ancient system. After the fall of Rome and then Constantinople, the Arabs and the Persians pursued and refined the tradition of fountains, water sports and hot baths. "The fashion then reappeared in Europe during the baroque period [4] (Figure 3). But it was not until the eighteenth and, even more so, the nineteenth century, with the rediscovery of the body and the health cult, that the popularity of spas reached its height". Marienbad, Vichy, Baden, Spa, Bath and Montecatini flourished. In France, the Empress Eugénie set the style by going to spas. In the novel 'Mont-Oriol' [5], written in 1887, Guy de Maupassant provided a realistic description of the opening of a rural spa.

Water was a gift from the gods like the fountain tree or holy tree of Canary Islands which until the year 1610, transformed mist into water for the early inhabitants of the island of Hierro (Figure 4). The Incas believed that Lake Titicaca was the center of the original world (Figure 5). In Aztec Mexico, the peasants worshipped Tláloc, the god of rain, symbolized by a frog or a toad. In fact, water was the essential factor in the stability and organization of the pre-Columbian peoples of Mexico. Around 1730 in the New World, Bartolomé

Arzáns, chronicler of the life of Potosi, the largest city in the Americas of the seventeenth century: still considered rain a divine phenomenon...
In ancient Rome, after an engraving of panvinco (sixteenth century) in Rome, teams of gladiators played out in miniature the major naval battles such as that between Greeks and Persians at Salamine. In the city of Rome the most celebrated venue for such nautical games was the presently occupied by the place Navona the lowest lying point in the city Which is close to the Tiber River.
The form of the present day Place Navona closely follows that of the ancient circus.

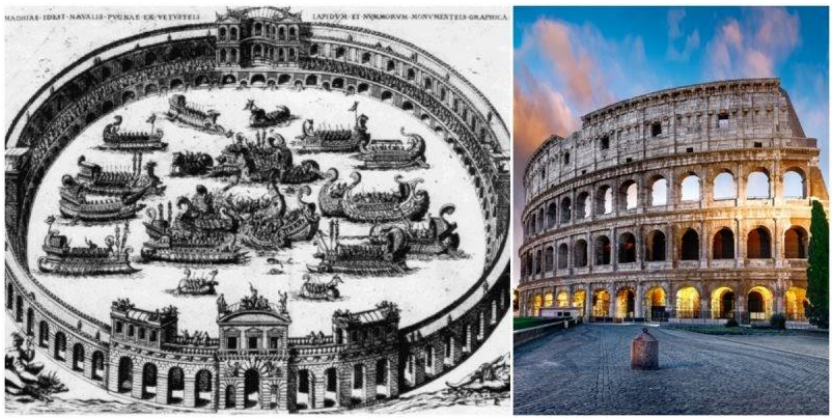


Fig.2.2. Nautical Circus

The figure above, which has graced the place Navona in Rome since 1651. Four figures represent the major rivers of the world known in the seventeenth century: Nile. Río de la Plata, Danube and Ganges. The statue of the Nile, in the back part (left) of the photo, has raised an arm and covered its face, since at the time the source of the major African river was not known.

Fig.2.3. Bernini's Fountain of the Four Rivers

The ancient shepherds venerated this tree until it was blown down by the wind in the seventeenth century. In an arid environment, the sacred tree received a large quantity of droplets of mist. Producing a veritable fountain at its feet. One legend had it that a young shepherdess enamoured of a Castilian soldier (the kingdom which conquered the Canary Island in the fifteenth century) paid with her life for telling him the secret of the tree. See Gioda

Fig.2.4. The fountain tree of the Canaries

cradle of the Inca empire(fifteenth to sixteenth centuries) .situated AT 3,800 m altitude and covering 8,300 km2,it was the most sacred site of the Incas :the origin of the universe was none other than Lake Titicaca. The Inca myth concerning the origin of the world alluded to the flood sent by the creator Viracocha, to punish the early man for his sins and pride. After this gigantic flood, the first land area emerged on Lake Titicaca. From an Island on the lake, the first Inca emperor Manco Capac left to found the capital Cuzco After Wachtel(1990).

Fig.2.5. Lake Titicaca

Control of water is, and always has been, based on cultural constructions of water, whilst at the same time it carries in itself values or ideologies. Dams, the classical symbols of water control, and as such also the symbols for different types of political capital and moral authority, have ideological connotations and signify particular development policies. However, large-scale water projects have also ended up as symbols of failure, in ancient times as well as in ours. It is important to study both the unnatural and natural history of water disasters, since not only will floods vary and have different causes and consequences but fundamental concepts like flood, drought, water shortage and water conflicts have different meanings and connotations in different physical and social settings.

The Chinese have an age-old saying that nicely sums up the long but unending story of man-water relations: 'Man always aspires higher but water flows to the lowest point.' This aims to encourage research into water history. This history is not only rich in itself but also makes it possible to throw new light on a number of important historical questions, from the first river civilizations to the present day, whether one investigates this complex and fascinating history as unfolded in the slow rhythm of la longue durée or in the abrupt changes caused by catastrophic events. As the research field develops it will be a source of wisdom for the understanding of historical developments at large. Faced with the future water situation, there is, especially, one important lesson that can be learnt from this: there are no quick fixes to the water problem.

Drinking Water

Water covers more than two-thirds of the earth's surface, but mostly salty and undrinkable. The available freshwater resource is only 2.7% of the available water on earth but only 1% of the available freshwater (in lakes, rivers and groundwater) is accessible. Most of the available freshwater resources are inaccessible because they are in the hidden part of the hydrologic cycles (deep aquifers) and in glaciers (frozen in the polar ice), which means safe drinkable water on earth has very small proportion (~3%) in the freshwater resources. Freshwater can also be obtained from the seawater by desalination process. In some countries, sufficient freshwater is not available (physical scarcity). In some countries, abundant freshwater is available, but it is expensive to use (economic scarcity).

A Karachi Water and Sewerage Board (KWSB) engineer speaking on conditions of anonymity, revealed that the local distribution system of the water board has failed and has been functioning on rotten lines for a while.

"The biggest reason for the crisis is that the city is not being supplied with water in accordance to its massive population. The population of Karachi has reached 25 million according to which the city needs over 1,200 million gallons a day (MGD) of water, yet the combined supply from the Indus River and Hub Dam is only 550 MGD. In addition to that, water is also lost due to leakage and theft from illegal connections, further reducing the supply to just 420 MGD," the engineer explained.

As per reports available with The Express Tribune, water supply in different blocks of Gulistan-e-Jauhar, Gulshan-e-Iqbal, North Nazimabad and Gulberg has improved during the lockdown, while some improvements have also been made in Baldia Town and Orangi Town. In addition to that, water pressure has also improved in other areas, but those living at the tail end of the supply lines continue to suffer.

Similarly, areas with faulty supply lines or those where the valve operation system is non-existent, such as some blocks of Gulshan-e-Iqbal, North Karachi and several sectors of New Karachi, are also suffering from a growing water crisis.

Water is connected to every form of life on earth and is the basic human need. At a basic level, everyone needs access to safe water in adequate quantities for drinking, cooking, personal hygiene and sanitation facilities that do not compromise health or dignity. Therefore, access to safe and dependable (clean and fresh) water is the fundamental/basic right of humans.

Globally, it is estimated that 89% of people have access to water suitable for drinking. According to UNDP[6] report, one out of six people do not have access to clean water, that is, about 1.1 billion people lack access to safe drinking water. The number of people without safe drinking water is more than the number reported by UNDP[6] .This is due to the fact that most of the water supply facilities initiated during the MDGs in developing countries are not functioning properly.

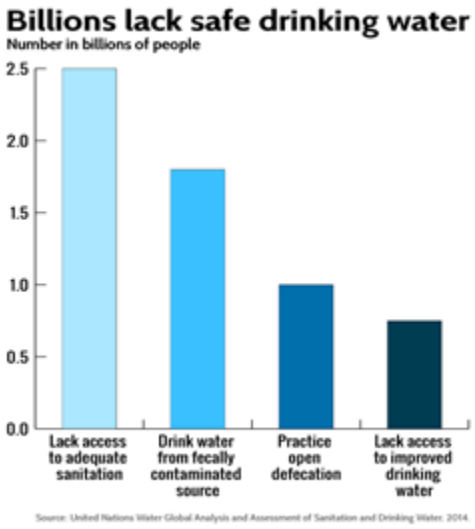


Fig.3.1. Stats showing lack of Drinking water in various ways

Research has shown that the majority of people without access to safe water are from developing nations .Many people in the developing country especially Africa, still depend on unsafe water sources for daily water need and affected by chronic water problems and water-borne diseases. Millions of people die due to water-related diseases like cholera [22], diarrhea, malaria, dengue fever, and so on. Globally, water-borne diseases kill more than 25,000 people per day and about 5000 children die per day due to water-related diseases (mainly diarrhea), most of them can be easily prevented. Diarrhea and related diseases kill about 1.8 million children every year. It is also estimated that about 1.8 billion

people drink water contaminated with Escherichia coli [7] (indicator of fecal contamination).

Climate change, population growth, agricultural demands, and mismanagement of water resources all contribute to the growing global water crisis. Due to water scarcity, some 24 to 700 million people will be displaced from arid and semi-arid regions of the world. A safe water supply is the backbone of a healthy economy, yet is woefully under prioritized, globally.

Less than 50% of the population in India has access to safely managed drinking water. Chemical contamination of water, mainly through fluoride and arsenic, is present in 1.96 million dwellings.

Moreover, two-thirds of India's 718 districts are affected by extreme water depletion, and the current lack of planning for water safety and security is a major concern. One of the challenges is the fast rate of groundwater depletion in India, which is known as the world's highest user of this source due to the proliferation of drilling over the past few decades. Groundwater from over 30 million access points supplies 85 per cent of drinking water in rural areas and 48 per cent of water requirements in urban areas.

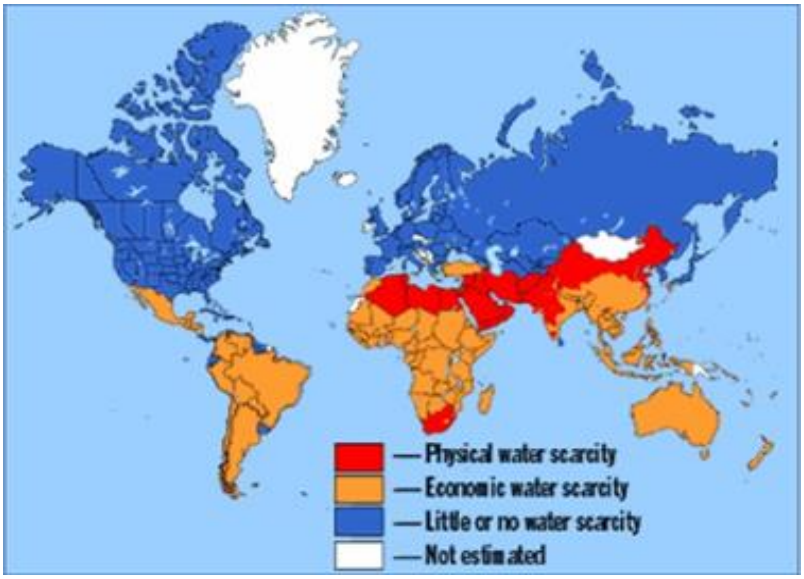


Fig.3.2. Water scarcity rate using heat maps

1. By 2025, half of the World's Population will be living in Water-Stressed Areas
2. The World's Population will raise to 9.7 Billion by 2050, Leaving Much in Water-Stressed Conditions
3. Three in Ten People on Earth Currently do not Have Access to Safe and Clean Water
4. 1.6 Million People Die Every Year from Waterborne Diseases
5. In the US, 2.1 Trillion Gallons of Clean Water is Lost Each Year Due to Poor Infrastructure
6. Women Walk an Average Distance of 4 Miles Every Day Just to Fetch Water that is Likely Contaminated
7. Meeting the UN's Sustainable Development Goals for the Water Crisis will Cost $114 Billion per year

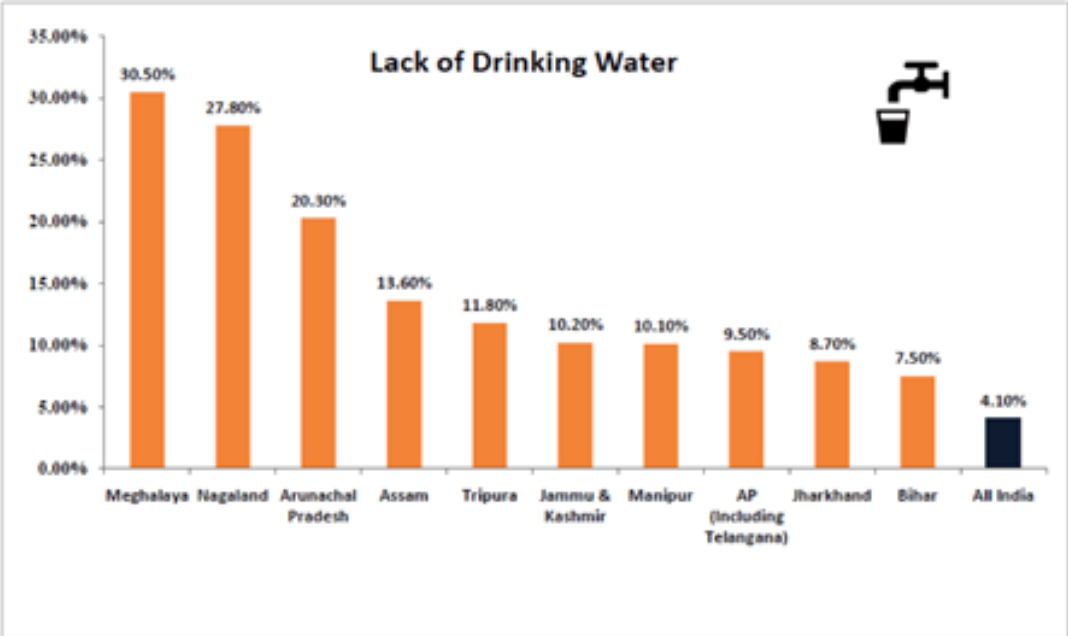


Fig.3.3. Lack of Drinking Water in INDIA

Agriculture and Food Security

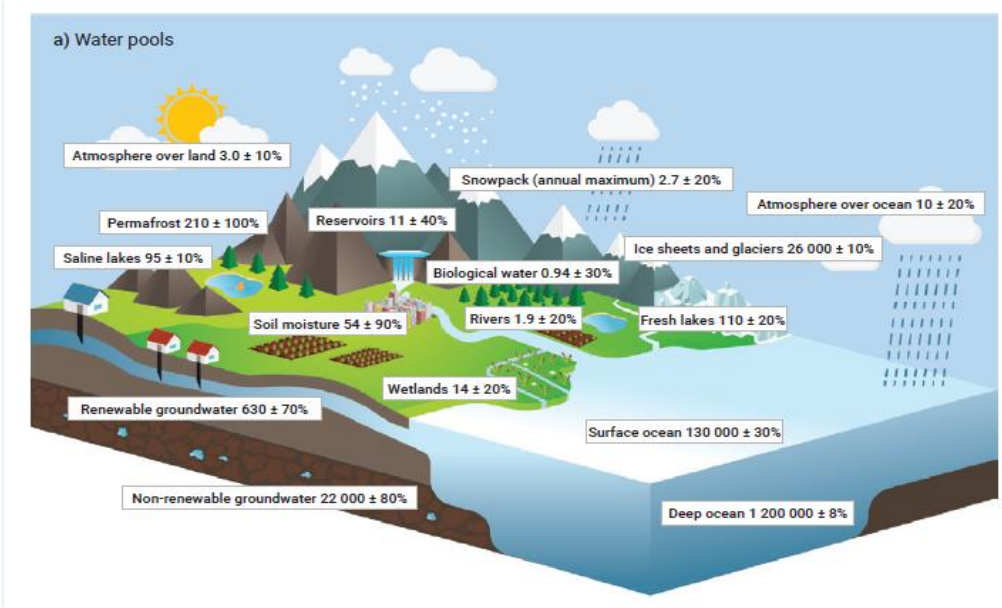


Fig.4.1. Water pools

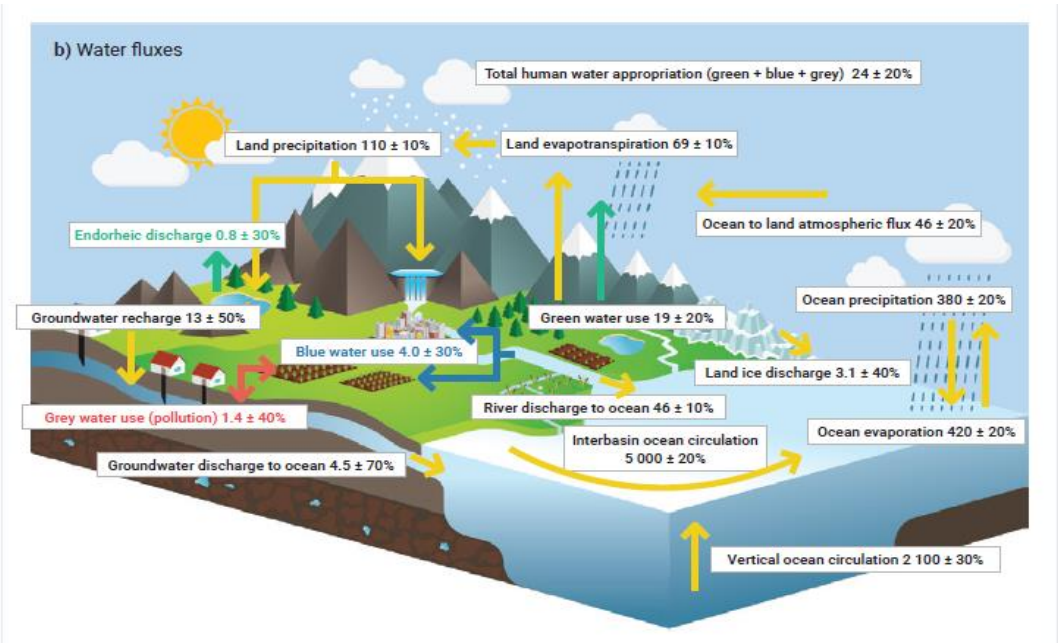


Fig.4.2. Water Fluxes

Climate is a resource for agriculture. Human systems of crop production, livestock husbandry, freshwater aquaculture and near-shore fisheries have adapted to distributions

of temperature and precipitation over millennia [8]. In this sense, agriculture's exposure to risks from day-to-day variations in weather and longer-term patterns of seasonal and inter-annual shifts in temperature and precipitation are well recognized, not least by farmers and commodity traders. It is the increasing rate and magnitude of these shifts and the prospects of further changes within the next 50–100 years that are cause for concern, particularly for the rural poor who have no alternative to agriculture for maintaining their livelihoods. Despite the fact that the global food system has generally managed to meet growing demand for calories, 821 million people (or 11% of the global population) remain severely undernourished, and this number is rising in absolute terms.

While the impact of abrupt weather-related shocks is generally acknowledged, chronic poverty, economic dislocation and market remoteness have made rural producers vulnerable to long term climatic shifts and water scarcity. This disruption of food production patterns is not always substituted by alternative (imported) supply at affordable prices, and the systems of food aid distribution are not always able to satisfy demand for basic calories and nutritional supplements. It is therefore expected that increasing climate variability and weather extremes will threaten food security, including people's access to healthy and nutritious diets. The challenge to respond to the policy drives to 'decarbonize' agriculture through climate mitigation measures that reduce greenhouse gas (GHG) [9] emissions and enhance water availability.

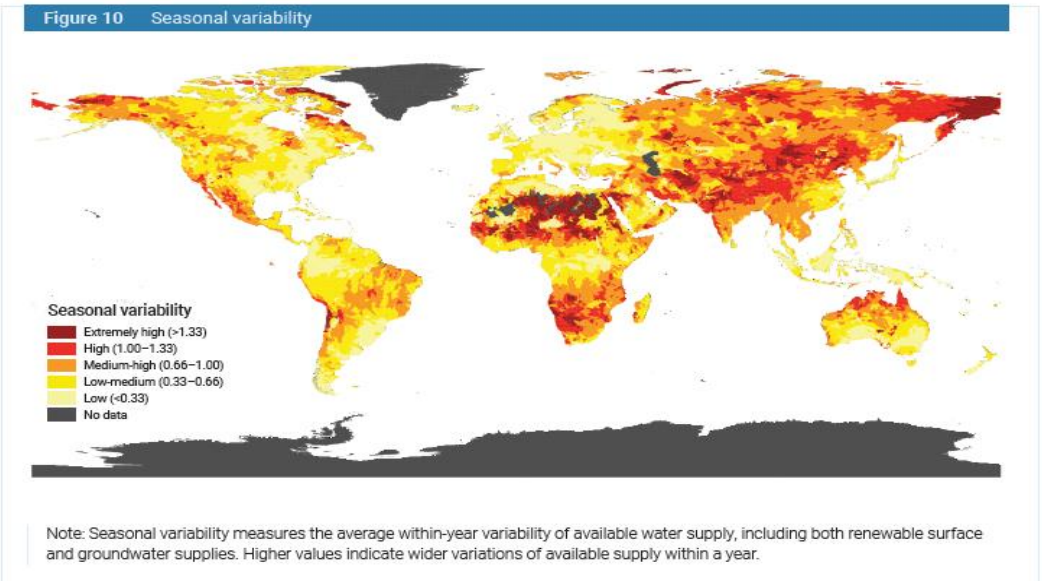


Fig.4.3. Heat Map showing availability of water supplies (Seasonal Variability)

The role of agricultural water management is central to agriculture's adaptive response, allowing flexible crop production cycles in cash crops and some staple foods, notably rice. Soil moisture management in rain fed soils is also crucial in maintaining soil structure and promoting root growth and plant establishment to sequester carbon. The global scale of these challenges is not trivial. Agriculture, forestry and other land use, termed the AFOLU 'sector' by the Intergovernmental Panel on Climate Change (IPCC), is estimated to account for 23% of total anthropogenic GHG emissions for the period 2007–2016. Reported agricultural statistics indicate that by 2016, 37% (48.7 million km^2) of the total land area (130.1 million km^2) was under some form of agricultural management. This includes cultivated land, permanent crops, pasture and managed wetlands. The rate at which land use conversion is occurring and the trend in higher-intensity agricultural inputs on land (inorganic fertilizer in particular) set a high bar for the adoption of sustainable adaptation measures and effective mitigation measures, which are crucial if the sector is to make a positive contribution to reaching climate targets.

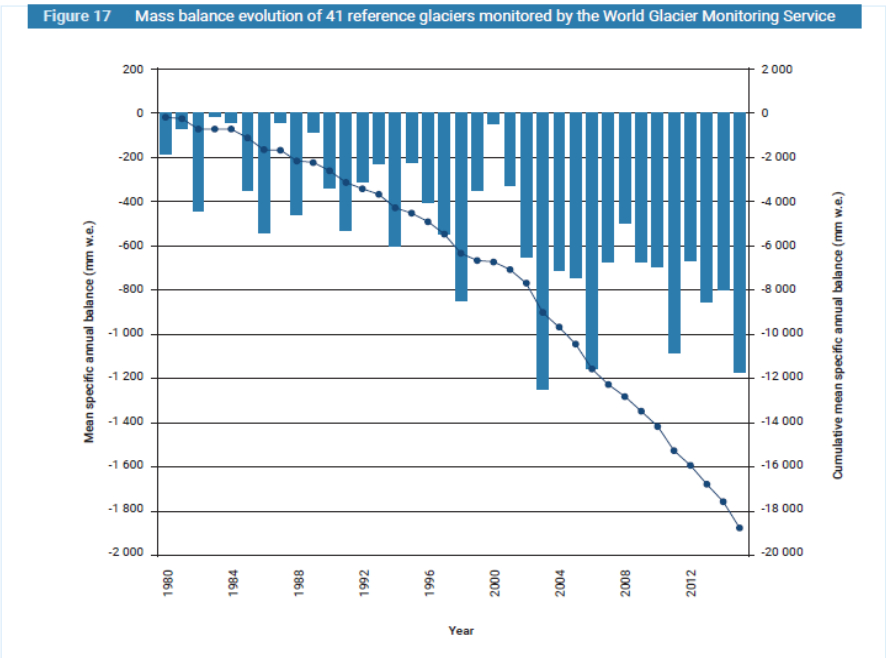


Fig.4.4. A Survey by Water Glacier Monitoring Service

The detrimental environmental outcomes from the current food production system have been raised, particularly with respect to emissions, biodiversity loss and natural resource depletion, as part of the so-called 'planetary boundaries'. Given these established land and water limits, global initiatives in the sustainable intensification of agriculture,

maintaining levels of growth in agricultural production while reducing the growth in inputs and emission levels, are already in evidence under the umbrella term 'Climate-Smart Agriculture' (CSA). CSA is a recognized suite of well-informed approaches to land and water management, soil conservation and agronomic practice that anticipate climatic variability, can sequester carbon and reduce GHG emissions.

In many cases, these are well established conservation agriculture practices that can be packaged to retain soil structure, organic matter and moisture under drier conditions, but they also include agronomic techniques (including irrigation and drainage) to adjust or extend cropping calendars to adapt to seasonal and inter-annual climate shifts. The flexibility offered by irrigation and drainage makes water management an attractive adaptive response with excellent carbon sequestration for both temporary and permanent crops. However, this flexibility can come at a cost in terms of local water resource depletion and water quality deterioration. These include landscape restoration as part of agricultural practice. There are still 2.1 billion poor people and 767 million people living in extreme poverty, 80% of whom live in rural areas, with the global distribution of poverty highly skewed (95% of rural poor) toward Sub-Saharan Africa and South/Southeast Asia. The Food and Agriculture Organization of the United Nations estimates that some 475 million smallholder farms (up to 2 hectares in size) produce subsistence and cash crops on only 12% of global farmland.

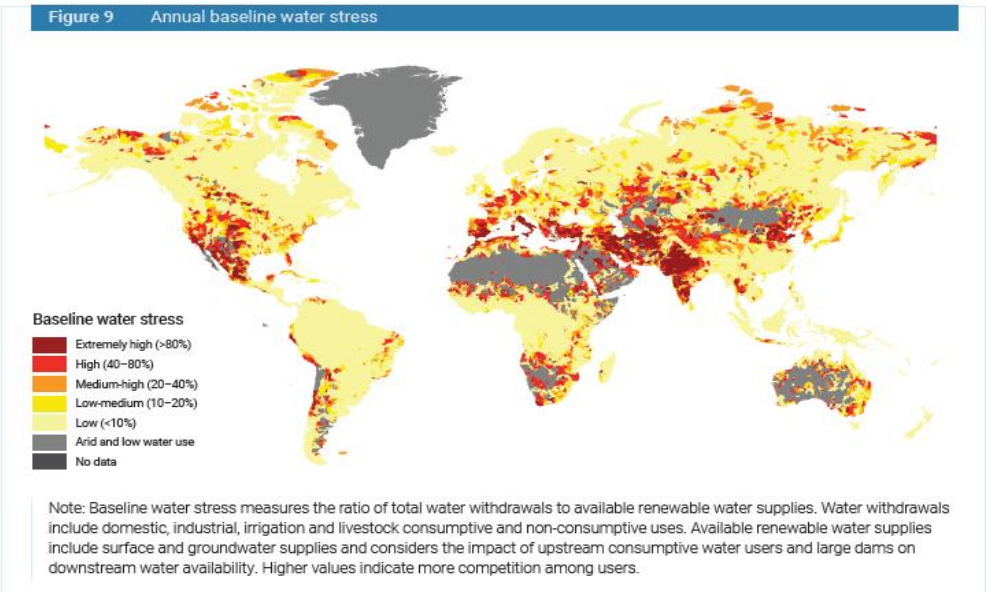


Fig.4.5. Heat Maps for annual baseline water stress

Climate impacts and the agriculture baseline: sorting out shocks from trends. The immediate effect of global warming in accelerating the hydrological cycle and raising the evaporative power of the atmosphere is expected to result in increased demand for water resources, as the agriculture sector strives to keep pace with growth in demand for production. The range of climate impacts on agriculture and the implications for agricultural water management have been set out in a comprehensive typology indicating the relative vulnerability and adaptability across the major agricultural system, including the risk-sensitive areas highlighted in the Prologue. Water management response options indicate the range of adaptive approaches applicable to each case.

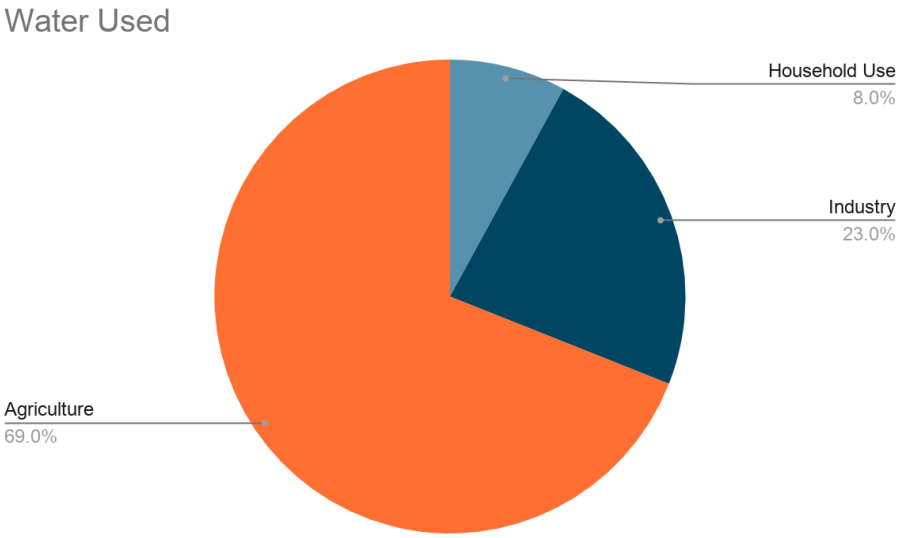


Fig.4.6. Pie-Chart for rate of Water used in Different sectors

Agricultural water demand

Irrigation land, which is responsible for 69% of global water withdrawals (AQUASTAT, 2014), is where the impact of elevated temperatures and aridity will be felt most. Although the current extent of this type of land (about 3, 3 million km2) accounts for only 2.5% of the total land area, it does represent 20% of cultivated land and generates some 40% of the global agricultural output. It is also where the process of water withdrawal, diversion, application and drainage can produce a set of long-term environmental externalities, notably aquifer depletion, soil salinization and pollution from runoff and drainage.

Statistical estimates of the area serviced by groundwater are in the order of 1,250,000 km2 (Siebert et al., 2013), most of which is powered by non-renewable energy. This is in addition to the proliferation of energized pumping for distribution and drainage on surface irrigation schemes.

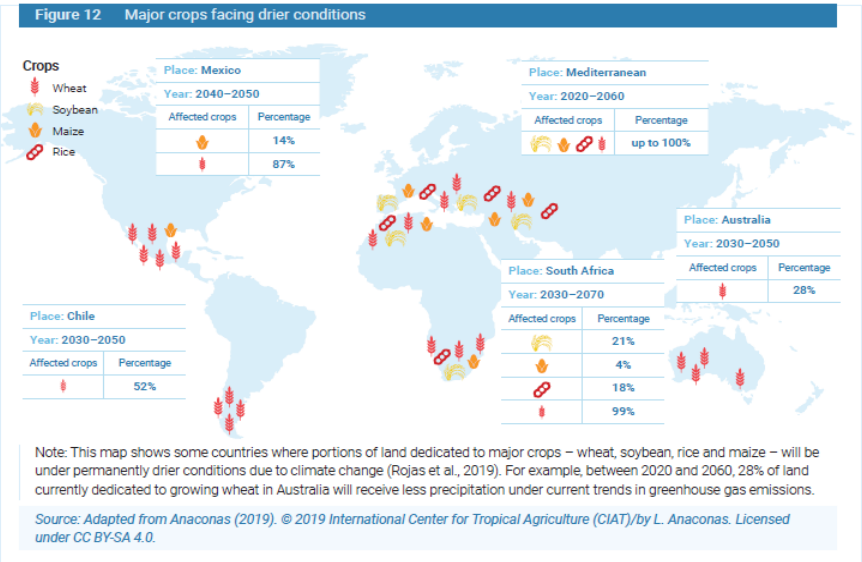


Fig.4.7. Survey for crops facing drier conditions

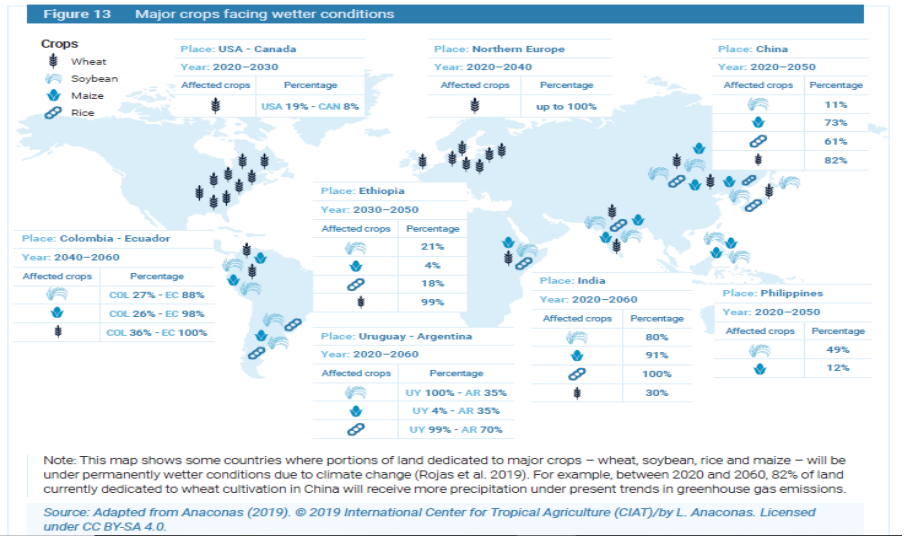


Fig.4.8. Survey for crops facing wetter conditions

The use of water by agriculture dominates global water use, but competition from other sectors is slowing the growth of freshwater allocations to the agriculture sector. The global baseline from aggregate reported statistics for the year 2010 estimated agricultural withdrawals at 2,769 km^3/year, up from an estimated 2,300 km^3/year in 1990. Expansion and intensification of crop production on irrigated land is the most significant driver of agricultural water demand, while locally, agro-forestry and water storage for livestock and aquaculture have also impacted basin and catchment water accounts.

The role of groundwater in agriculture and rural development is often underestimated and economic competition for high-quality groundwater from other sectors, notably industry and municipal supplies, is impacting adjacent rural areas, where millions of smallholders rely on access to shallow groundwater circulation to buffer for dry-season recessions and extended periods of drought. The extent of shallow and deep groundwater extraction structures, together with small dam structures for irrigation, aquaculture and stock watering purposes, is not systematically recorded at subnational levels, making the estimate of areas equipped for irrigation and water withdrawals from areas that are actually irrigated subject to a degree of uncertainty.

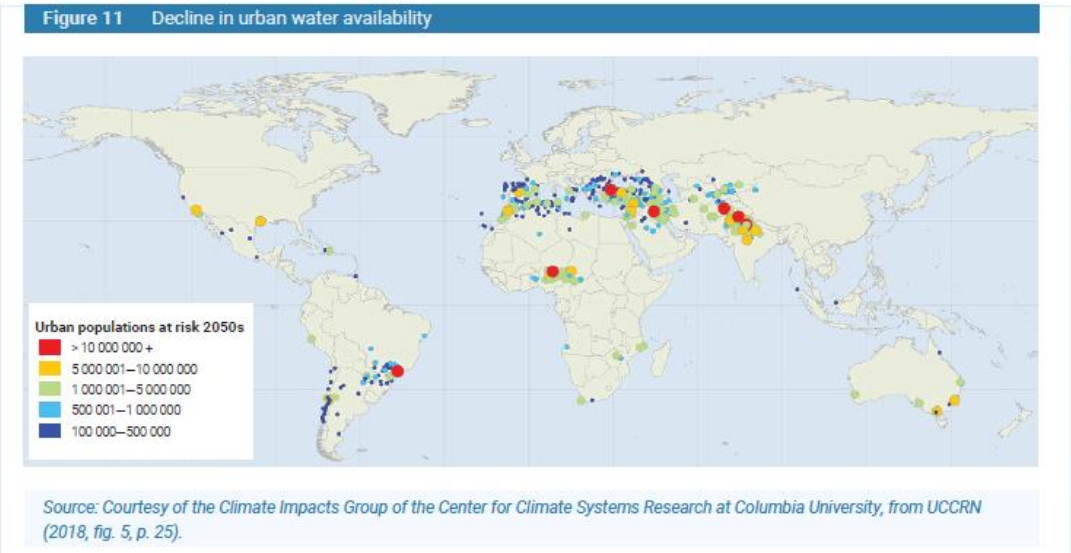


Fig.4.9. Scatter plot showing risk of water unavailability in urban population

The water footprint of livestock is not just limited to the consumptive evapotranspiration on grazing land, but now involves extensive systems of water supply for watering and cooling of live animals as well as irrigation water for production of fodder and imported

protein concentrate (notably soya) or grain (poultry feed). The growth projections in meat production to 2030 are remarkable – a 77% increase in beef, pork, poultry and sheep is projected for developing countries and a 23% increase from 2015–2017 levels for developed countries. Non-ruminants (pigs and poultry) are expected to see the highest growth rates. Given this expected growth, the extent of grazing land and its sensitivity to drought are important, since feed substitutes (soya and cereals) are predominantly rain fed and are likely to be impacted, unless production is buffered by irrigation. The feedlot model of zero grazing with irrigated legumes and grasses is employed both in in the Middle East and the United States of America (USA), but also gaining broader hold in semi-arid and temperate climates where pasture would otherwise be damaged under dry and waterlogged conditions. As consumption of animal protein and dairy products drives a growing livestock population, the production of feed/forage/crop residues (in both rain fed and irrigated systems) plus direct consumption of surface and groundwater for livestock watering and cooling is resulting in a continued growth of water withdrawals by the animal husbandry sector.

As agricultural productivity has increased, crop selection and cropping calendars have become finely tuned to relatively stable meteorological conditions. Where high-value crop production is limited by temperature and aridity, precision production is taken 'indoors' to minimize the effect of climatic variability.

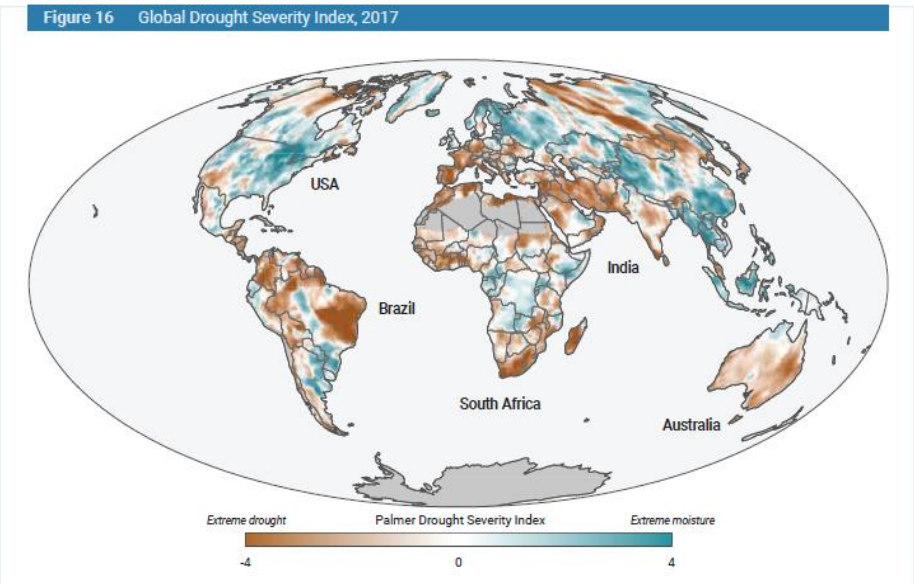


Fig.4.10. Severity Index

The role of agricultural water management in adaptation

The scope for adaptation in rain fed agriculture is determined largely by the ability of crop varieties to cope with shifts in temperature and to manage soil water deficits. Conditioning of soils to optimize soil moisture retention may include many conservation-agricultural techniques, including no-tillage and surface mulching with crop residues, thereby temporarily raising soil organic carbon. Where root crops are grown in temperate latitudes, the uptake of plastic mulching has become commonplace to protect early crops from frost and retain soil moisture by inhibiting evaporative loss to the atmosphere. Plant breeding (for drought tolerance, lodging inhibition), cropping calendar phenological [10] adjustments, nutrient targeting and specific plant protection/integrated pestmanagement are additional elements of CSA that can be applied. Certainly, for rain fed agriculture, the climate risks remain.

What are the shifts in approach that can sharpen these adaptive responses? One key area where water resource management and agro-meteorology [11] can progress is through the development of operational information products that can be disseminated at scale and linked to field-level monitoring by farmers themselves.

These include the following:

• Seasonal climate forecasts for upcoming months and even years are now widely available. Timely, actionable and reliable climate forecasts can play a crucial role in both short-term and long-term decision-making for farmers. The choice of planting dates and seasonal cropping calendars for high-yielding crop varieties offers a level of precision adjustment in planning the most weather dependent economic sector.

Near-real-time weather information is now becoming readily accessible, allowing farmers to make decisions over crop protection (damaging rainfall, frost, disease) and crop insurance cover. These types of services are being extended where mobile telephone networks extend into rural areas (Asia and Southeast Asia particularly).

• At field level, in-situ soil moisture monitoring technology is advancing with the deployment of low-cost electromagnetic sensors and in combination with high-resolution remote sensing techniques. While current technology may be only applicable to high-value precision agriculture or research projects, the deployment of real-time soil moisture monitoring to schedule irrigation is expected to come down in cost.

• The integration of operational water accounting into CSA has already helped local agriculture water budgeting to be linked to basin-level hydrology and recharge regimes. But a linkage to agronomy programmes such as integrated pest management, vermiculture [12] and rice intensification at field scale is essential if water management is to prove effective at scale. Evidence from related initiatives have indicated willingness of farmers to use improved agrometeorological services/information and be involved in the gathering of local agrometeorological data. More elaborate water accounting at irrigation system and sub-basin level, assisted by periodic satellite overpasses, is making the assessment of consumptive use and irrigation performance possible, together with the regulation of water use rights. Seasonal comparisons are already assisting national governments with adjustments of water use policies.

• Investment planning in agricultural water management is now much more likely to assess climate risks. In particular, methods of decision-making are being adopted as a means to manage risk from the bottom up by assessing the 'breaking points', in particular agricultural systems reliant upon water infrastructure.

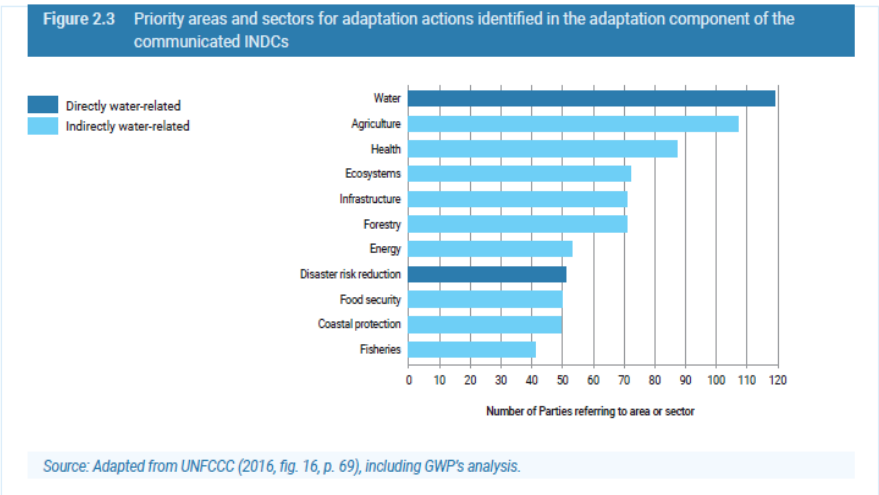


Fig.4.11. Showing water as a top priority sector for adaptation of communicated INDC's

Beyond the generation of relevant information and software/hardware adjustments in existing irrigation schemes, the use of saline water and wastewater, treated to appropriate levels, is being deployed as agronomic techniques and regulatory provisions permit. While systems of desalination are energy-intensive, lower marginal costs have triggered use in

irrigation where no freshwater alternative exists and markets for early-season horticulture products are favorable. The use of wastewater technology packages is seeing broad application (FAO, 2010) where use can comply with biosafety regulation, such as limiting use to irrigated fodder (see Chapter 5). In addition, partially treated wastewater reuse in agriculture augments supply in otherwise water-scarce areas and also delivers plant nutrients.

The functional links between soil organic matter and soil moisture provide the main area for mitigation opportunities. Conservation agriculture techniques and their regional variants are being promoted on the basis of a no-regrets approach to improve productivity as much as reduce GHG emissions (FAO, 2016b). However, the economic feasibility of such measures has to be judged carefully. Scaling of investment and application of some techniques such as no-tillage and seed drilling is not possible on all soils. For example, the initial state of soil health in the marginal/skeletal soils most affected by aridity may not be amenable to substantial improvement without high levels of nutrients and imported organic material together with periodic irrigation.

Widespread adoption of conservation agriculture is dependent upon the type of crop being grown and the availability of seed drills, harvesting mechanization and the availability of residue biomass for mulching. Real yield increases are then dependent upon the availability of improved seed varieties. Lastly, the increased labour inputs or labour substitution through farm mechanization and changes in cultivation practice have to be available and affordable. Underpinning such adoption is the role of extension agents, input providers, farmer field schools and integrated pest management practitioners. Specific agroforestry and agronomic practice targeted at carbon sequestration and emission reduction can be grouped into three main types:

• Agroforestry, which exists in multiple forms, from productive trees for fruit products, to native trees for windbreak and shade, to extensive plantations for energy feedstock. Agroforestry can have positive impacts on soil water infiltration, soil water storage, groundwater recharge, runoff and erosion control, soil nutrient cycling, and biodiversity. In pure water budget terms, the conversion of cultivated land or grassland to afforested [26] land will increase consumptive use, particularly if high growth rates are achieved. However, the climatic context must also be taken into account and in temperate zones where forests attract high levels of occult precipitation and bind upland soils, forested

catchments may be promoted/protected as a mitigation measure, since they can also sustain higher levels of base flow for urban water supply.

• 'Mild' alternate wet–dry cultivation of rice has been shown to reduce methane emissions, maintain yields and potentially reduce water demand by up to 24% when compared with continuous flooding. Other co-benefits can include reductions in pumping costs and lower arsenic concentrations in the grain. However, this has to be set against increased emissions of N2O from periodically dry soil surfaces, a reduced rate of nitrogen being forced into the root zone (as a result of submergence), loss of aquaculture and related ecosystem functions, and the reduction in weed suppression and groundwater recharge associated with continuous flooding.

• Afforestation [26] to sequester carbon may have advantages since regrowth appears to have higher sequestration potential compared with mature forest cover. Again, there are tradeoffs in river basins where upstream forest regrowth will increase water consumption in transpiration and can reduce downstream flows. There is also the additional consideration that in semi-arid zones where water tables are moderately deep, additional water inputs may be required to initiate growth. More moderate carbon sequestration through the adoption of agroforestry techniques may be viable where shade is beneficial to field or perennial crops.

Energy and Industries

Industry usage

Water is used for a range of Industrial applications, including dilution [13], steam generation, washing, and cooling of manufacturing equipment. Industrial water is also used as cooling water for energy generation in fossil fuel and nuclear power plants (hydropower generation is not included in this category), or as wastewater from certain industrial processes. The industries that produce metals, wood and paper products, chemicals, gasoline and oils, and those invaluable grabber utensils you use to get your ring (which also needed water to manufacture) out of the garbage disposal are major users of water.

The visualization shows the total annual water withdrawals which are used for industrial purposes. Globally, the United States is the largest user of industrial water, withdrawing over 300 billion m^3 per year. This is significantly greater than China, the second largest, at 140 billion m^3.

Most countries across the Americas, Europe and East Asia & Pacific regions use more one billion m^3 for industrial uses per year. Rates are typically much lower across Sub-Saharan Africa and some parts of South Asia where most use less than 500 million m^3. Globally, approximately 19% of total water withdrawals are used for industrial purposes. The visualization provides an overview of industrial water withdrawals measured as the share of total water withdrawals (which is the sum of agricultural, industrial and domestic uses).

In contrast to the global distribution for agricultural water withdrawals, industrial water tends to dominate in high-income countries (with an average of 17 percent), and is small in low-income countries on average 2 percent). Estonia uses the greater share of withdrawals for industrial applications at 96 percent. The share in Central and Eastern Europe tends to be around 70 percent; 80 percent in Canada; and approximately half in the United States. Across Sub-Saharan Africa, this tends to contribute less than 2 percent to total withdrawals.

Industrial withdrawals were an estimated 14,800 Mgal/d in 2015, about 5 percent of total withdrawals for all categories of use. Surface water was the source for 82 percent of total industrial withdrawals.

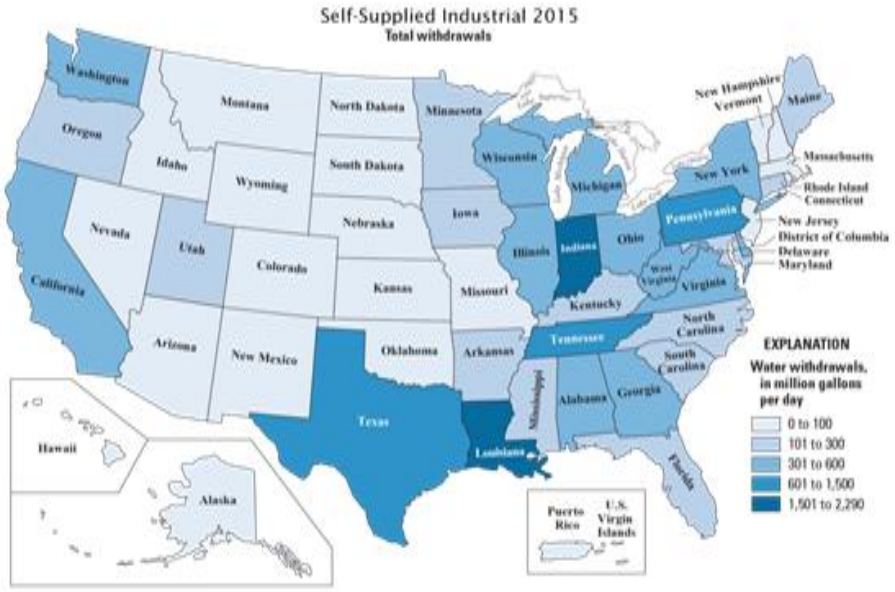


Fig.5.1. Water withdrawals report

Since 1985, self-supplied industrial withdrawals have consistently declined and are 2015 estimates are about 43 percent less than 1985. Declines in self-supplied industrial water withdrawals between 1985 and 2015 can likely be linked to a number of changes in factors in the United States economy, such as the decline in manufacturing and increases in the service sector.

In addition to changes in the United States economy, declines in self-supplied industrial withdrawals reflect greater efficiencies in industrial processes and an emphasis on water reuse and recycling within industrial facilities, both driven by environmental regulations and limited availability of freshwater resources in some areas.

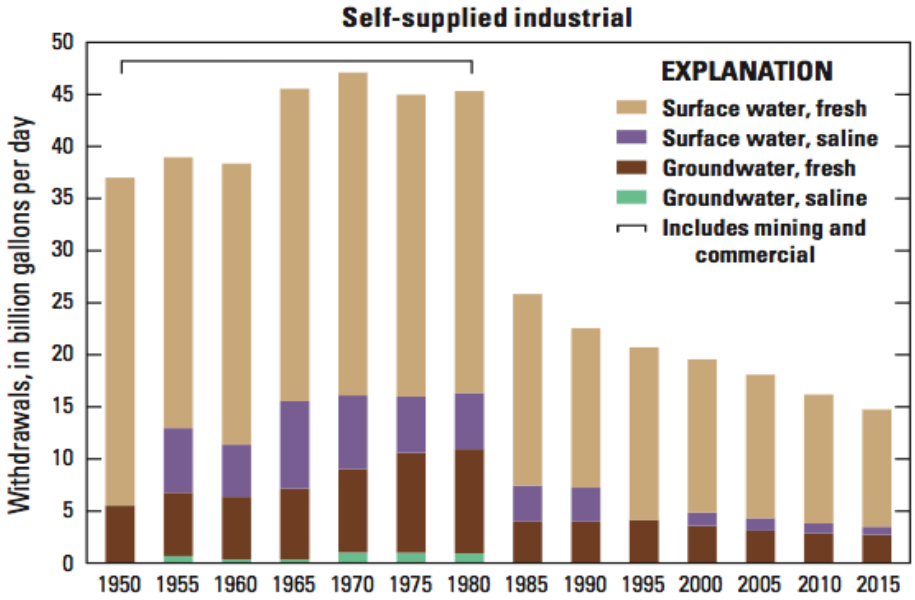


Fig.5.2. Self-supplied industrial report

Water pollution has many sources. The most polluting of them are the city sewage and industrial waste discharged into the rivers. Industrial waste is defined as waste generated by manufacturing or industrial processes. The types of industrial waste generated include cafeteria garbage, dirt and gravel, masonry and concrete, scrap metals, trash, oil, solvents, chemicals, weed grass and trees, wood and scrap lumber, and similar wastes. Industrial waste may be toxic, ignitable, corrosive or reactive. If improperly managed, this waste can pose dangerous health and environmental consequences. The EPA estimated in 1980 that more than 70,000 different chemicals were being manufactured in the U.S., with some 1,000 new chemicals being added each year. The human health and environmental impacts of many of these chemicals are largely unknown.

High levels of toxic contaminants have been found in animals and humans, particularly those, like farm workers and oil and gas workers, who are continually exposed to such waste streams. Waste water from manufacturing or chemical processes in industries contributes to water pollution. Industrial waste water usually contains specific and readily identifiable chemical compounds. Water pollution is concentrated within a few subsectors, mainly in the form of toxic wastes and organic pollutants. Out of this a large portion can be traced to the processing of industrial chemicals and to the food products industry. Most major industries have treatment facilities for industrial effluents but this is

not the case with small-scale industries, which cannot afford enormous investments in pollution control equipment as their profit margin is very slender. The effects of water pollution are not only devastating to people but also to animals, fish, and birds. Polluted water is unsuitable for drinking, recreation, agriculture, and industry. It diminishes the aesthetic quality of lakes and rivers.

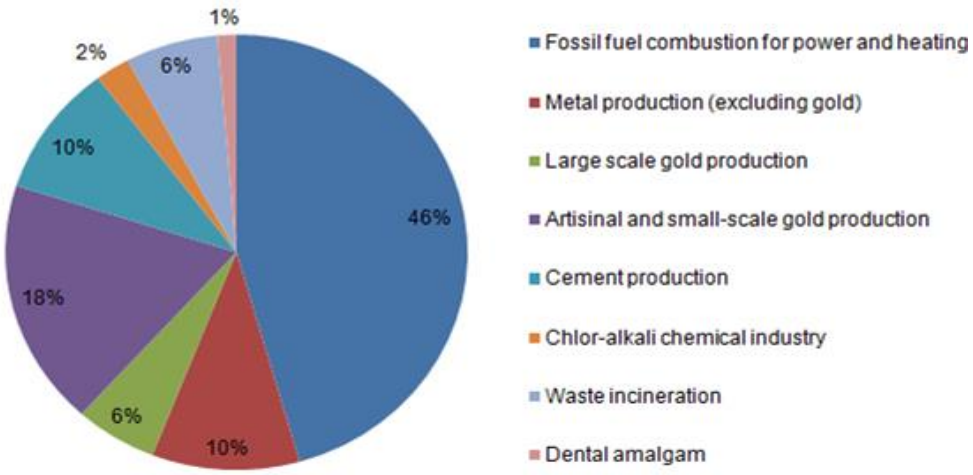


Fig.5.3. Pie chart for Waste of water in different sectors

WHAT CAN BE DONE AND WHAT IS BEING DONE?

Waste reduction techniques:

- Change the composition of the product to reduce the amount of waste resulting from the product's use.
- Reduce or eliminate hazardous materials that enter the production process.
- Use technology (including measuring and cutting) to make changes to the production process; equipment, layout or piping; or operating conditions.
- Purchase what you need to avoid waste from unwanted materials.
- Good operating practices such as waste minimization programs, management and personnel practices, loss prevention, and waste segregation help to reduce waste at their source.

Recycling Techniques:

- Return waste material to original process.
- Use the waste material as a raw material substitute for another process.
- Process waste material for resource recovery.
- Process waste material as a by-product.
- Investigate contractors to recycle waste material.
- Advertise waste material.
- Use packaging waste again (cardboard, bubble wrap or polystyrene).

The term Cleaner Production was coined by the United Nations Environment Program (UNEP) when it launched the Cleaner Production Program in 1989. Cleaner Production is the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment. (UNEP, 1989).

- For production processes - the strategy includes conserving raw materials and energy, eliminating toxic raw materials, and reducing the quantity and toxicity of all emissions and wastes.
- For products - the strategy focuses on reducing negative impacts along the life cycle of a product, from raw materials extraction to its ultimate disposal.
- For services - the strategy involves incorporating environmental concerns into designing and delivering services.

Cleaner production requires changing attitudes, responsible environmental management and evaluating technology options.

Benefits of cleaner production:

- Economic benefits include increased profits; improved marketability; lower expenditure on materials and resources; additional sources of income; increased quality and greater productivity; better customer service; and increased goodwill from being seen as a responsible member of the community.
- Environmental benefits include less pollution; reduced production of waste; more efficient use of resources; less waste going to landfill; and less effluent to sewage or discharges to water bodies.

Technologies have been developed to solve a wide range of solid waste and other environmental and recycling problems. Many new technologies for separation and recycling of fly ash, metals, plastics, glass, sands, abrasives, automobile scrap, and plating waste sludge have been developed.

Energy Sector-

The fuels or technologies used to achieve the clean energy transition could, if not properly managed, increase water stress or be limited by it. Some low-carbon technologies, such as wind and solar PV require very little water, others, such as biofuels, concentrating solar power (CSP), carbon capture, utilization and storage or nuclear power are relatively water-intensive. An integrated approach focused on tackling climate change, delivering energy for all and reducing the impacts of air pollution (Sustainable Development Scenario) results in lower water withdrawals in 2030 relative to today and other scenarios thanks to the increased deployment of solar PV and wind, a shift away from coal-fired power generation and energy efficiency. However, consumption in this scenario increases by 50% relative to today.

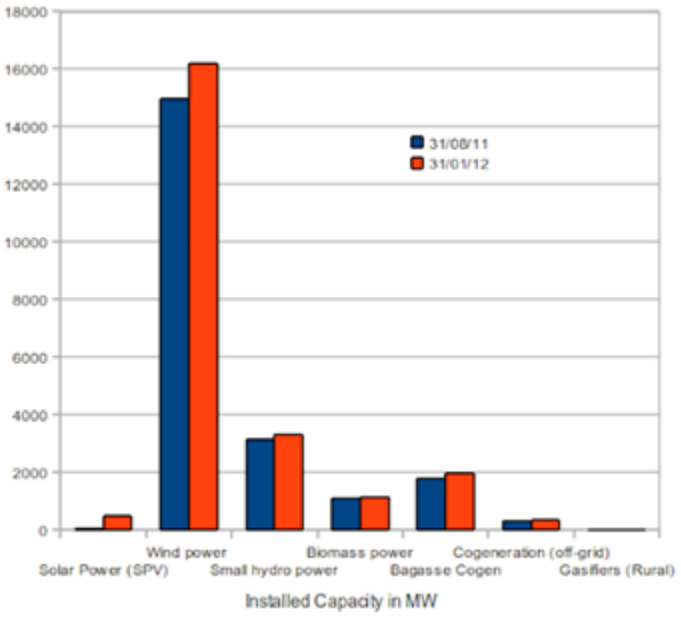


Fig.5.4. Installed Capacity in MW

Water Use in Energy Production

Almost all energy production relies on the use of vast amounts of water across many different power plants. Most power plants around the world burn fuel such as gas or coal to produce energy. The tremendous heat this process generates boils water, thus emitting a surplus of steam within the plant. The steam is responsible for spinning the turbines, which can generate electricity. Also, the refinement of transportation fuels, mining coal, growing crops for biofuels and extracting specific sources of petroleum all require the use of water. If we do not drastically change our methods of energy production, there will be permanent ramifications to our environment.

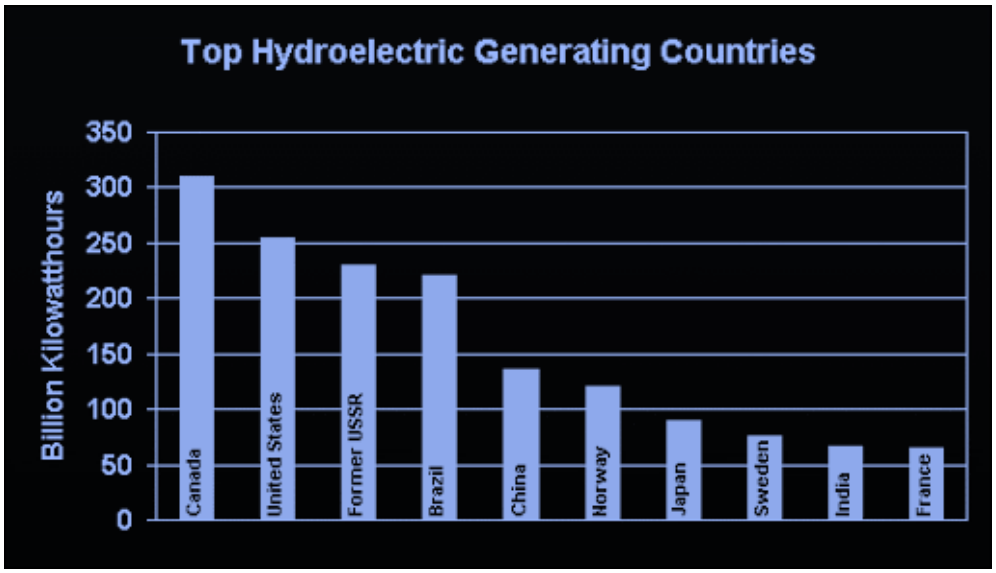


Fig.5.5. Countries generating large amount of Hydroelectricity

The Consequence of Avoiding Sustainable Energy Production: Water Pollution

Due to the link between water and energy, issues for one source can create enormous problems for the other. This predicament leads to dangerous implications for water pollution in the nearby water source of energy plants. The water used for once-through coal plants usually gets pumped directly back into its source. The wastewater is considerably warmer, creating thermal pollution, which can increase the heart rate of sea animals and decrease their fertility. When the water returns to its source of rivers, lakes, streams and oceans, it is often dangerously toxic for humans and the environment.

In contrast, wet-recirculating plants bypass this issue of extensive water pollution by employing water-cooling systems. However, in the process, these plants consume more water — up to billions of gallons each year. The time to fundamentally change the way the energy industry functions is now.

Solutions for the Energy Industry to Decrease Water Pollution

Many technology leaders are shaping solutions for various plants to address the water-related impacts of energy production. Some of the most common solutions to decreasing water pollution include:

- Engage in proper water management through raw water pre- treatment, boiler protection, demineralization and more.
- Lowering the amount of electricity needed for making vehicles, buildings and appliances can simultaneously save water and production costs.
- Participate in the use of more renewable energy technology for production. For instance, photovoltaics or wind can eliminate the need for electricity, and thus, water.

In 2017 alone, about 80% of U.S. and Canada electricity production involved the use of non-renewable sources. The industries in these countries that used the most energy include the industrial, transportation, residential and commercial sectors. Although experts have recognized the need for change, and energy leaders have made small strides in recent years, the industry overall has a long way to go to attain a brighter future.

Human Settlements

Safe drinking water and adequate sanitation services are vital to human health. They offer other important benefits as well – some easily identifiable and quantifiable, such as costs avoided and time saved, as well as other less tangible benefits that are more difficult to measure, including advantages in terms of convenience, increased well-being, and personal dignity, privacy and safety.

Two main water problems are affecting the sustainability of human settlements

These problems have incommensurable consequences on human health and well-being, safety, the environment, economic growth and development.

In industrialized countries, the consumption patterns of cities are severely stressing the global ecosystem, while settlements in the developing world need more raw material, energy, and economic development simply to overcome basic economic and social problems. Human settlement conditions in many parts of the world, particularly the developing countries, are deteriorating mainly as a result of the low levels of investment in the sector attributable to the overall resource constraints in these countries.

How does water affect where people settle? How do these patterns of growth affect the environment?

The Maldives Islands are situated in the Indian Ocean. They are an economically disadvantaged country. They rely on fishing, boat building and repair, and fish products. Water affects where they settle, because they need access to water to help them economically and to improve their ways of living.

Pattern

Patterns of growth affect the environment, because it changes the land and water. When the colonists used the land for agriculture, the extensive use caused soil erosion. Soil erosion generally has a bigger effect on smaller bodies of water such as rivers and lakes. The water becomes polluted and no longer usable. As more people settle in, quicker the resources are consumed. There are more pollutants and wastes. They were usually wastes that came from the soils, or wastes from the people. Today there are more pollutants that go into the water. The crops deplete the nutrients in the soil. This limits the amount of flora that is able to grow around the bodies of water.

In the past

We know that people sell water so they could use it for transportation and agriculture. Water affects where people settle in, people tend to settle near bodies of water. People settle near water, because they use it as transportation, agriculture, and to sustain themselves and their communities.

Some of the examples are as follows:

New Mexico (Chesapeake Colonies)

The Chesapeake Colonies relied on planting tobacco. They settled near bodies of water to help them maintain their crops, and to transport them around when they were ready to trade. When the Pueblo people were settling in New Mexico, they settled around the six moderately dependable rivers. The environment in New Mexico is very dry. The Pueblo people created a system of irrigation to help them grow their crops in dry lands.

New England

During colonial times, New England depended on fur trading and timber extraction. The colonists settled near the oceans, because they were dependent on them to transport their goods to other harbors.

Similarly, many people settle close to water resources and the people away from it migrate **Urban areas** are expected to absorb all of the world's population growth over the next four decades, as well as accommodating significant rural-to-urban migration. The vast majority of these people will be living in overcrowded slums with inadequate, often non-existent, water and sanitation services.

Safe drinking water systems and adequate sanitation that effectively disposes of human waste will be essential to ensure cities and towns grow sustainably. Extending these services to the millions of urbanites currently unserved will play a key role in underpinning the health and security of cities, protecting economies and ecosystems and minimizing the risk of pandemics.

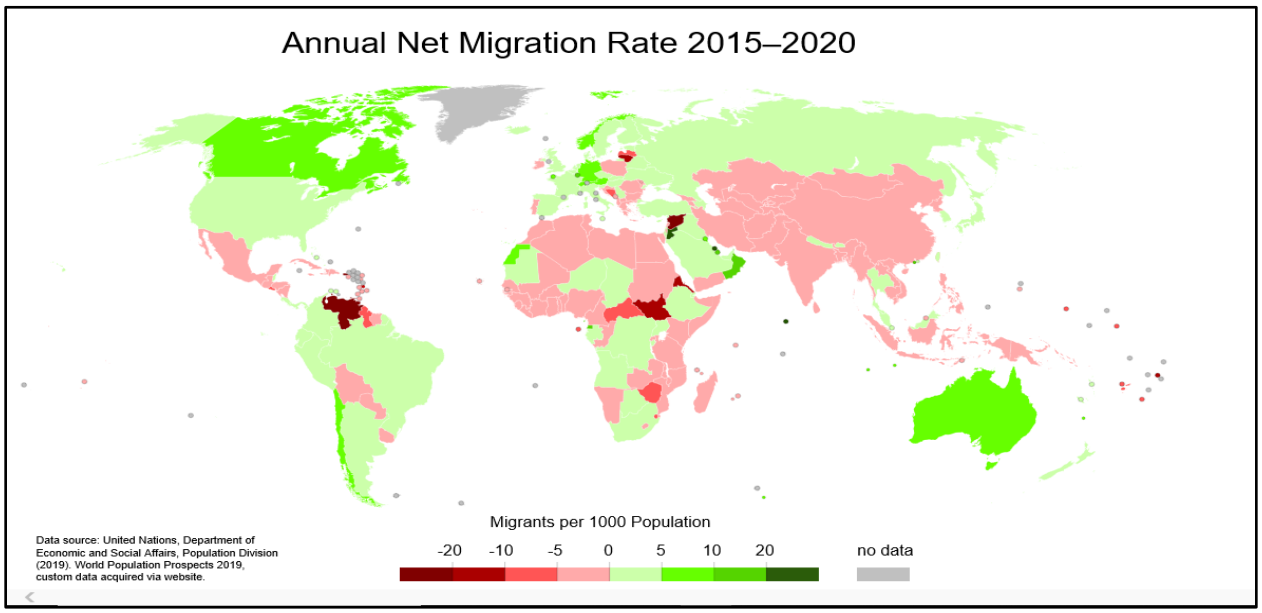


Fig.6.1. Annual net migration rate 2015-2020

Of almost 1.8 billion people who gained access to **improved drinking-water** in the period 1990–2008, 59% live in urban areas. In urban areas, however, the increase in coverage is barely keeping pace with population growth.

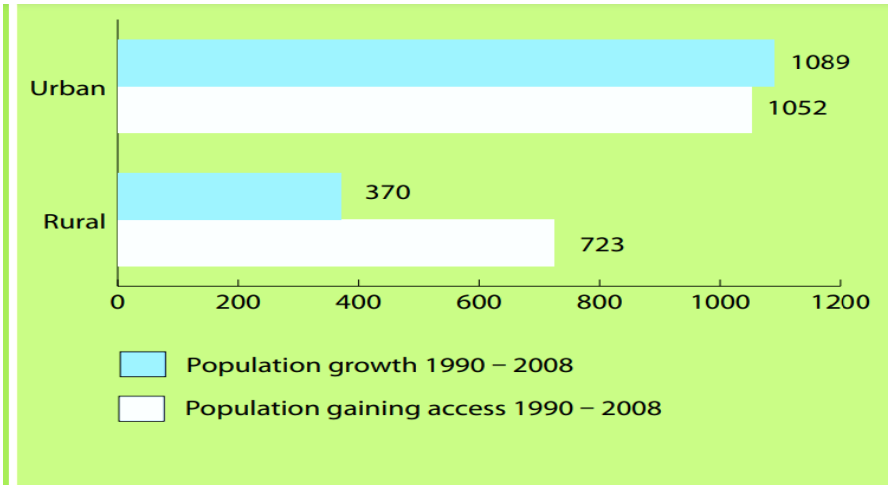


Fig.6.2. Population Growth in Urban and Rural Area

Ref: https://www.zaragoza.es/contenidos/medioambiente/onu/789-eng-ed3-res17.pdf

A heavy burden on the poor especially women and children:

Burdens associated with inadequate coverage and inefficient service delivery fall heaviest on the most vulnerable and the poorest.

Poor citizens, especially women and children, are also the most excluded from decision-making. Lack of access to safe sanitation affects women not only in terms of their health but also in terms of their dignity and safety. Women and girls especially find their productivity impaired by their social roles, which often include the costly and time-consuming tasks of collecting and storing water.

The costs of inadequate water supply and sanitation are high: 1.6 million children die every year from diarrhoea, mainly as a result of inadequate sanitation, water supply and hygiene. And the economic costs of lost time in fetching water and environmental degradation from wastewater pollution are also high – for example, this has been estimated at more than 1.4 percent of GDP in Bangladesh, 1 percent in Colombia, and 0.6 percent in Tunisia (World Bank, 2010).

Groundwater Depletion :

The Central Groundwater Board of India estimates that 15% of the administrative blocks in India extract more water than is replenished and there is significant concern about rapid depletion. Evidence suggests these dropping groundwater levels have affected human settlements and also increased poverty, conflict and decreased agricultural profits.

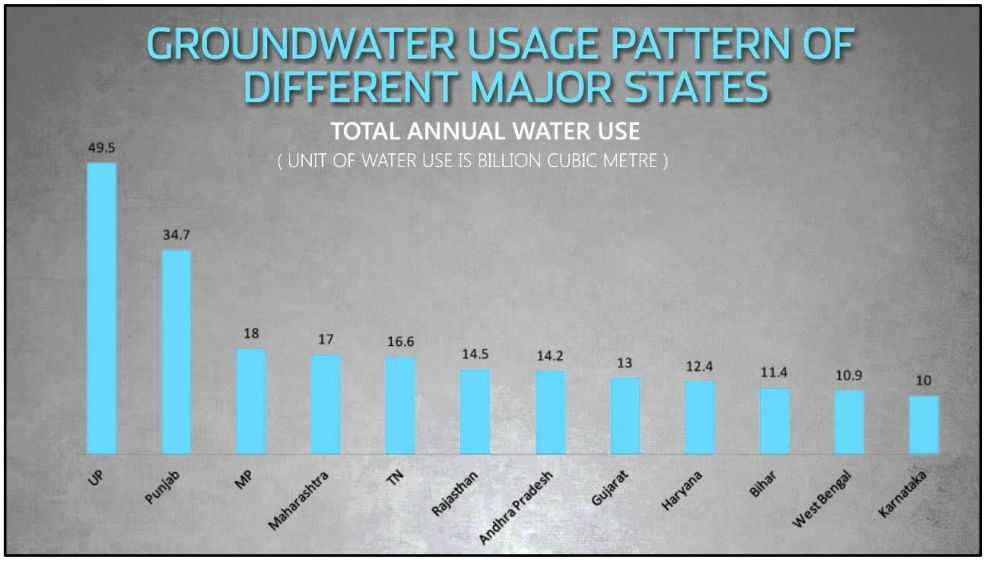


Fig.6.3. Usage of Groundwater by different states.

Groundwater is a highly overused resource because of the following reasons :

(a) Due to large and growing population and consequent greater demands for water and unequal access to it.

(b) In the housing societies or colonies in the cities, there is an arrangement of own ground water pumping devices to meet water needs.

Some of the negative effects of groundwater depletion: drying up of wells, reduction of water in streams and lakes, deterioration of water quality, affecting human settlements as the ground level is sinking with compression of soil.

More than half of the global population live in towns and cities. By 2050, that proportion is expected to rise to two-thirds. Population growth is happening fastest in urban areas of less developed regions, with the urban population estimated to grow from 3.9 billion people today to 6.3 billion in 2050.

Regional Perspective

Regions:

There is water in abundance there is no doubt in that, but most of it is saline and hence not fit for drinking. We need fresh water for our survival. For drinking water, we need to have continuous flow of freshwater resources. Therefore most of humanity resides no less than 10kms away from a water resource. But not every country is equally rich with water. There are countries like Canada with an abundance of freshwater resources accounting for up to 20% of the world's freshwater. While Kuwait on the other hand has the least amount of water to person ratio. The stark difference in water supply between Canada and Kuwait is worrisome. Kuwait has 10 m3 of water per person while Canada has 10,000 times that. With the help of this we can categorize regions in 3 categories
a) Water deficit b) Water adequate and c) Water surplus.

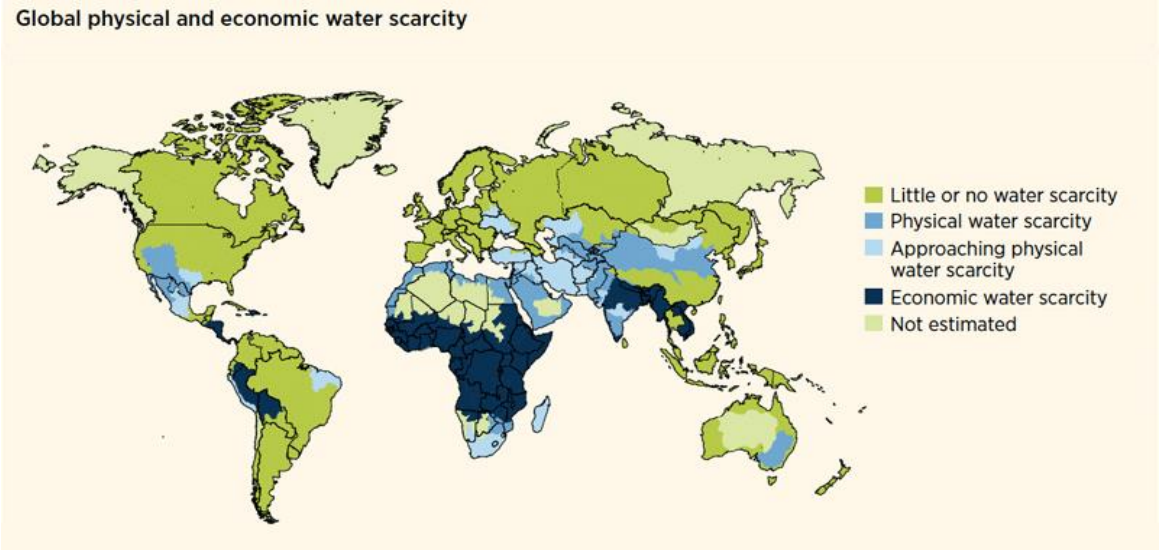


Fig.7.1. Regional distribution of water scarcity

a) Water deficit: Water deficit countries have less water than what they practically require. Kuwait is a water deficit country. With less access to freshwater resources these countries have to look for alternatives. Less water supply can also hinder the economic growth of any region. Middles East and African countries fall under this category.

b) Water adequate: The countries that have water supply enough to meet the needs are called water adequate countries. These countries include India and China. Here we have adequate amounts of water but misuse and mismanagement can affect the supply of water. These countries mostly don't have enough infrastructure advancement that the water deficit countries have adapted to. If there is any shortage of water due to any reason these countries would have to face the consequences and can also fall in the water deficit category if measures are not taken.

c) Water surplus: The countries that have more water than they require is called a water surplus country. These countries have less population density and abundant supply of water. Canada is one such water surplus country. These countries have an advantage as they don't have to invest in water infrastructure. They don't have to dig wells or spend on desalination. There are very few countries that are surplus in water.

Sub-Saharan Africa:

Impacts of climate change on Africa's water resources are already acute. For example, numerous studies find that rainfall in southern Africa has decreased recently, probably as a result of climate change. Such impacts will also increasingly interact with multiple non-climate-related drivers of water scarcity and water pollution, such as a growing population, economic development, conflict and fragility. The impact of population increase will be particularly pronounced on the African continent, where the population has been predicted to grow by more than a half billion by 2050, increasing water stress, particularly in urbanizing regions.

Generally, existing economic and livelihood practices, like natural ecosystems, are vulnerable in the face of climate change and poorly prepared to adapt without intervention. In agricultural systems, especially in semi-arid areas, conventional livelihood-based approaches appear not robust enough to deal with the long-term impacts of climate change. Terrestrial and marine ecosystems, as well coastal areas are highly vulnerable to sea level rise, land-based runoff and storms and storm surges.

Cape Town water crisis:

In summer 2018 Cape Town was running out of water. The dam that was supposed to be the main supply of water to the city had turned into a desert. The dam was filled only upto 10% of the capacity but the water was quite muddy making it unusable.

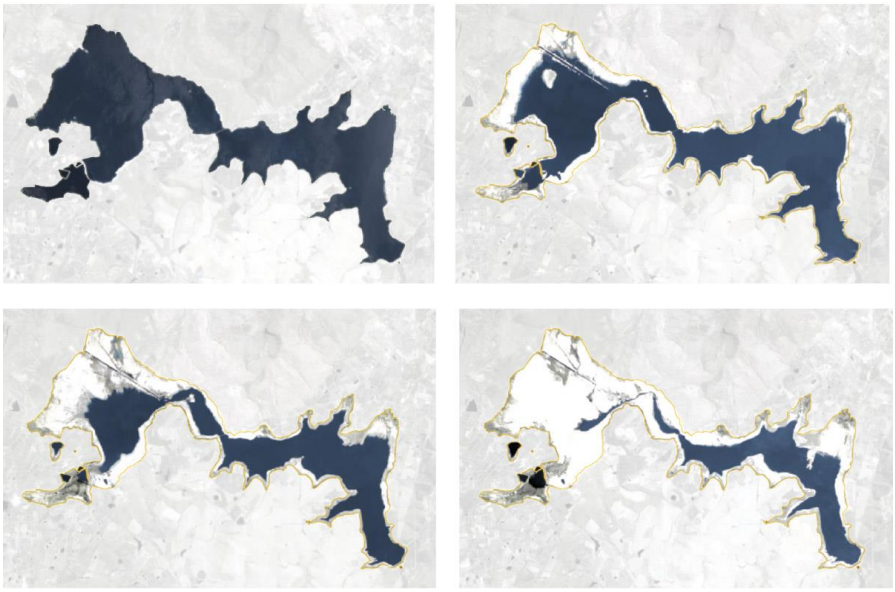


Fig.7.2. Cape Town's main lake is shrinking within a couple of decades.

In a region defined by deep racial and economic disparity the threat of dry taps is highlighting the stark divide between the haves and the have nots in the city. When Cape Town approaches day zero, all the taps in the city will have no water. That day every resident including the suburbs will have no water and city officials say that it is nearer than most people think.

In Newlands, one of Cape Town's most affluent suburbs located at the foot of the Table Mountains the natural springs have provided water for local residents for decades, but now thousands of people from miles away come from miles away reaching the place as early as 5 a.m. to fill up their jugs. This is not only in Newlands but such crowd gatherings were a normal sight in Cape Town. Many turned this crisis into an opportunity by offering home delivery of water for the rich. But the poor who can't afford have to stand in line for water every week. There has also been a boom in the rainwater harvesting and collections

business. With more people now realizing the importance of water and installing such systems in their homes.
The government has capped the usage of water to 50L per person with a heavy penalty for people not abiding by the law.

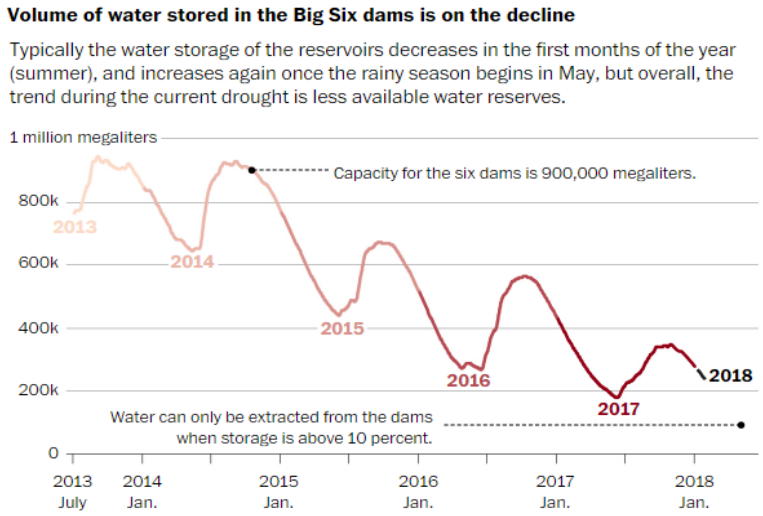


Fig.7.3. Line chart showing Water stored in dams are declining

But what's ironic is that the thing considered as the new normal for many Capetonians [14] is everyday life for many black residents living in townships. Under the aphartied systems blacks residents were forced to live in barren and under resourced committees called as townships where they continue to live even today. Over 25% of Capetonians [14] live in so-called townships.

Water shutdowns have been imposed in the suburbs where most of the white population lives and where water has been used much wastefully. This tells us how water affects the economic development of people. The sad reality that the rich will be rich only because they have access to clean drinking water with taps installed to their homes. The underprivileged black community was kept away from such economic development.

The city has come up with new ways to make people save water. There are boards and hoardings all around the city indicating the water crisis. 'If it's yellow let it mellow' and 'flush the toilet with grey water' are some of the slogans for the city.

Many of the capetonians [14] were under the impression that water will always be available. But now they have agreed to use water carefully.

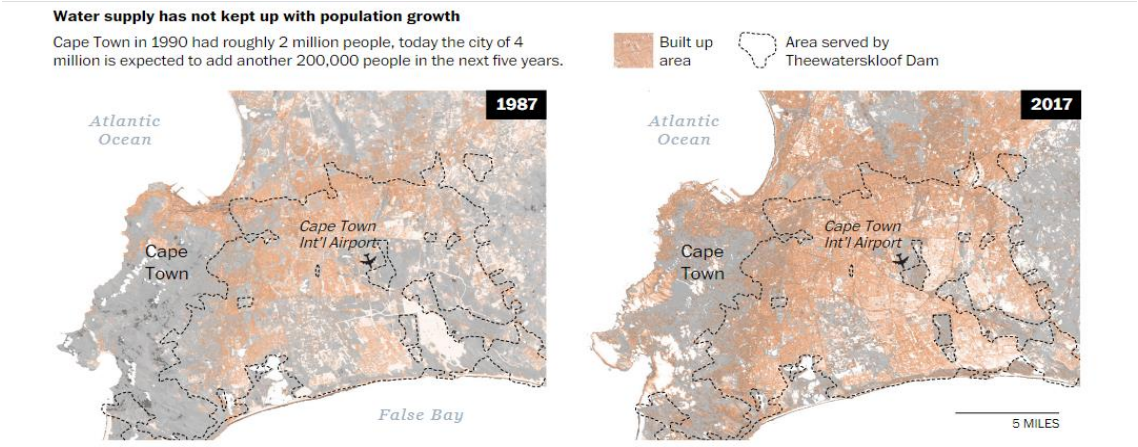


Fig.7.4. Population growth

Where the City Official Failed:
City officials had known about the crisis for decades but ignored to acknowledge and work on it. The city municipality run by the Democratic front is accused to have purposely done nothing so that the central government run by the ANC comes to the rescue and takes the blame.

Mexico City:

Around the world, people are struggling for access to drinking water. All Things Considered *is examining the forces at play in separating the haves from the have-nots — from natural disasters to crumbling infrastructure and corruption.*

It's the rainy season now in Mexico. Between May and September, on most late afternoons, thick clouds roll into Mexico City's mountain-ringed valley. The skies darken and then an amazing downpour ensues.

Despite the rainfall, for five months of the year, many of the metropolitan area's more than 20 million residents don't have enough water to drink. Nearly all that rainwater runs off the streets and highways into the city's massive drainage system built to stave off perennial flooding.

"It's a historic mistake the city has had to pay for more than 500 years," -says Ramón Aguirre Díaz,

Who has run Mexico City's municipal water system for more than a decade?

The ancient Aztecs first picked the spot. They built their city atop the huge lakes that filled this valley, leaving the natural freshwater supply intact around them. The city flooded back then too, but the Aztecs, probably the last civilization to properly manage this watershed, built a system of dikes to control the problem. The "historic mistake" kicked in around the 1600s, when Hernándo Cortés [15] and his band of conquerors arrived. To make room for their expanding empire, over a few hundred years, they slowly but surely drained all the valley's lakes.

By the 20th century, long after Mexico's independence from Spain, the fresh surface water was mostly gone and the hunt for new sources had taken over. Hundreds of miles of pipes now bring in about 30 percent of the city's water needs from faraway rivers and lakes. The rest comes from the valley's vast underground aquifer. Today, Aguirre says, twice as much water is pumped out as is put back in.

"We are depleting volumes of water that took hundreds, thousands of years to store. Sooner or later it will run out," he says. When exactly that is, no one really knows. But for those living in the poorer eastern stretches of the city, like 52-year-old Marco Marquez, it feels like now. During the rainy season, Marquez gets about an hour of water a day. His little patio is crammed with different sizes of storage containers filled with water. During the dry season, he can go two, even three months without water. He says sometimes the government will send in a water tanker truck, known as a *pipa,* which literally means pipe.

"The quality of the water the government provides is really bad quality, it's disgusting," he says. "You can only use it to flush the toilets or wash the sidewalk."

Marquez says sometimes he and some neighbors pool their money to buy a private *pipa* with water from better wells.
He needs clean water to run his fresh fruit stand. He has named the small storefront, run out of a street-facing room in his house, the Oasis.

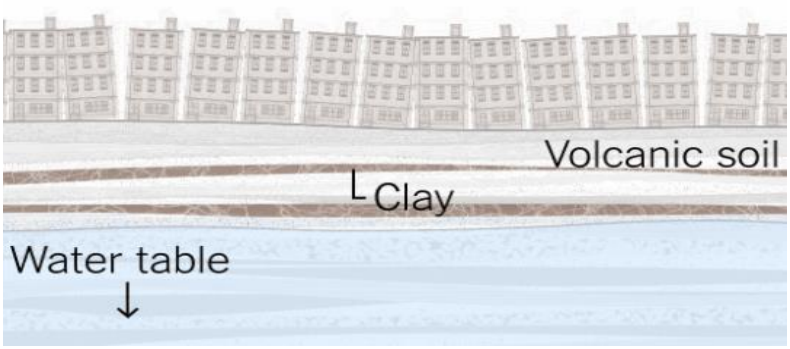


Fig.7.5. Illustration of how land of Mexico City is getting an irregular structure

Fig.7.6. Actual image of irregularity in lands of Mexico City

The city's underground pipes, half of which are at least 60 years old, fail at an alarming rate. It could take at least 50 years, and hundreds of millions of dollars, to replace all the old, ruptured pipes, according to one official estimate. That means the water tankers are in high demand. Twenty-two-year-old Juan Flores stands on top of a 2,600-gallon tanker. He guides a huge hose connected to a pipe pumping water directly out of the aquifer into the truck.

Fig.7.7. Shiring Mexican capital

As the ground sinks, it leaves buildings tilting — most notably, the iconic cathedral in Mexico City's historical center — as well as roadways breaking apart and pipes rupturing or buckling backward.

María Estella Isla, 42, is on her patio, where she has just started a load of laundry. She hasn't had water in days, so she has to fill her washing machine with water she scoops out of a big blue plastic storage barrel large crack cuts through this Mexico City street. Half of the street is lower than the other half, one of many signs this metropolis is sinking.

A large fissure in the ground runs right through a property, out the gate and down the street. One half of the block has sunk. It's at least a foot lower than the other side. The underground sewer line connected to her house now tilts upward and floods her patio, especially on rainy days. Since last century, Mexico City has spent billions of dollars on flood control. A major tunnel project launched almost a decade ago has been plagued with delays and enormous cost overruns, with a budget now topping $2 billion. It is not helping the city's water shortage or sinking problems. The system moves rainwater and sewage out of the city quickly, but little is recycled or used to recharge the aquifer.

Anthropologist Dean Chahim, a Ph.D. candidate at Stanford, is studying Mexico City's water woes. He says water managers must find a more balanced approach to the city's water supply to rely less on groundwater. There is a need for more water recycling, rainwater catchment and recharging of the aquifer. Many of these are being done, but on a very small scale.

"And we have to redistribute the water. At the end of the day, it can't be that people in one part of the city [the richer neighborhoods] are drinking 400 liters [106 gallons] a day and others [the poorest] are drinking 40," says Chahim.

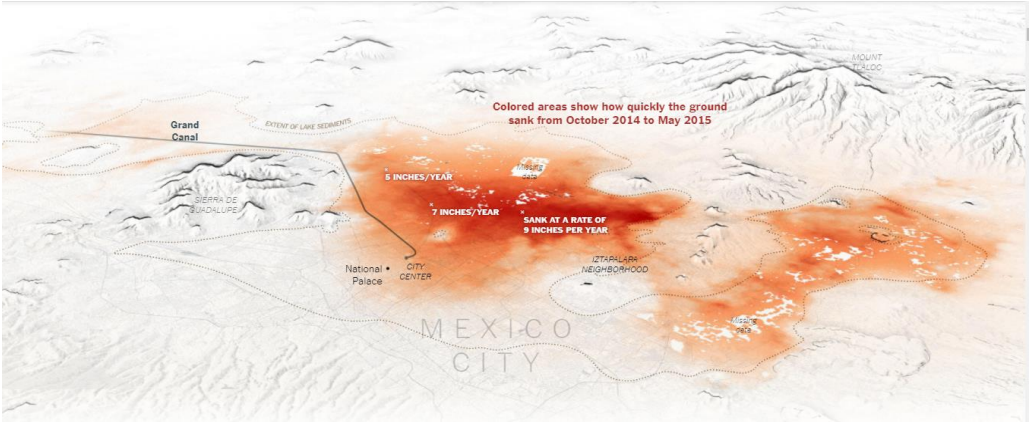


Fig.7.8. Lost lake which was a natural reservoir surrounding the city

The World Health Organization says a person needs between 50 and 100 liters of water a day (13 and 26 gallons) to meet basic needs.
Water administrator Aguirre says there have been a multitude of studies and solution recommendations.
He says what's needed now is the political will, and more money, to make changes.
"The city won't make it to the 22nd century if we don't resolve [the water problems] soon," says Aguirre, who leaves office at the end of November.

Asia:

There is high variation and low confidence in projected water-related impacts of climate change at the sub regional scale in Asia and the Pacific. Water-related climate impacts intersect with other socio-economic trends that impact water quality and quantity, including industrialization (which is reshaping sectoral demand for water and increasing pollution), population growth and rapid urbanization. The latter have also increased exposure to water-related natural hazards such as floods.

The region is highly vulnerable to climate-induced disasters and extreme weather events, which are disproportionately burdening poor and vulnerable groups. In August 2017 alone, intense monsoon rains affected 40 million people in Bangladesh, India and Nepal,

claiming nearly 1,300 lives and putting 1.1 million people in relief camps. The increase in demand for irrigation has already led to severe groundwater stress in some areas, especially in two of Asia's major 'food baskets' – the North China Plain and Northwest India.

KARACHI WATER CRISIS:

KARACHI, Pakistan - Orangi is a maze, a spider's web of narrow, winding lanes, broken roads and endless rows of small concrete houses. More than two million people are crammed into what is one of the world's largest unplanned settlements here in western Karachi, Pakistan's largest city.

But Orangi has a problem: it has run out of water. It is so rare for water to flow through the taps here that residents say they have given up expecting it. The last time it flowed through the main pipeline in Begum's neighbourhood, for example, was 33 days ago.

Instead, they are forced to obtain most of their water through drilled motor-operated wells (known as 'bores'). Ground water in the coastal city, however, tends to be salty, and unfit for human consumption.

The only other option for residents is to buy unfiltered water from private water tanker operators, who fill up at a network of legal and illegal water hydrants across the city. A 1,000-gallon water tanker normally costs between $12 and $18. But not everyone in this working class neighbourhood can afford to buy water from the tankers or to pay the approximately $800 its costs to install a drilled well for non-drinking water.

On average, residents in these areas use about 67.76 litres of water per day, according to data collected by Al Jazeera. That includes the water they use for drinking, cooking, cleaning, washing clothes, bathing and sanitary uses.

So what is going on here? How is it possible that in one of the largest cities in the world, there simply isn't enough water being supplied? Is it because the reservoirs and water sources supplying Karachi just aren't large enough for this rapidly expanding megacity?

The answer to these questions is somewhat surprising.

Karachi draws its water mainly from the Keenjhar Lake, a man-made reservoir about 150km from the city, which, in turn, gets the water from what's left of the Indus River after it completes its winding 3,200km journey through Pakistan.

Through a network of canals and conduits, 550 million gallons of water a day (MGD) is fed into the city's main pumping station at Dhabeji.

That 550MGD, however, never reaches those who need it. Of that water, a staggering 42 percent – or 235 MGD – is either lost or stolen before it ever reaches consumers, according to the Karachi Water and Sewerage Board (KWSB) [16], the city's water utility.

Karachi's daily demand for water should be about 1,100 MGD, based on UN standards for water consumption for the megacity of more than 20 million. If that estimate – considered generous by local analysts – were to be pared down, however, Karachi's current water supply should still be adequate to service most of the city's needs.

If 550GMD of water actually reaches Karachi, then right now, with conditions as they are, we would be able to manage the situation very well and provide water to everyone,

So where is it all going?

Malik complains that the water supply infrastructure in the city is aged, parts of it running for more than 40 years, and that the funds simply are not there to fix the problems.

KWSB is, by any standard, a sick institution. This fiscal year, it estimates that it will be running at a deficit of 59.3 percent. Only about 60 percent of consumers pay their bills, with the biggest defaulters being government institutions themselves, which owe KWSB about $6 million in arrears.

"There is nothing left for any kind of maintenance or capital investment."

That lack of capital investment affects not just the ability to provide water, but to make sure that it is clean enough to be consumed. The water is obviously contaminated. There are discharges, there are cross-connections of water, where sewage lines are leaking into supply lines. Construction practices are such that…often sewage lines are side by side with water lines, or even above them.

And KWSB never seems able to get around to addressing these problems, several analysts said. There is corruption, inefficiency, political interference, so it's an organisation rooted in a number of problems.

The bulk of Karachi's 'lost' water is being stolen and sold right back to the people it was meant for in the first place.

WHO IS STEALING KARACHI'S WATER?

Akhtari Begum, 48, has to manage a household of five people on her husband's income of $160 a month.

She ends up spending more than a third of that on water.

"Water does come [in the main line], but it gets stolen before it gets to us," she says. "So we don't get any water, we have to get tankers."

A typical 1,000-gallon water tanker costs anywhere between $12 and $16, depending on where you are in the city, what time of year it is, and how desperate you might be.

Water tankers have been a part of Karachi's water supply landscape for decades. Initially introduced as a stop-gap measure while the KWSB was meant to be expanding the city's water supply infrastructure, they have grown to dominate the sector.

Today, there are more than 10,000 tankers operating across the city, completing roughly 50,000 trips a day, according to Noman Ahmed, the head of the architecture and urban planning department at Karachi's NED University. They are meant to fill up at 10 KWSB-operated hydrants, but the business is so lucrative that more than 100 illegal hydrants operate across the city, tapping into the city's mains to steal water.

"There are more than a hundred of them [illegal hydrants], and those are just the ones that have been identified. Every day there's a new one being made somewhere," says Anwar Rashid, a director at the Orangi Pilot Project (OPP), which tracks the tankers' illegal activity.

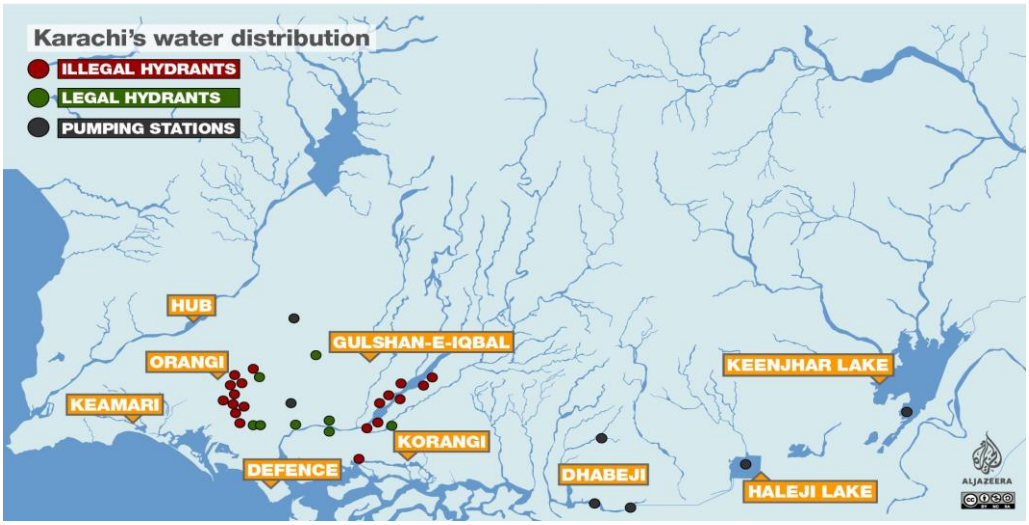


Fig.7.9. KARACHI'S water distribution

"They're visible easily. They tap into the bulk mainline. They syphon off the water. And then there are tankers standing there, and they'll fill up directly from the [illegal hydrant] and then drive off.

"When they take from the bulk, then that means that the water that was meant for residential areas will be reduced," says Rashid.

"THE MAFIA IS VERY STRONG"

The KWSB has carried out more than 400 operations against illegal hydrants in recent years. They are sometimes even escorted by the police or the military for the safety of the officials. But the people who are meant to be controlling the theft are the ones cashing in, tanker operators, analysts and former KWSB. Unauthorized hydrants are run with the connivance of the water board and the police. There are about 100 illegal hydrants still operating in the city…most of them are in Manghopir, in Baldia, in Malir, in Landhi, and Korangi. They're running in Ayub Goth on the Super Highway.

The mafia is very strong in Karachi.

The ex-chief said he had himself received phone calls of this nature. Another current senior KWSB official who asked to remain anonymous confirmed that he, too, had

received such phone calls from members of the government, asking him to curb operations against illegal hydrants.

The result is a system where water is being stolen, commodified and then sold to citizens through the free market. A market, analysts say, that inherently favours the rich over the poor.

"The social contract, regarding what is the role of the state vis-a-vis the people that is now mediated through the medium of money and privatization" says Daanish Mustafa, a professor of geography at Kings College London who studies the sector. "The rights-based approach to water, that water is a fundamental right of the people and a fundamental responsibility of the state, which has ended.

Comparing the water usage between different countries:

When asked about KWSB personnel being involved in the theft of water, the KWSB's Hyder told Al Jazeera, "It has never been our position that no member of our organization is involved [in the theft of water]. But the moment someone is found [to be] involved in this, they are fired and charged under the law. We have charged our own staff … we have zero tolerance for this."

There are periodic drives to shut down these illegal operations. But none last for long. If the very people responsible for shutting down the illegal theft of water are the ones benefitting from it, who will watch the watchmen?

"If I fix the water system in an area, then no one will take a tanker. If we fix the system, whatever illegality is happening will [be] finished," says the current senior KWSB official.

"These things are possible. We can do them," he adds. "But we don't want to do them."

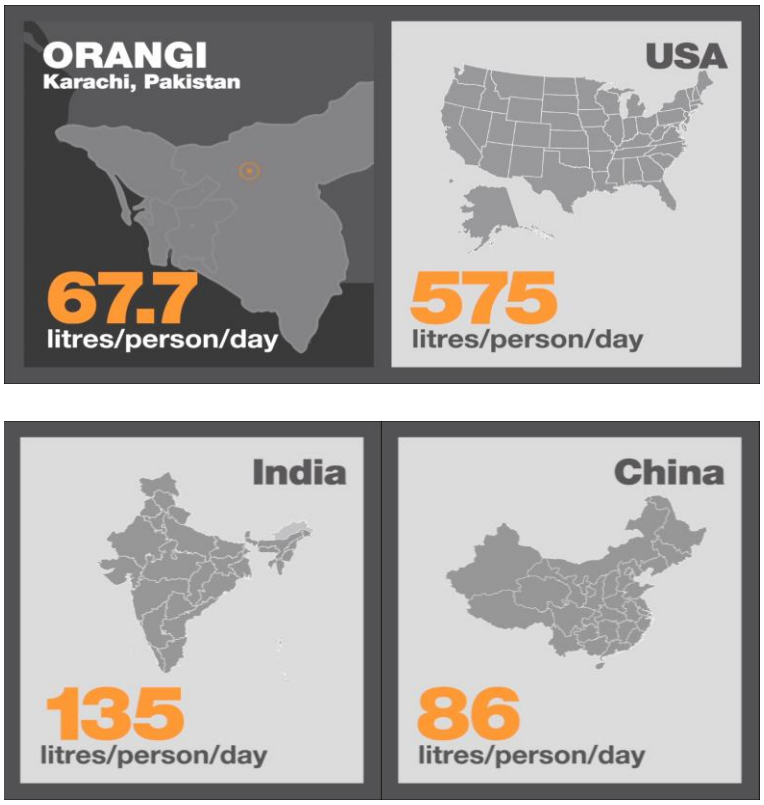


Fig.7.10. KARACHI'S water stats by AL-JAZEERA

CAN'T AFFORD IT, CAN'T LIVE WITHOUT IT

A few streets away in Orangi's spider web, Rabia Begum says the city's poor are trapped because no matter what the price, people need water.

Water Scarcity

Water scarcity is defined as the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully. Water scarcity is a relative concept and can occur at any level of supply or demand. Scarcity may be a social construct (a product of affluence, expectations and customary behavior) or the consequence of altered supply patterns - stemming from climate change for example.

As we know that water covers up-to 70% of our planet, and it is easy to think that it will always be plentiful. However, freshwater - the stuff we drink, bathe in, irrigate our farm fields with—is incredibly rare. Only 3% of the world's water is fresh water, and two-thirds of that is tucked away in frozen glaciers or otherwise unavailable for our use.

As a result, some 1.1 billion people worldwide lack access to water, and a total of 2.7 billion find water scarce for at least one month of the year. Inadequate sanitation is also a problem for 2.4 billion people—they are exposed to diseases, such as cholera [22] and typhoid [23] fever, and other water-borne illnesses. Two million people, mostly children, die each year from diarrheal diseases alone.

Hydrologists [17] typically assess scarcity by looking at the population-water equation. An area is experiencing water stress when annual water supplies drop below 1,700 m^3 per person. When annual water supplies drop below 1,000 m^3 per person, the population faces water scarcity, and below 500 cubic metres "ABSOLUTE SCARCITY" [18].

Source: World Water Development Report 4. World Water Assessment Programme (WWAP), March 2012.

Many of the water systems that keep ecosystems thriving and feed a growing human population have become stressed. Rivers, lakes and aquifers are drying up or becoming too polluted to use. More than half the world's wetlands have disappeared. Agriculture consumes more water than any other source and wastes much of that through inefficiencies. Climate change is altering patterns of weather and water around the world, causing shortages and droughts in some areas and floods in others.

At the current consumption rate, this situation will only get worse. By 2025, two-thirds of the world's population may face water shortages. And ecosystems around the world will suffer even more.

The human population has successfully harnessed many of the world's natural waterways—building dams, water wells, vast irrigation systems and other structures that have allowed civilizations to grow and thrive. But water systems are increasingly stressed, and some rivers, lakes and aquifers are drying up.

DID YOU KNOW?

Around 700 million people in 43 countries suffer today from water scarcity.

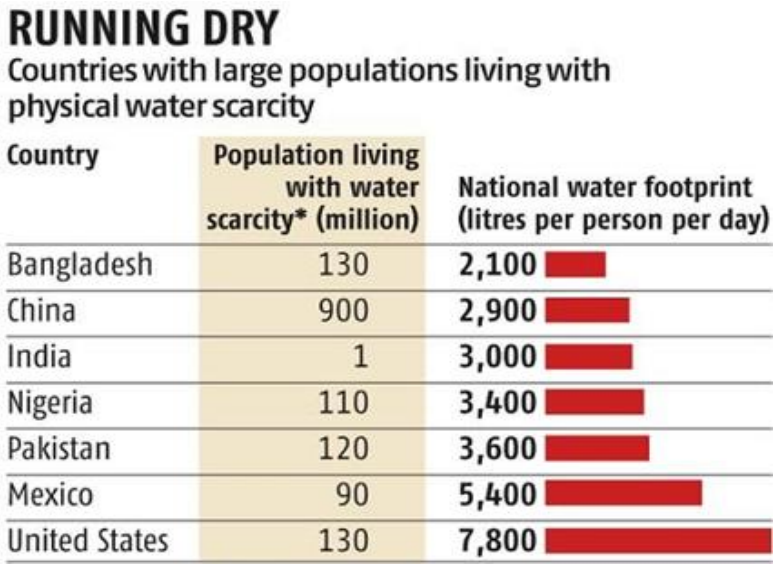
By 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be living under water stressed conditions.

With the existing climate change scenario, almost half the world's population will be living in areas of high water stress by 2030, including between 75 million and 250 million people in Africa. In addition, water scarcity in some arid and semi-arid places will displace between 24 million and 700 million people.

Sub-Saharan Africa has the largest number of water-stressed countries of any region.

WATER SCARCITY FACTS THAT YOU MUST NOT IGNORE

- By 2025, an estimated 1.8 billion people will live in areas plagued by water scarcity, with two-thirds of the world's population living in water-stressed regions.
- Water demand is projected to grow by 55 percent by 2050 (including a 400-percent rise in manufacturing water demand).
- According to the U.S. Intelligence Community Assessment of Global Water Security, by 2030 humanity's "annual global water requirements" will exceed "current sustainable water supplies" by 40%.



RUNNING DRY

Countries with large populations living with physical water scarcity

Country	Population living with water scarcity* (million)	National water footprint (litres per person per day)
Bangladesh	130	2,100
China	900	2,900
India	1	3,000
Nigeria	110	3,400
Pakistan	120	3,600
Mexico	90	5,400
United States	130	7,800

Fig.8.1. Water scarcity for different countries

WATER SHORTAGE COULD AFFECT 5-BILLION PEOPLE BY 2050, UN REPORT WARNS

More than 5 billion people could suffer water shortages by 2050 due to climate change, increased demand and polluted supplies, according to a UN report [20] on the state of the world's water.

The comprehensive annual study warns of conflict and civilizational threats unless actions are taken to reduce the stress on rivers, lakes, aquifers, wetlands and reservoirs.

"For too long, the world has turned first to human-built, or 'grey', infrastructure to improve water management. In doing so, it has often brushed aside traditional and indigenous knowledge that embraces greener approaches," says Gilbert Houngbo, the chair of UN Water, in the preface of the 100-page assessment. "In the face of accelerated consumption, increasing environmental degradation and the multi-faceted impacts of climate change, we clearly need new ways of manage competing demands on our freshwater resources."

Humans use about 4,600 cubic km of water every year, of which 70% goes to agriculture, 20% to industry and 10% to households, says the report, which was launched at the start of the World Water Forum. Global demand has increased six--fold over the past 100 years and continues to grow at the rate of 1% each year.

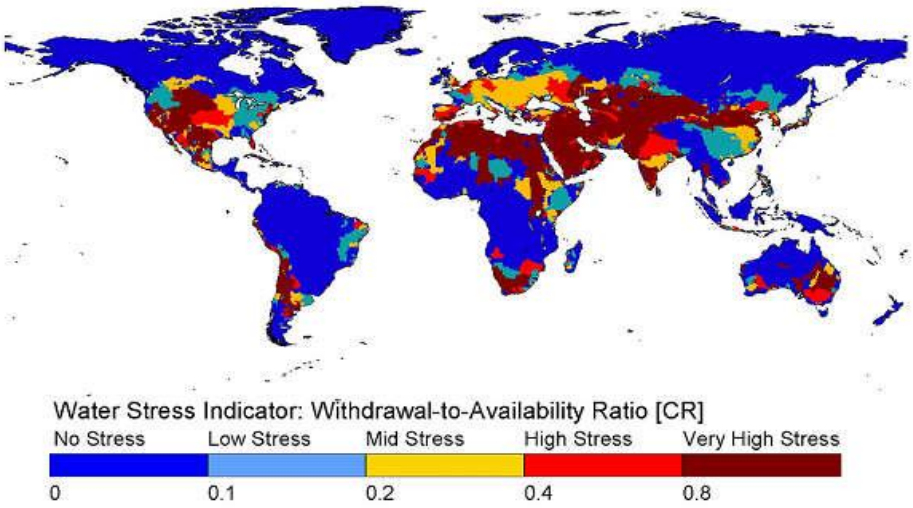


Fig.8.2. Water stress indicator

This is already creating strains that will grow by 2050, when the world population is forecast to reach between 9.4 billion and 10.2 billion (up from 7.7 billion today), with two in every three people living in cities. Demand for water is projected to rise fastest in developing countries. Meanwhile, climate change will put an added stress on supplies because it will make wet regions wetter and dry regions drier.

Drought and soil degradation are already the biggest risk of natural disaster, say the authors, and this trend is likely to worsen. "Droughts are arguably the greatest single threat from climate change," it notes. The challenge has been most apparent this year in Cape Town, where residents face severe restrictions as the result of a once-in-384-year drought. In Brasília, the host of the forum, close to 2m people have their taps turned off once in every five days due to a unusually protracted dry period.

By 2050, the report predicts, between 4.8 billion and 5.7 billion people will live in areas that are water-scarce for at least one month each year, up from 3.6 billion today, while the number of people at risk of floods will increase to 1.6 billion, from 1.2 billion.

CAUSES OF WATER SCARCITY :

- **CLIMATE CHANGE –**

As humans continue to pump more carbon dioxide and other greenhouse gases into the atmosphere, patterns of weather and water will change around the world. Droughts will become more common in some places, floods in others. Glaciers and snow packs will disappear in some areas, affecting the freshwater supplies to those downstream communities. These changes will combine to make less water available for agriculture, energy generation, cities and ecosystems around the world.

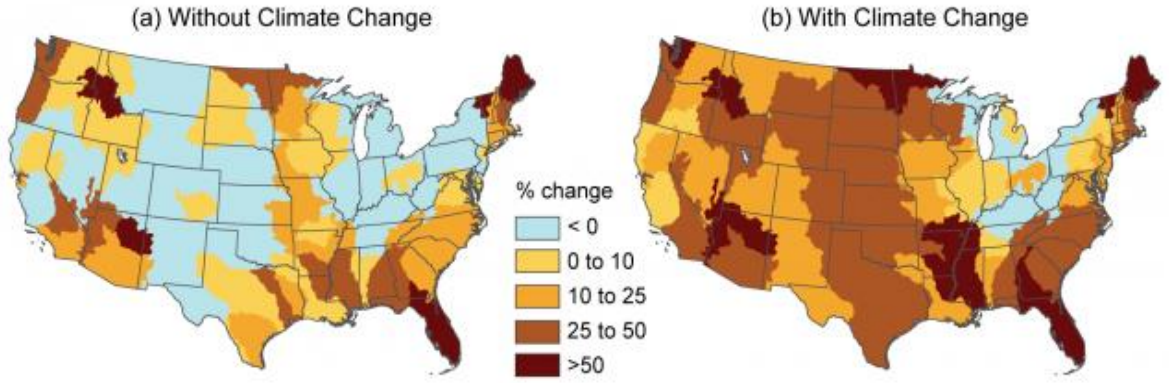


Fig.8.3. Relation between Water scarcity and climate change

- **POLLUTION-**

Water pollution comes from many sources including pesticides and fertilizers that wash away from farms, untreated human wastewater, and industrial waste. Even groundwater is not safe from pollution, as many pollutants can leach into underground aquifers. Some effects are immediate, as when harmful bacteria from human waste contaminate water and make it unfit to drink or swim in. In other instances—such as toxic substances from industrial processes—it may take years to build up in the environment and food chain before their effects are fully recognized.

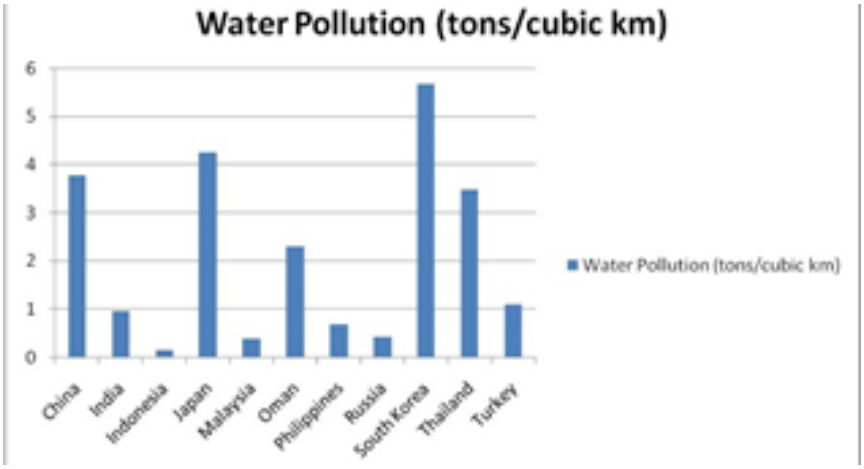


Fig.8.4. Water pollution in different countries

- **AGRICULTURE-**

Agriculture uses 70% of the world's accessible freshwater, but some 60% of this is wasted due to leaky irrigation systems, inefficient application methods as well as the cultivation of crops that are too thirsty for the environment in which they are grown. This wasteful use of water is drying out rivers, lakes and underground aquifers. Many countries that produce large amounts of food including India, China, Australia, Spain and the United States have reached or are close to reaching their water resource limits. Added to these thirsty crops are the fact that agriculture also generates considerable freshwater pollution.

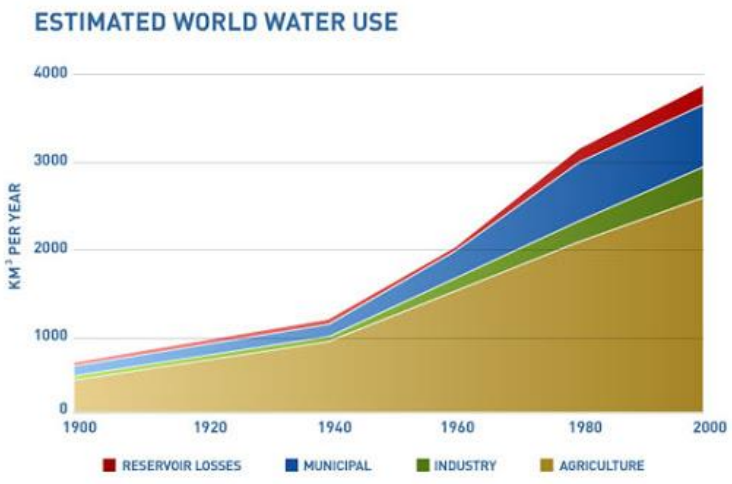


Fig.8.5. Water use in different Sectors

- **POPULATION GROWTH-**

  In the last 50 years, the human population has more than doubled. This rapid growth—with its accompanying economic development and industrialization—has transformed water ecosystems around the world and resulted in a massive loss of biodiversity. Today, 41% of the world's population lives in river basins that are under water stress. Concern about water availability grows as freshwater use continues at unsustainable levels. Furthermore, these new faces also need food, shelter, and clothing, thus resulting in additional pressure on freshwater through the production of commodities and energy.

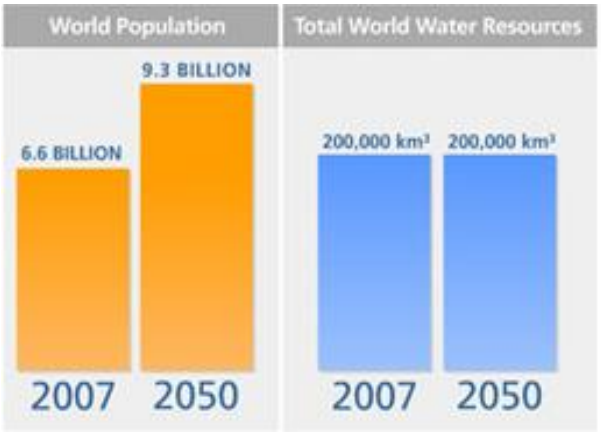


Fig.8.6. Relation between the Population and Water resources

Effects Of Water Scarcity :

- The problem of water scarcity has gained a lot of importance due to the potential damage it can inflict. As per some reports, 1.1 billion people worldwide lack access to water, and a total of 2.7 Billion people find water scarce for at least one month of the year.
- As per 2017 Global Risks Report of the World Economic Forum [19], in terms of impact on humanity, the water crisis is ranked as the 3rd most important global risk.
- Governments will be forced to choose between agricultural, industrial, municipal or environmental interests and some groups would win at the expense of others.
- Water scarcity can result in forced migration. It may lead to domestic or regional conflicts, in geopolitically fragile areas.

- As per the UN report [20], over 2 Billion people live in countries experiencing high water stress. As per UNESCO [21] 24 Million and 700 Million people will be displaced in some Arid and Semi-arid regions by 2030.
- Inadequate sanitation is also a problem for 2.4 Billion people. They are exposed to diseases, such as Cholera [22] and Typhoid [23] fever, and other water-borne illnesses. 2 million people, mostly children, die each year from diarrheal diseases alone.

WATER SCARCITY IN INDIA

India has 4 % of the world's freshwater which has to cater to 17 % of the world's population.

As per NITI Aayog [24] report released in June 2019, India is facing the worst-ever water crisis in history. Approximately 600 million people or roughly around 45 % of the population in India is facing high to severe water stress. As per the report, 21 Indian cities will run out of their main source of water i.e. groundwater by 2020. The report goes on to say that nearly 40 % of the population will have absolutely no access to drinking water by 2030 and 6 % of India's GDP [25] will be lost by 2050 due to the water crisis.

Fig.8.7. Water scarcity in INDIA

Water Geopolitics

Water wars!

They have been predicted since the 1970's.The Egyptian president Sadat, for instance, referred to water scarcity as "The only matter that could take Egypt to war again". Since then, various indicators on water use and water availability demonstrate that water scarcity has increased - but still these water wars did not happen. Even more, societies seemed to be quite resilient to the effects of water scarcity.

So why does this discourse about potential water wars and water scarcity as a threat to national security still persist?

In this report, we will explore this contradiction in discourse and water politics of the various countries. We look into issues that link water and development, and how governance of increasingly scarce water resources relates to conflict over access to and control over these resources. Especially when ideology and 'privatization' gets in the way of development and geopolitics enters the stage.

“I believe water will be the defining crisis of our century, the main vehicle through which climate change will be felt from droughts, storms, and floods to degrading water quality. We’ll see major conflicts over water; water refugees. We inhabit a water planet, and unless we protect, manage, and restore that resource, the future will be a very different place from the one we imagine today.” -Alexandra Cousteau

THE GEOPOLITICS OF NILE RIVER

The Nile River is one of the most geopolitically significant waterways in the world. It's the lifeblood of Egypt and runs through 10 African countries, providing a regular source for conflict over water rights and distribution.

Egypt could not survive without the Nile. The river is the desert country's primary source of fresh water and irrigation for agriculture. About 99 percent of Egypt's 83 million

inhabitants live along the narrow sliver of greenbelt on each bank of the Nile river, covering an area about 22,000 square miles from the Aswan High Dam to the Mediterranean shore. Cairo has historically dominated usage of the Nile waters, but upstream countries are challenging distribution.

Flowing from two main tributaries — the White Nile and the Blue Nile — the river is also a major source of geopolitical contention through much of Central and East Africa. The larger of the two tributaries, the Blue Nile, originates in Ethiopia and the White Nile originates in the Great Lakes region, making it the world's longest river. Cooperation among the Nile river states varies widely and each seeks water usage for agriculture, domestic and industrial uses, as well as the right to build dams for hydroelectric power. Cairo's historic claim to the river is no longer guaranteed, and among the upstream countries, Ethiopia is most active in pursuing self-development projects, like the Grand Ethiopian Renaissance Dam that could impact Cairo's water usage.

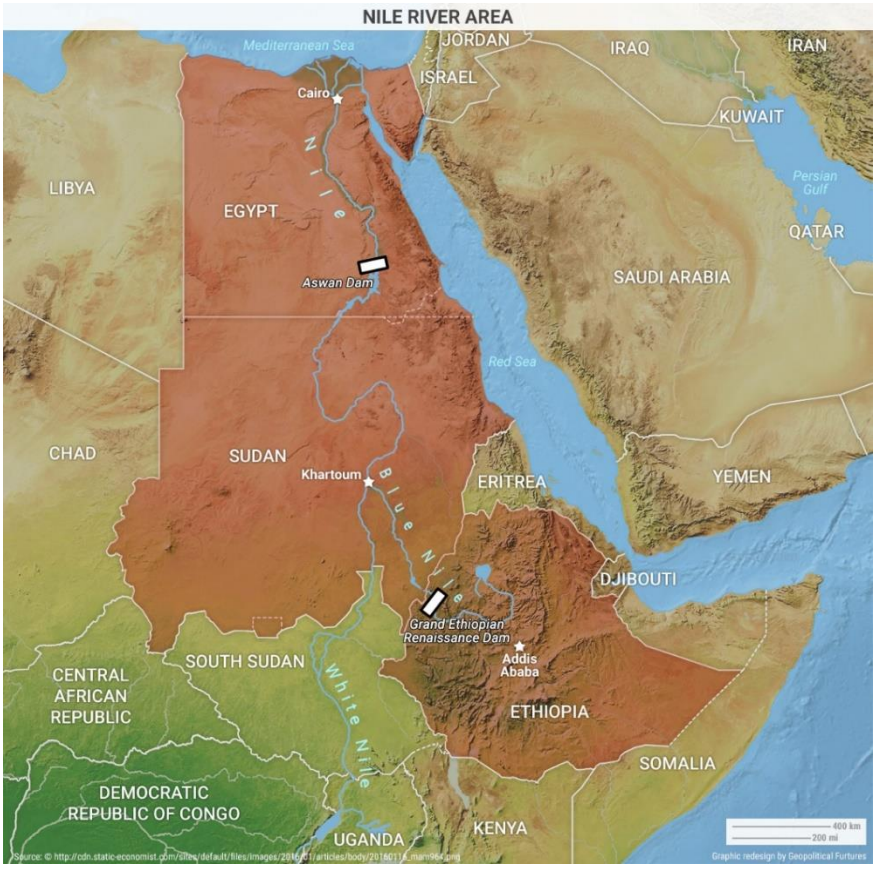


Fig.9.1. Geopolitics for River Nile between Egypt, Sudan and Ethiopia

World Water Day [28] 2019: "Leaving no one behind" in the Nile River basin

During the past 3 decades of various global sustainable development action plans (with Agenda 21 in 1992, the Millennium Development Goals from 2000 to2015, and now the Agenda 2030 with the Sustainable Development), the hardest thing proved to target the 'marginalized groups' in society (see: World's most marginalized still left behind by global development priorities: UNDP report).

Water, Development and Conflict

In the Nile River Basin, every aspect of human development is connected by water. Growing food, getting basic hygiene, earning a living, doing sports or having a nice environment all depend on access to sufficient water. Population growth and economic development push the rapidly rising demand for water; they also lead to environmental degradation and climate change, putting additional pressure on water resources and threatening their renewable supply. Water then becomes increasingly scarce.

GEOPOLITICS BETWEEN INDIA-PAKISTAN

The water dispute between Pakistan and India began during the early 1960s.
However, the Indus Treaty between the two countries created an understanding of how water between the two countries would be shared. Six rivers that is; the Chenab, Indus, Beas, Sutlej, Ravi and Jhelum flow to Pakistan from India. This treaty divided three rivers for use by each country, and India had the Beas, Sutlej and Ravi. Pakistan had access to the Jhelum, Chenab and Indus. During the 1990s, India constructed a hydro-electric plant in Doda district along Chenab River. This river is one of the tributaries of the Indus River and was designated by the Indus Treaty for use by Pakistan.

Status of disputes between Pakistan and India over water sharing

Indus water treaty

The Indus water treaty was developed to solve the water dispute between Pakistan and India during the 1960s. This treaty set out how water from the various rivers is to be shared between India and Pakistan. India was granted access to the Jhelum, Chenab and Indus rivers for purposes of developing hydro-electricity but not construction of dams. However, for development in these rivers to be acceptable, India is expected to provide technical

details of projects to Pakistan before commencing operations. India on the other hand has access to the Beas, Sutlej and Ravi rivers. For Pakistan to develop these rivers, it is similarly expected to provide India with details, before commencing operations. Pakistan is also not allowed to develop dams along these three rivers. When India was constructing the Baglihar Dam, Pakistan had several concerns which it raised during this process. These include the dam size, design, water capacity and gated spillways. Although there have been numerous discussions on these contentious issues, the 1960 treaty has been insufficient in ending the conflict.

Present status of the dispute

The dispute between Pakistan and India over water has continued over several decades. Currently, the dispute revolves around the construction of a hydro-electric plant along a tributary of Indus, which is Kishenganga River. Although India is defending its right to construct the dam, Pakistan is raising several issues over the project. Pakistan explains that India is planning to divert the river course and this is bound to have adverse effects on Pakistani who rely on the river. Pakistani officials explain that this would reduce the capacity of the river by more than 30% during winter as a result. When this happens, the Pakistani plans to construct their own dam will be adversely affected. However, the dispute is about to be solved through arbitration, as both parties are hopeful to see this mechanism work.

However, this conflict has adversely affected both countries by limiting development through cooperation. It also poses a danger of encouraging terrorism between the two countries especially if terrorists find it a cause worthy of their intervention. This conflict may also degenerate into war, especially if a terrorist activity occurs as a result of the conflict or if leaders intentionally provoke each other in a bid to resolve the dispute. This may lead to a regional war and may cause very many fatalities.

Finally, water conservation is an important policy which should be embraced by Pakistan and India to reduce expenses on water costs and prevent the depletion of the water resource. These measures should be embraced by all countries with resources, since they will prevent future problems or conflicts which are associated with possession of resources.

GEOPOLITICS IN MEXICO

There is water, but not for everyone The National Water Resources Plan for 2014-2018 indicates that average natural water availability per capita in Mexico fell from 18,035 cubic metres a year in 1950 to 3,982 cubic metres in 2013.

In spite of this reduction, water availability is not the main problem. United Nations guidelines state that countries with less than 1,000 cubic metres per capita per year suffer from water scarcity, and those with between 1,000 and 1,700 cubic metres per person face water stress.

In absolute terms, Mexico has an average annual water availability of 471 billion cubic metres, according to CONAGUA's Water Atlas 2013, including surface and underground water as well as water imported from the United States under bilateral treaties.

However, nearly 14 million people have no water in their homes. The problem is greatest in the states of Veracruz (southeast), Guerrero (southwest), and Mexico state (centre) adjacent to the nation's capital.

Moreover, 34 million people depend for their water on aquifers that are gradually drying out.

De facto privatization

The organizations and academics blocked the CONAGUA bill because they viewed it as a water privatization measure that commodifies the resource, bans research into water quality and levels of pollution, and favours diversion of the flow of rivers and the construction of dams and other works.

"The risk is that inequality will increase. We need comprehensive management of water resources," said Arellano.

De facto privatization of water services has continued to advance slowly in Mexico in a number of different ways. Agua para Todas, Agua para la Vida (Water for All, Water for Life) is a network made up of more than 400 researchers and 30 NGOs that has created a map of water conflicts sparked by deforestation, overuse, pollution and other causes.

In 2013 the volume of water handed over in concession for use in agriculture and industry surpassed 82 billion cubic metres, 51 billion of which came from surface sources and 31 billion from aquifers.

"There is a lack of transparency about which companies have benefited from privatization. There is no need to wait 20 years to see its effects," Campero said.

By 2030 – in 15 years' time – demand is forecast to increase to over 91 billion cubic metres while supply will only reach 68 billion cubic metres, a gap between supply and demand for which innovative solutions have still not been envisaged.

"We want water; it is not fair that the state should deny us access to it," complained Romero in the Azcapotzalco neighbourhood of Mexico City.

WATER WITH BORDERS

When states compete over these scarce water resources, often 'national security' pops up as a concern. Water then gets politicized - 'securitized' - and becomes a devisive rather than a binding element. As national security and ideology are closely linked, it will be increasingly difficult for states to compromise on sharing these water resources.

This is especially the case in the Middle East and the Nile River Basin, and tensions over water gave birth to the discourse of 'water conflicts' and 'rivers of fire', images that popular media are eager to adopt.

On the face of it, violent interstate competition over water resources doesn't seem so strange in the context of ongoing political tensions in the Middle East. Can't water fuel the fire in the Israeli-Arab conflict, or spark something more dangerous among Turkey, Kurds, Saudi Arabia or Iran in the Great Game of the Gulf?

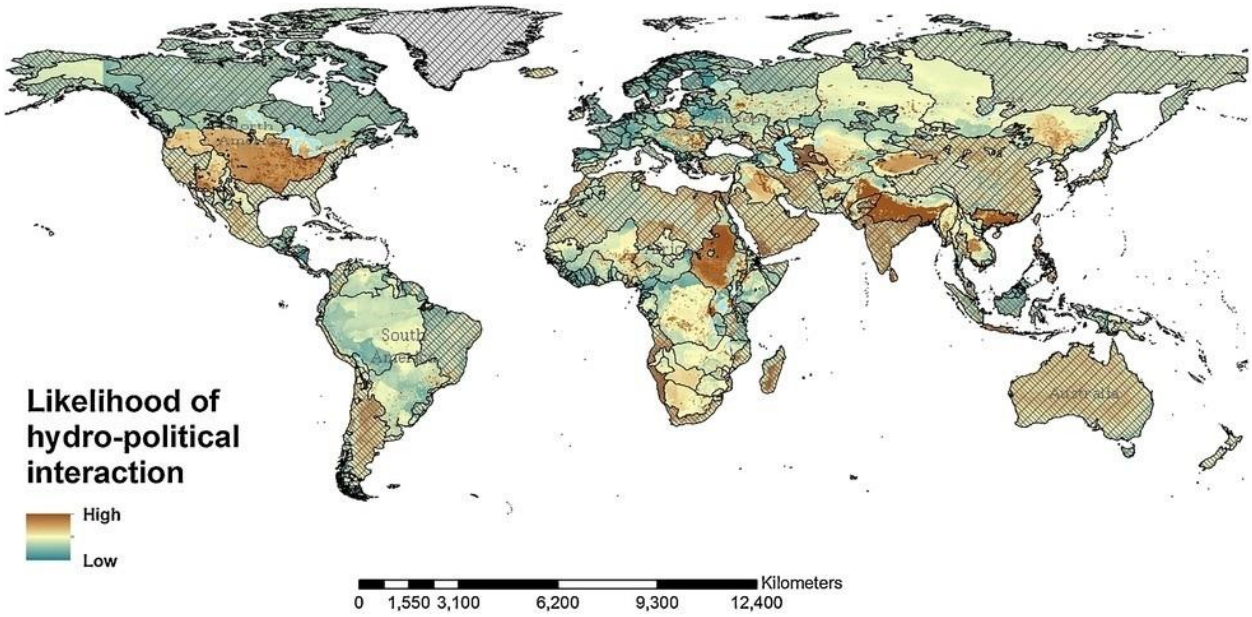


Fig.9.2. Waters war heat map

Past experiences demonstrate that cooperation is however more likely to happen than open conflict over water. Just as every once in a while, tensions rise over damming the Nile River, adversaries still sit together in the conference rooms of the Nile Basin Initiative.

THE GEOPOLITICS OF INDIA'S WATER WOES

India has been hit with an onslaught of destructive floods followed by severe droughts in recent years. Meanwhile, the country's increasing animosity with Pakistan risk complicating the Indus Water Treaty, which dictates the share of water each country receives from the Indus River basin. Suffice to say, water has become a hot geopolitical issue for the country of 1.3 billion people, and likely will be for the foreseeable future.

In this podcast, Stratford's South Asia Analyst, Faisel Pervaiz, speaks with contributor Ambika Vishwanath about India's escalating water crisis and the ways in which it will seep into each crevice of the country's domestic and foreign policy aims.

Privatization Of Water

Water privatization refers to the transfer of ownership of water resources from the public sector to the private sector. Since 1990, the government, through its reforms, has encouraged private sector projects in the water sector in the hope that transferring the responsibility of water to private companies will bring more transparency and accountability to the process.

As per the policy, "Private sector participation should be encouraged in planning, development and management of water resources projects for diverse use, wherever feasible. Private sector participation may help in introducing innovative ideas, generating financial resources and introducing corporate management and improving service efficiency and accountability to users. Depending upon the specific situations, various combinations of private sector participation, in building, owning, operating, leasing and transferring of water resources facilities, may be considered."

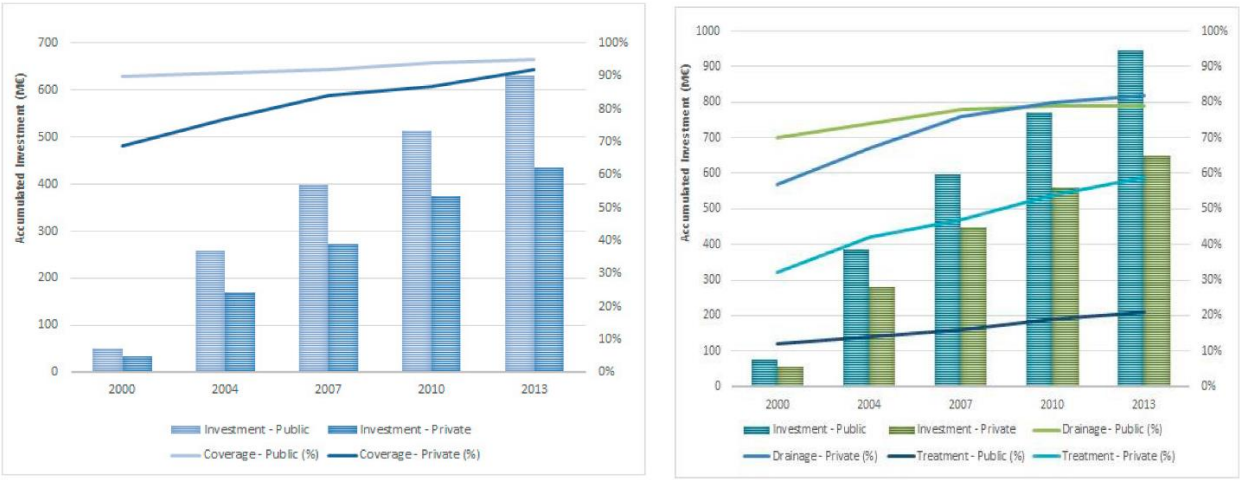


Fig.10.1. Comparison between Public and Private Sectors

FORMS OF PRIVATIZATION

Broadly speaking, there are two forms of private sector participation in water supply and sanitation. In a full privatization, assets are permanently sold to a private investor. In a public-private partnership, ownership of assets remains public and only certain functions are delegated to a private company for a specific period. Full privatization of water supply and sanitation is an exception today, being limited to England, Chile and some cities in the United States. Public-private partnerships (PPPs) are the most common form of private sector participation in water supply and sanitation today.

The three most common forms of PPPs, in the order of increasing responsibilities for the private partner, are:

- A management contract, under which the private operator is only responsible for running the system, in exchange for a fee that is to some extent performance-related. Investment is financed and carried out by the public sector. The duration is typically 4–7 years.
- A lease contract, under which assets are leased to the private operator who receives a share of revenues. It thus typically bears a higher commercial risk than under a management contract. Investment is fully or mostly financed and carried out by the public sector. The duration is typically 10–15 years.
- A mixed-ownership company in which a private investor takes a minority share in a water company with full management responsibility vested in the private partner.
- A concession, under which the private operator is responsible for running the entire system. Investment is mostly or fully financed and carried out by the private operator. The duration is typically 20–30 years.

Concessions are the most common form of PPPs in water supply and sanitation. They are followed by leases, also called affermages [29] that are most commonly used in France and in Francophone West Africa. Management contracts are used in Saudi Arabia, Algeria and Armenia, among others. Mixed-ownership companies are most common in Spain, Colombia and Mexico.

A concession for the construction of a new plant is called a Build-Operate-Transfer (BOT) contract. Under a BOT contract the private operator signs an agreement with a utility that purchases treated water or wastewater treatment services.

IMPACT OF PRIVATIZATION

The evidence concerning the impact of water privatization is mixed. Often proponents and opponents of water privatization emphasize those examples, studies, methods and indicators that support their respective point of view. As with any empirical study, results are influenced by the methods used. For example, some studies simply compare the situation before privatization to the situation after privatization. More sophisticated studies try to compare the changes in privately managed utilities to those of publicly managed utilities that operate under similar conditions during the same period. The second group of studies often use econometric techniques. The results also depend on the choice of the indicator used to measure impact: One common indicator is the increase in access to water supply and sewerage. Other indicators are changes in tariffs, investments, water-borne diseases or indicators for service quality (e.g. continuity of supply or drinking water quality) and efficiency (e.g. water losses or labor productivity).

Impact on Health

A study of water privatization's impact on health, as measured by child mortality, found that between 1991–1997 in Argentina child mortality fell 8 percent more in cities that had privatized their water and sewer services compared to those that remained under public or cooperative management. The effect was largest in poorest areas (26 percent difference in reduction). The main reason was a greater expansion of access to water in cities with privatized utilities. This increase was concentrated in poorer areas that did not receive services before private sector participation was introduced.

Water privatization has historically had mixed impacts on child mortality and the overall health of the people affected by it. In Argentina during the 1990s, areas where child mortality was upwards of 26% fell to just under 8% after water was privatized. This occurred due to the regulations private water companies were held to which were more rigorous than their government-controlled counterparts. A long with this, development of water infrastructure in impoverished areas at the hands of private companies also positively affected child mortality rates. Governments are prone to privatize water companies, among other reasons, to better the quality of the water provided to the country’s citizens. Children are more likely to be negatively affected by contaminated

waters which makes child mortality a good measure to dictate the effectiveness of water privatization.

In Argentina, water privatization did not fulfill many promises the citizens were expecting. This includes the expansion of sewerage treatment and connections and the reduction of the price of water, which actually increased. Along with this, the private water companies in Argentina needed help from the Argentine government to bypass regulatory agencies after it treated to cancel their contract due to conflicts of interest. It is also worth noting that many worker unions were opposed to privatizing water but their pleads were largely ignored by the Argentine government.
The impact of water privatization on the amount of carcinogenic found in water is highly debated. In some cases, such as the case in the state of North Rhine-Westphalia, Germany, public water systems are likely to invest more money into making water quality good. Water companies working on a commercial basis might find it too costly to implement systems to better the water quality beyond what is necessary by law. Thus, posing a greater threat of containing harmful cancer-causing substances in the water.

Impact on Tariffs

In almost all cases, water tariffs increased in the long run under privatization. In some cases, such as in Buenos Aires and in Manila, tariffs first declined, but then increased above their initial level. In other cases, such as in Cochabamba or in Guyana, tariffs were increased at the time of privatization. In some cases in Sub-Saharan Africa, where much of the investments are funded through development aid, tariffs did not increase over a long period. For example, in real terms tariffs remained stable in Senegal, while in Gabon they declined by 50% in five years (2001–2006) and by 30% in ten years in Côte d'Ivoire (1990 to 2000). These exceptions notwithstanding, tariff increases are the rule over the long term. However, initial tariffs have been well below cost recovery levels in almost all cases, sometimes covering only a fraction of the cost of service provision. Tariff increases would thus have been necessary under public management as well, if the government wanted to reduce subsidies. The magnitude of tariff increases is influenced by the profit margin of private operators, but also to a large extent by the efficiency of utilities in terms of water losses and labor productivity.

A study of household water expenditures in cities under private and public management in the U.S., however, concludes that "whether water systems are owned by private firms or governments may, on average, simply not matter much."

Impact on Efficiency

A World Bank study argues that the most consistent improvement made by public-private partnerships in water supply was in operational efficiency. Private operators thus made a strong indirect contribution to financing by improving efficiency, making it possible for utilities to finance investments internally instead of having to rely on more debt.

An earlier World Bank paper reviews six empirical studies on the impact of private management on the efficiency of water utilities in Africa, Asia, Argentina and Brazil. It concluded that some studies did find evidence for higher cost-efficiency by private operators and for improvements as a result of privatizations, but overall evidence suggests that "there is no statistically significant difference between the efficiency performance of public and private operators in this sector." A 2008 literature review by the Asian Development Bank shows that of 20 studies reviewed, only three show concrete evidence on technical efficiency improvements or cost reductions under private management.

PROFITABILITY

An empirical study of 34 concessions in nine Latin American countries during the 1990s, including 10 water concessions in 5 countries (3 in Argentina, 1 in Bolivia, 1 in Brazil, 3 in Chile and 2 in Colombia), has estimated the profitability of concessions compared to the cost of capital of private companies. According to the study, contrary to public perception, the financial returns of private infrastructure concessions have been modest. The average annual return on capital employed was 7 percent. For a number of concessions, the returns have been below the cost of capital. On average telecommunications and energy concessions have fared much better than water concessions. Seven out of 10 water concessions had negative rates of return and two concessions had returns that were lower than the cost of capital of the private companies

Organization

UN-WATER

United Nations Water (UN-Water) is an interagency mechanism that coordinates the efforts of United Nations entities and international organizations working on water and sanitation issues.
Water is at the core of sustainable development and is critical for socio-economic development, healthy ecosystems and for human survival itself. Ecosystems across the world, particularly wetlands, are in decline in terms of the services they provide. Water is vital for reducing the global burden of disease and improving the health, welfare and productivity of populations. Today, 2.1 billion people lack access to safely managed drinking water services and 4.5 billion people lack safely managed sanitation services.

Water is also at the heart of adaptation to climate change, serving as the crucial link between the climate system, human society and the environment. Without proper water governance, there is likely to be increased competition for water between sectors and an escalation of water crises of various kinds, triggering emergencies in a range of water-dependent sectors.

By 2025, 1.8 billion people are expected to be living in conditions with absolute water scarcity, and two-thirds of the world population could be under water stress conditions.

What UN-Water do:

Inform Policies

UN says "We face complex challenges to ensure everyone has access to sustainably-managed water and sanitation services. We need partnerships and collaboration to tackle the complexity of those challenges while helping to create a healthy, sustainable and prosperous world where no-one is left behind."

Key policy processes: UN-Water's Members and Partners have helped place water and sanitation at the heart of recent milestone agreements such as the 2030 Agenda for Sustainable Development and the 2015 Paris Agreement within the UN Convention Framework on Climate Change.

The Water Action Decade: In December 2017 UN Member States adopted United Nations General Assembly resolution 71/222 on an International Decade for Action on 'Water for Sustainable Development' 2018-2028.

In response to the ambitious 2030 Agenda, the Water Action Decade will accelerate efforts towards meeting water-related challenges, including limited access to safe water and sanitation, increasing pressure on water resources and ecosystems, and an exacerbated risk of droughts and floods.

Monitor and Report

One of UN-Water's key objectives is to provide coherent and reliable data and information on key water trends and management issues. During past decades, several initiatives, mechanisms and programmes, both within and outside the United Nations family, have been collecting information on the various components of the water cycle.

UN-Water's campaigns

Every year, UN-Water coordinates the United Nations international observances on freshwater and sanitation. Depending on the official UN theme of the campaign, they are led by one or more UN-Water Members and Partners with a related mandate. On World Water Day, UN-Water releases the World Water Development Report focusing on the same topic as the campaign.

Water Facts

Water is complex because it is linked to almost everything in the world. But complexity should not hinder understanding: Water is a precondition for human existence and for the sustainability of the planet.

History of UN-Water:

1977: The UN's Inter-secretariat Group for Water Resources coordinates UN activities on water and has a three-person secretariat in the UN Department of Economic and Social Affairs' (UN-DESA) predecessor in New York.

1992: The Group is subsumed into the UN Administrative Coordination Committee's (ACC) Subcommittee on Water Resources, which functions for several years before being disbanded. Members continued.

1993: The UN General Assembly designates 22 March as World Water Day [28].

2003: UN-Water is established, endorsed by the successor to the ACC: the UN System Chief Executives Board for Coordination.

2005-2015: UN-Water coordinates the 'Water for Life' International Decade for Action, culminating in the Sanitation Drive to 2015.

2012: The Key Water Indicator Portal is launched, backed by a federated database containing data from several UN agencies.

2013: The UN General Assembly designates 19 November as World Toilet Day.

2014: UN-Water launches its 2014-2020 Strategy in support of the 2030 Agenda.

2015: The 2030 Agenda's Sustainable Development Goals are launched and a dedicated goal on water and sanitation is adopted by the UN General Assembly with input from UN-Water's Technical Advice Unit.

2016: The Integrated Water Monitoring initiative is launched with the aim of reporting on progress on water and sanitation in a coherent and coordinated way.

2017: "Why Waste Water" was the 2017 World Water Day theme emphasizing both the importance of not wasting water, as well as new policy initiatives around waste water.

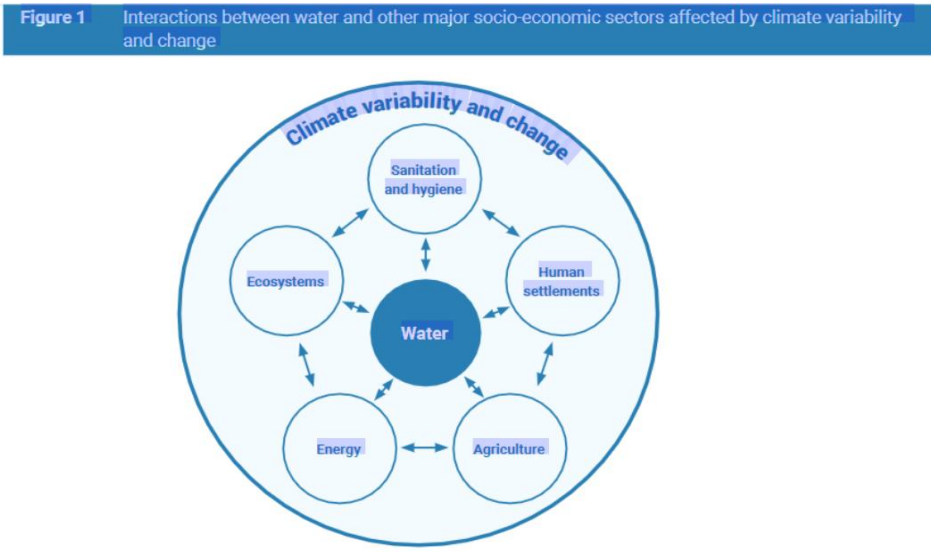


Fig.11.1 Interaction between water and different sectors

1) Water and Climate Change:

Water is the primary medium through which we will feel the effects of climate change. Water availability is becoming less predictable in many places, and increased incidences of flooding threaten to destroy water points and sanitation facilities and contaminate water sources. In some regions, droughts are exacerbating water scarcity and thereby negatively impacting people's health and productivity. Ensuring that everyone has access to sustainable water and sanitation services is a critical climate change mitigation strategy for the years ahead.

Challenges:

Higher temperatures and more extreme, less predictable, weather conditions are projected to affect availability and distribution of rainfall, snowmelt, river flows and groundwater, and further deteriorate water quality. Low-income communities, who are already the most vulnerable to any threats to water supply are likely to be worst affected. More floods and severe droughts are predicted. Changes in water availability will also impact health and food security and have already proven to trigger refugee dynamics and political instability.

Opportunities:
Water plays a pivotal role in how the world mitigates and adapts to the effects of climate change. An integrated view on water, the biosphere and environmental flows is required to devise sustainable agricultural and economic systems that will allow us to decelerate climate change, protect us from extremes and to adapt to the unavoidable at the same time.

2) Water and Disasters:

When disaster strikes, it usually manifests itself through water. Floods, landslides, tsunamis, storms, heat waves, cold spells, droughts and waterborne disease outbreaks are all becoming more frequent and more intense. The impacts and costs of these events are exacerbated by such factors as unplanned urbanization and degradation of ecosystem services. Reducing risk to, and improving the resilience of, water and sanitation services will be key to maintaining access during a climatically uncertain future.

Challenges:
Water-related disasters pose both direct impacts (e.g. damage to buildings, crops and infrastructure, and loss of life and property) and indirect impacts (e.g. losses in productivity and livelihoods, increased investment risk, indebtedness and human health impacts).The increasing economic cost and toll of disasters should be a significant incentive for governments and humanitarian organizations to focus more attention on preparedness, prevention and addressing the root causes of vulnerability.

Opportunities:
Meeting the challenges associated with water-related disasters requires investment in and implementation of good disaster risk-reduction. Despite improvements in preventive efforts, scaling these up to meet current and future needs remains a central challenge.

3) Financing Water and Sanitation:

A radical increase in water and sanitation investments is required to finance the Sustainable Development Goals, according to the UN-Water GLAAS report released in

2017. The current level of WASH (water, sanitation and hygiene) financing is not sufficient to meet SDG targets to achieve universal access to safe and affordable drinking-water, adequate sanitation and hygiene.

4) Water Scarcity:

Water scarcity can mean scarcity in availability due to physical shortage, or scarcity in access due to the failure of institutions to ensure a regular supply or due to a lack of adequate infrastructure. Water scarcity already affects every continent. Water use has been growing globally at more than twice the rate of population increase in the last century, and an increasing number of regions are reaching the limit at which water services can be sustainably delivered, especially in arid regions.

Challenges:
Water scarcity will be exacerbated as rapidly growing urban areas place heavy pressure on neighbouring water resources. Climate change and bio-energy demands are also expected to amplify the already complex relationship between world development and water demand.

Opportunities:
There is not a global water shortage as such, but individual countries and regions need to urgently tackle the critical problems presented by water stress. Water has to be treated as a scarce resource, with a far stronger focus on managing demand. Integrated water resources management provides a broad framework for governments to align water use patterns with the needs and demands of different users, including the environment.

5) Human Rights to Water and Sanitation:

Access to water and sanitation are recognized by the United Nations as human rights, reflecting the fundamental nature of these basics in every person's life. Lack of access to safe, sufficient and affordable water, sanitation and hygiene facilities has a devastating effect on the health, dignity and prosperity of billions of people, and has significant consequences for the realization of other human rights.

Challenges and opportunities:
International human rights law demands a specific focus on those people who do not fully enjoy their rights, leading to explicitly 'pro-poor' development in many countries. It also requires a commitment to progressively reduce inequalities by tackling the discrimination and stigmatization that can lead to people being excluded from, or marginalized in relation to, water and sanitation access.
What are the rights and what do they mean?

- The right to water entitles everyone to have access to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic use.
- The right to sanitation entitles everyone to have physical and affordable access to sanitation, in all spheres of life, that is safe, hygienic, secure, and socially and culturally acceptable and that provides privacy and ensures dignity.

Water-Aid

Water-Aid is an international non-governmental organization, focused on water, sanitation and hygiene. It was set up in 1981 as a response to the UN International Drinking Water decade (1981–1990). It operates in 34 countries as of 2018.

The organization was first established by the UK water industry on 21 July 1981 as a charitable trust at their main office premises in London, and established first projects in Zambia and Sri Lanka. In 2010, it became a federation comprising as of 2018 members in the United Kingdom, USA, Australia, Japan, Sweden, Canada and India, and regional offices and country programmes in 27 countries in Latin America, Africa and Asia. Activities involve providing people with clean water, safe sanitation and hygiene behavior change, and advocacy with governments and water utilities.

History:

Water-Aid was founded in 1981 by members of the UK water industry at the Thirsty Third World conference held in London. Water-Aid was formally established as a charity in the UK on 21 July 1981. Its president is Prince Charles, the Prince of Wales, since 1991. Other members were established as follows: Water-Aid America and Australia in 2004, Sweden in 2009. In 2010, the organization became a federation, and established the Water-Aid

International secretariat. In 2014, Water Can/EauVive, an NGO founded in Canada in 1987, became Water-Aid Canada and joined the federation.

Activities:

Water-Aid works in partnership with local organisations in 34 countries in Africa, Asia, Central America and the Pacific region to help poor communities establish sustainable water supplies and toilets, close to home, and to promote safe hygiene practices. It also works to influence government water and sanitation policies to serve the interests of vulnerable people and to ensure water and sanitation are prioritized in poverty reduction plans.

Canada

Water Can/EauVive was established as a registered Canadian charity in 1987 by Michael Lubbock to "help the world's poorest people gain access to clean drinking water, basic sanitation and hygiene education". It works in 37 countries — like Bangladesh, Kenya, Nicaragua, and Uganda — by partnering with local organizations to assist the poorest and most marginalized communities. Water-aid Canada implemented sanitation projects benefiting 2.2 million people and safe water projects benefiting 1.7 million people by 2014. The charity also organized 4,000 education sessions focused on menstrual hygiene in Bangladesh. It receives funding through donations by individuals, organizations, and foundations and the Canadian International Development Agency. In 2013, it became a member of the global federation Water-aid, and was named Water-aid Canada in mid-2014.

Zambia

Water-Aid first started work in Zambia during the 1992-1994 drought. Since then, the organization has expanded its operations to seven districts in the country, five of which are in the Southern Province (Monze, Siavonga, Namwala, Itezhi Tezhi and Kazungula) while the other two are Kafue in Lusaka Province and Kaoma in Western Province. The organization spends about ZMK8-9 billion (just over £1 million) annually on projects there, and have since provided 42,600 people in Zambia with access to clean, safe water.

Efforts in Monze District

Water-aid is working with the government to help extend access to safe water, sanitation and improved hygiene for rural communities in Monze District. Sichiyanda is one such village in the Monze district where efforts are in progress. Projects in the village began in 2001 and the community worked together to dig a well with a dedicated bucket and windlass. Hygiene education is also taking place, where villagers are taught to keep areas clean by building dish racks and rubbish pits and ensuring that there are no stagnant pools of water where mosquitoes can breed. In addition, 28 latrines have already been constructed with more underway. Such programmes have led to significant improvements in the lives of villages in rural Monze.

India

Water-Aid works closely with its partners in local communities to utilize low cost technologies to deliver sustainable water supply, sanitation and hygiene solutions to the poor in the economically less developed countries. Water-Aid's vision is of a world where everyone has access to safe water and sanitation. Today, Water-Aid covers over ten states (Andhra Pradesh, Bihar, Chhattisgarh, Delhi, Jharkhand, Karnataka, Madhya Pradesh, Orissa, Tamil Nadu and Uttar Pradesh), rendering their services to the communities that needed help most.

Role in India- The main thrust of Water-Aid India's projects is to advocate the use of latrines and to provide hygiene education with training manuals to the poorer and less educated areas. It aims to bring across the detrimental effects of poor hygiene; such as diseases, loss of efficiency and high expenses in the form of costly medicine. Water-Aid India hopes to inspire local communities to develop their own cost effective solutions to the existing problems.

In addition, Water-aid India, with other partner organisations, came together to tackle the issue of having access to potable water in the coastal states of India. Sustainable development has proved challenging for many of India's coastal states, as they struggle to balance their delicate ecology against heavy economic demands and the desire for growth. Water-aid India and its partners explored the feasibility of technological alternatives to the problem of salinity in the groundwater - for example, rainwater harvesting, desalination and dew harvesting - and looked towards establishing an area-specific strategy for ensuring access to a domestic water supply in coastal regions.

Solution

This report has brought together case studies from around the world of currently available, replicable and practical solutions for water use transformation.

United Kingdom- Balancing Supply and Demand through Water Metering

The south and east of England has an average annual rainfall of around 700mm, with effective rainfall only about 400mm; much less in drought years. The low rainfall, coupled with a high density of population, forecast significant growth and the potential impact of climate change mean that an already water-stressed region will become even more so over the next two decades. In 2010, Southern Water Services Ltd (SWS), in order meet the supply-demand gap, commenced a five year project to install 500,000 intelligent meters. This was accompanied by significant customer engagement and a leakage reduction programme in order to demonstrate that the company was also working to reduce losses.

Kalol, India- Reducing the cost of water re-use in the textile sector

The textile industry forms a critical part of the Indian economy contributing 4% of total GDP and employing over 45 000 000 people. The processing of textiles is, however, a significant user of freshwater and poses significant pollution challenges in the disposal of its wastewater.

Dan Region, Israel- Effluent treatment and aquifer storage for agricultural use

Effluent re-use for irrigation is vital in water conservation in Israel, helping to facilitate reduced freshwater withdrawal nation-wide. Now, over 40% of Israel's agricultural water needs are currently supplied by effluent water.

Adana, Turkey- Reducing water use in fish and seafood processing

The seafood and fish processing industry consumes high volumes of water in order to maintain appropriate hygiene levels and prevent the products from spoilage. In addition up to 70% of the raw fish is discarded as waste, predominantly through the wastewater system of the processing facilities, producing heavy organic effluent.

Guadiana, Spain- Integrated water resource management in Agriculture

Groundwater has been used for irrigation in the Upper Guadiana Basin for centuries. The region is semiarid, with an annual rainfall of 415mm, and is characterized by interconnecting aquifers and groundwater dependent ecosystems like the Tablas da Daimiel National Park wetland.

Rajasthan, India- Basin based approach for groundwater management

SABMiller India partnered with local stakeholders in Alwar to implement a basin-wide groundwater management initiative which ensures the security and sustainability of the local deep aquifer. The deep aquifer is the only reliable source of water supply for the agricultural, industrial and municipal sectors in the semi-arid region. The seasonal monsoon rainfall is the only other source of water supply.

SOLUTION FOR PREVENTING WATER PROBLEMS IN INDIA

AT CENTRAL GOVERNMENT LEVEL :

Ministry of Jal Shakti

The Government of India established the Ministry of Jal Shakti to consolidate interrelated functions pertaining to water management. The Ministry launched Jal Shakti Abhiyan – a campaign for water conservation and water security.

Jal Shakti Abhiyan Campaign helped us by building -

1592 water-stressed blocks in 256 districts

The major focus areas of Jal Shakti Abhiyan is given below

- Water conservation and rainwater harvesting
- Renovation of traditional and other water bodies/tanks
- Borewell recharge structures
- Watershed development
- Intensive afforestation
- Block and District water conservation plans
- Promotion of efficient water use for irrigation
- Better choice of crops for Krishi Vigyan Kendras

Jal Abhiyan is a time-bound, mission-mode water conservation campaign. Hence to make sure that efforts are going in the right direction, The National Institute for Transforming India (NITI) Aayog has developed a comprehensive water management metrics named Composite Water Management Index (CWMI) [27].

The Government of India has announced an ambitious target of providing piped clean drinking water to all villages by 2024.

Adoption of Composite Water Management Index (CWMI) [27]

The National Institute for Transforming India (NITI) Aayog has developed the Composite Water Management Index (CWMI) [27] to enable effective water management in Indian states. The first edition was published in 2018 and became a very well-received publication inside and outside the country.

Mandate of CWMI

Establish a benchmark for state-level performance on key water indicators.

Identify the high performing states and low performing states thereby inculcating a culture of constructive competition among states

Identify areas for deeper engagement and investment on the part of the states.

AT STATE GOVERNMENT LEVEL :

Rajasthan – Mukhya Mantri Jal Swalambhan Abhiyan (MJSA)

The objective is to make villages self-sufficient in water through participatory water management approach.

Launched in 2016

A unique feature is the usage of Drones to identify water bodies for restoration. Gram Sabha in villages is responsible for budgeting of water resources for different uses, providing greater power to the community members in decision-making.

6 Accomplishments of the MJSA program-

In the 1st 2 phases of the program, 7742 villages in Rajasthan benefited by 2.3 Lakh water conservation activities.

In the 2nd phase, 1.35 Lakh water conservation structures were created in 4213 villages.

Benefited more than 88 lakh people, 93 lakh heads of livestock, covering an area of 33.50 Lakh hectares. 64 % of the handheld pumps had been rejuvenated.

Andhra Pradesh – Neeru Chettu Programme

The objective is to make Andhra Pradesh drought-proof and reduce economic inequalities through better water conservation and management practices. Highlights of the program are given below.

- Repaired about 7,000 farm ponds
- Repaired 22,000 check dams
- 102 lift irrigation schemes have been commissioned or revived.

This program has enabled irrigation access to approximately 2, 10,000 acres of land in the state.

Maharashtra – Jalyukt Shivar Abhiyan

Launched in 2015 – 16, with the aim of making 5000 villages water scarcity free, every year. This program entails the : Deepening and widening of streams. Construction of cement and earthen stop dams, Works on nullahs (sewage) and digging of farm ponds.
3 Accomplishments of the Jalyukt Shivar Abhiyan program

- Increase in groundwater levels of 1.5 to 2 metres.
- 11,000 villages have been declared drought-free
- Agricultural productivity has increased by 30 % – 50 %

Gujarat – Sujalam Sufalam Yojana

It is a water conservation scheme by the Gujarat Government launched in May 2018; it focuses on Deepening of water bodies before monsoons and Desilting of water bodies.
Target to increase water storage capacity by 11,000 lakh cubic feet through deepening of 13,000 lakes, check dams, and reservoirs. The program was a success as per media reports.
2nd edition was launched in 2019 in which the state increased its financial contribution to 60 % for programme activities, requiring private entities to pay only remaining 40 %

Madhya Pradesh – Kapil Dhara Yojana

Develop irrigation facilities on private land of small and marginal farmers, through the construction of dug wells, farm ponds, check dams etc.
Focuses on providing financial support to landholders without access to irrigation facilities and prioritizes marginalized communities to maximize impact.
The program has contributed to improved productivity, intensity, and diversity of crop production in the region and generates livelihood sources.

EUROPEAN UNION WATER INITIATIVE (EUWI): WATER POLICY REFORMS IN EASTERN EUROPE, THE CAUCASUS AND CENTRAL ASIA (EECCA).

In addition to analytical work, the OECD works with selected regions and countries to facilitate the reform of water policies. This confirms our aspiration to make reform happen.
Korea l Brazil l the Netherlands l Mexico l EECCA

KOREA

The 2018 report managing the Water-Energy-Land-Food Nexus in Korea: Policies and Governance Options assesses the key bottlenecks within the water-energy-land-food nexus in Korea, and proposes policy recommendations and governance arrangements to future-proof environmental integrity and enhance sustainable growth. Launched at the 2017 Korean International Water Week, the report Enhancing Water Use Efficiency in Korea: Policy Issues and Recommendations' main objective is to enhance water efficiency in Korea, by promoting innovation while minimizing the need for additional infrastructures; and focuses on three related areas:

i) Pricing instruments under the remit of MoLIT [33] and K-water

ii) The promotion of innovation, in particular the smart water management

ii) Water allocation regimes. Active participation of other ministries and stake holders is sought.

In 2016, the OECD and the Ministry of Land, Infrastructure and Transport (MoLIT)[33] embarked on a policy dialogue aimed at advancing the water agenda under the responsibility of MoLIT[33], to ensure that water management contributes to a sustainable and creative economy in Korea.

BRAZIL

The 2017 report Water Charges in Brazil: The Way Forward examines the current system of water abstraction and pollution charges in operation in Brazil. It assesses the current system's implementation challenges and provides possible solutions. The report explores how water charges can be both an effective means for dealing with water security issues, and a tool for enhancing economic growth and social welfare. Specific analysis is put forward for three case studies in the State of Rio de Janeiro, the Paraiba do Sul River Basin and the Piancó-Piranhas-Açu River Basin. The report highlights that water charges need

to operate in conjunction with an effective water regulatory regime and concludes with an Action Plan based on practical steps and recommendations for its implementation in the short, medium and long-term.

The 2015 report Water Resources Governance in Brazil captures the main messages and sets an action plan. Water is abundant in Brazil, but unevenly distributed across regions and users. Brazil faces at the same time severe droughts and an overabundance of water. For example, the 2015 drought in the São Paulo region occurred at the same time the Amazon region suffered severe flooding. Future economic, demographic, and climate trends make these issues more critical, as they affect rainfall variability, availability and demand, and increase the number of people and assets at risk.

The National Water Agency called on the OECD to

i) clarify the institutional arrangements, and in particular the interplay between federal and state initiatives
ii) review prevailing water allocation regimes, with a view to enhance water efficiency at least cost for the community.

THE NETHERLANDS

Two-thirds of the Dutch territory, more than half of the population and two-thirds of the economic activity, are at risk of flood. As a result, water management has long been a national security issue for The Netherlands. Due to this unique situation, and centuries of concerted effort and dedicated ingenuity to "keep feet dry", the Dutch have become a global leader in water management.

However, in the face of broader administrative reforms, fiscal tightening and increasing water challenges due to climate change, a number of key questions have emerged: how fit is the current system to meet future challenges? Are the current water governance and institutional arrangements effective and resilient? Is the Dutch society willing and able to pay the rising costs of water management? Can the Dutch "polder" approach effectively address issues related to the quality of the rivers and lakes, and cope with increasing risks of both floods and scarcity in the country?

To shed light on these questions, the OECD-Netherlands Policy Dialogue on Water Governance was set up. The report Water Governance in the Netherlands: Fit for the Future? flags issues which could shape an agenda for future water policies in the Netherlands.

MEXICO

Mexico's 2030 Water Agenda, designed by the National Water Commission of Mexico (CONAGUA), advocates for a new paradigm for more efficient management of water resources and services. The OECD worked with Mexico to provide evidence-based assessment, analytical guidance, and customized policy recommendations in support of its water policy reforms. The process was based on OECD tools, methodologies and frameworks, and involved high-level peer reviewers and experts from Australia, Brazil, Italy, and the United Kingdom.

The process was useful to engage stakeholders, particularly as the Head of State and senior officers at the Mexican Water Commission changed during the course of the project.

The report Making Water Reform Happen in Mexico was handed over to the President of Mexico right after his election to serve as a reference for major policy reforms. It is being used by donors to target their co-operation.

WATER POLICY DIALOGUES IN EASTERN EUROPE, THE CAUCASUS AND CENTRAL ASIA

The OECD assists the EECCA [30] countries in adopting a more integrated approach to water management, applying robust economic and financial analyses and improving multi-stakeholder participation. It also helps in identifying and removing some of the key obstacles to effective and efficient water management, while reflecting countries' level of socio-economic development. This work is part of the EECCA [30] component of the European Union Water Initiative (EUWI) [32], for which the OECD is a strategic partner, together with the UNECE. The EUWI [32] EECCA [30] is funded by the European Union with co-financing from Austria, Finland, Germany, Norway, and Switzerland.

The EUWI [32] EECCA [30] combines a regional co-operation dimension, where countries in the region share experience on water-related challenges and successful reforms; and country specific multi-year National Policy Dialogues (NPDs), where the OECD and UNECE facilitate reforms in the field of integrated water resource management and/or water supply and sanitation. The OECD focuses on the economic aspects of water resources management (policy coherence, managing water for growth and making the best use of economic instruments for water management), and on the financial sustainability of water supply and sanitation services (strategic and mid-term financial planning and financial support mechanisms to the sector). The UNECE focuses on the co-operation related to the trans-boundary waters.

ACTS RELATED TO WATER IN INDIA

1882 - The Easement Act allows private rights to use a resource that is, groundwater, by viewing it as an attachment to the land. It also states that all surface water belongs to the state and is a state property.

1897 - The Indian Fisheries Act establishes two sets of penal offences whereby the government can sue any person who uses dynamite or other explosive substance in any way (whether coastal or inland) with intent to catch or destroy any fish or poisonous fish in order to kill.

1956 - The River Boards Act enables the states to enroll the central government in setting up an Advisory River Board to resolve issues in inter-state cooperation.

1970 - The Merchant Shipping Act aims to deal with waste arising from ships along the coastal areas within a specified radius.

1974 - The Water (Prevention and Control of Pollution) Act establishes an institutional structure for preventing and abating water pollution. It establishes standards for water quality and effluent. Polluting industries must seek permission to discharge waste into effluent bodies. The CPCB (Central Pollution Control Board) was constituted under this act.

1977 - The Water (Prevention and Control of Pollution) Cess Act provides for the levy and collection of cess or fees on water consuming industries and local authorities.

1978 - The Water (Prevention and Control of Pollution) Cess Rules contains the standard definitions and indicate the kind of and location of meters that every consumer of water is required to affix.

1991 - The Coastal Regulation Zone Notification puts regulations on various activities, including construction, are regulated. It gives some protection to the backwaters and estuaries.

Conclusion

"Clean water is imperative to maintaining ecological balance and protecting the public's health. The increase in water pollution since 2010 has contributed to the increase in unsafe drinking water."

Water pollution is a global issue and world community is facing worst results of polluted water. Major sources of water pollution are discharge of domestic and agriculture wastes, population growth, Industrialization, excessive use of pesticides and fertilizers and urbanization. Bacterial, viral and parasitic diseases are spreading through polluted water and affecting human health. It is recommended that there should be proper waste disposal system and waste should be treated before entering in to river. Educational and awareness programs should be organized to control the pollution. Water scarcity, is an issue that will greatly affect the amount of crops grown and will determine whether there is enough food to feed the world by 2050. Since the population is increasing, there will need to be a lot more work, research and money for there to be a sufficient food supply.

There is enough water to meet world's demand but uneven distribution has led to unequal access so that some countries and even individuals have more than others. Success calls for strategies and policies that promote and support water quality management. Other undertakings including rainwater harvesting and building storages that regulate water availability over time support these strategies. However caution must be exercised to ensure that smaller storage facilities close to the farming land and settlements are considered alongside the large storages usually constructed for hydro-power generation.

Additional strategies include economical irrigation methods such as drip irrigation that should be given priority over cheaper wasteful ones such as flood and sprinkler irrigation and reducing water loss through evaporation by storing water in underground aquifers. A holistic approach in the usage of both surface and ground water resources including inclusive smart partnerships and win–win situations should be encouraged and supported by governments, non-governmental organizations and donors alike.

Recommendations

Water, the most precious commodity is being abused to such an extent that there is fear that this might lead to another world war or it may be difficult even to get drinking water. Water is indeed an integral part of the human body as it accounts for 66 percent of it. The only liquid that quenches thirst satisfactorily is water and a mere two percent dehydration reduces performance by 20 percent.

Global freshwater availability percentage, even though small, holds not only the humans but the industrial sector by its cuff when it is short of desired demand. In urban and rural-domestic sectors elsewhere, notably the United States, conservation measures are most effective when they have broad public support. Important voluntary domestic water conservation measures include the following:

- Adopting water-saving plumbing fixtures, such as toilets and shower heads.
- Adopting water-efficient appliances (notably washing machines).
- Limiting outdoor uses of water, as by watering lawns and gardens during the evening and early morning, and washing cars on lawns and without using a hose.
- Adopting water-saving practices in commerce, such as providing water on request only in restaurants and encouraging multiday use of towels and linens in hotels.

Public support of such measures is highly variable because many of them are voluntary, relying on individual actions, or have negative societal impacts. The study area is at an advantage in this regard, because the population is relatively well aware of how water is used. Public awareness of levels of water use is the key to effective urban conservation programs. Voluntary domestic conservation measures can result in significant water savings. Among such conservation measures, low-flush toilets use approximately 6 liters of water per flush, while conventional toilets operate with 13 to 19 liters. Involuntary conservation measures applied to the urban sector are easier but more expensive to implement. Such measures include repairing leaking distribution systems and sewer pipes, expanding central sewage systems, metering all water connections, and rationing and water use restrictions.

These measures are expensive, but the costs and potential water savings must be weighed against the costs of developing equivalent alternate supplies. The dynamic growth possible in both public and private sectors throughout the study area holds the promise of incorporating water conservation measures into the new infrastructures to be built.

Appendices

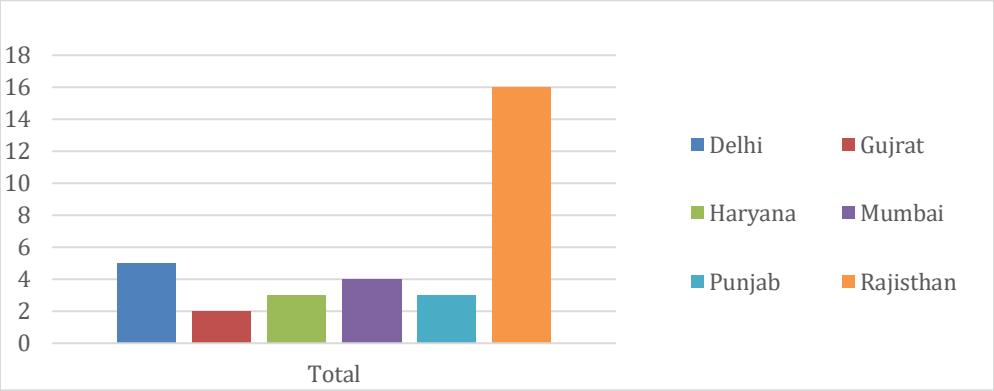
A] Sample Data sheet on topic: **"Water in India"**

A survey was taken by our group to collection some data and information related to water scarcity and water usage in India

Conclusions college basis survey
The survey form was filled by 33 students or other people, about 18 -25 years old.

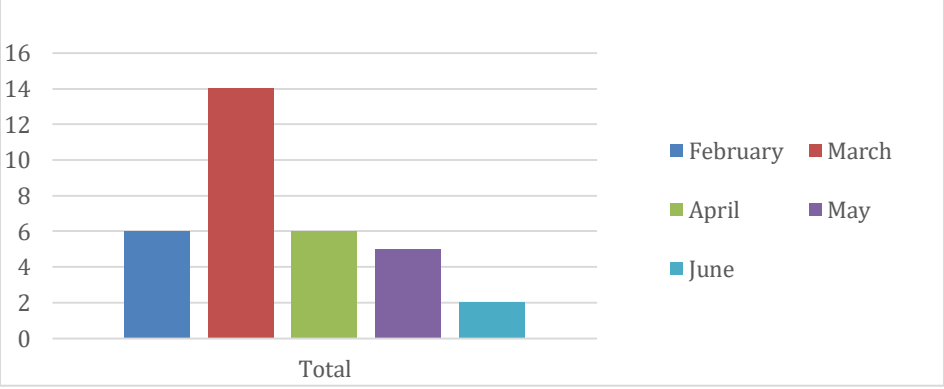
Q1) In which state do we face more scarcity of water?

Ans: This survey form shows more than 15 students says that **Rajasthan** face more scarcity than any other state in India.



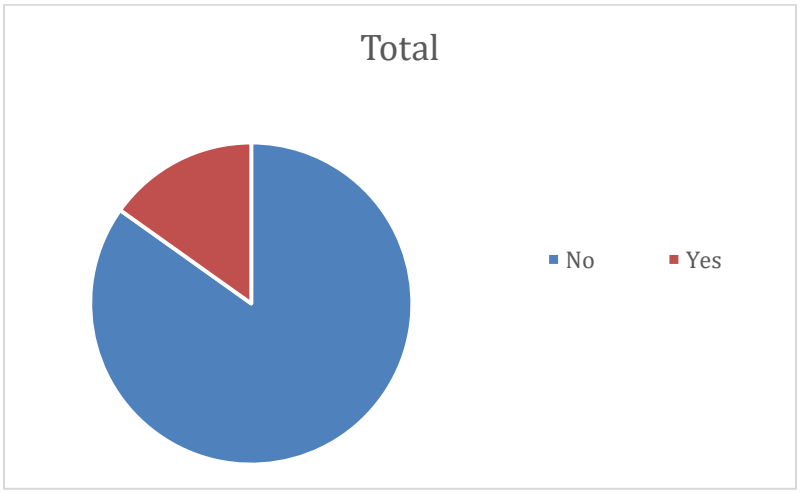
Q2) In which month do we face more water scarcity?

Ans: In **March.**



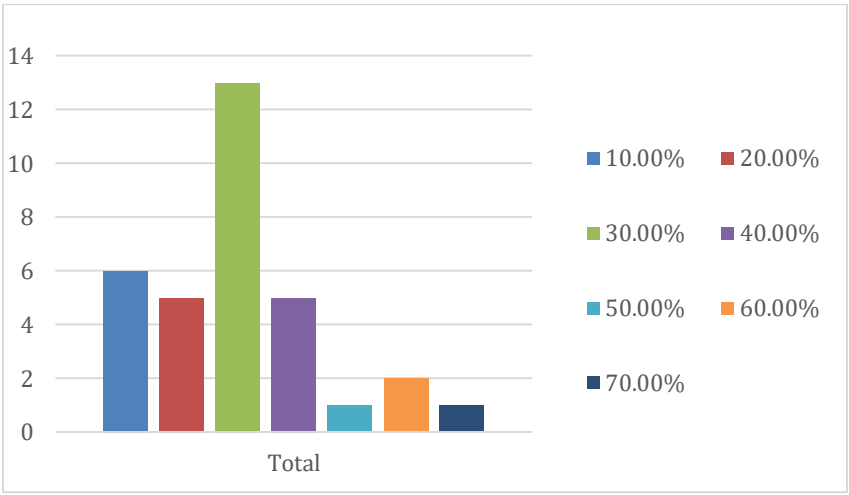
Q3) Do you experience water shortages?

Ans: Almost 85% of students don't face any water shortages in their region.



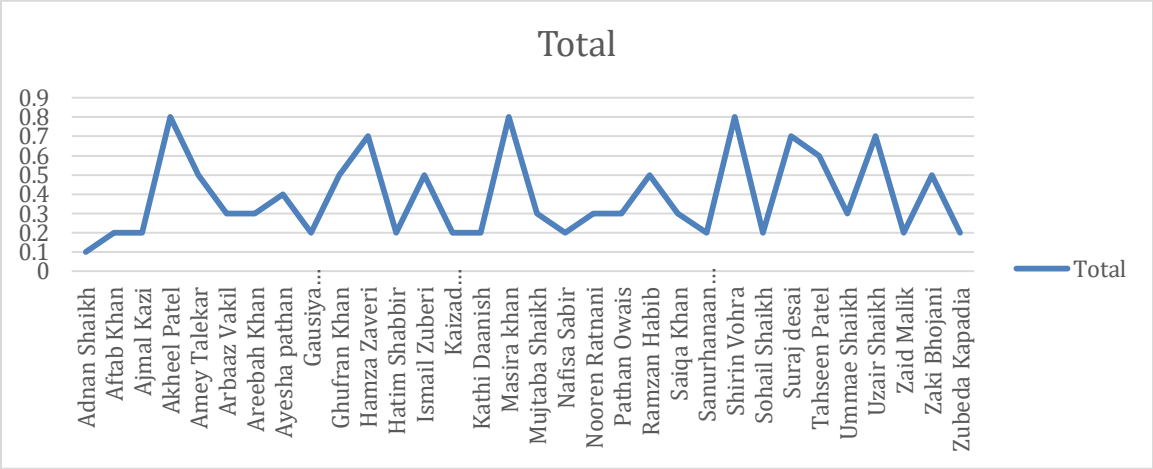
Q4) How much of all the India's population can't access fresh drinking water ?

Ans: Almost **30%** of India's total population can't access fresh drinking water.



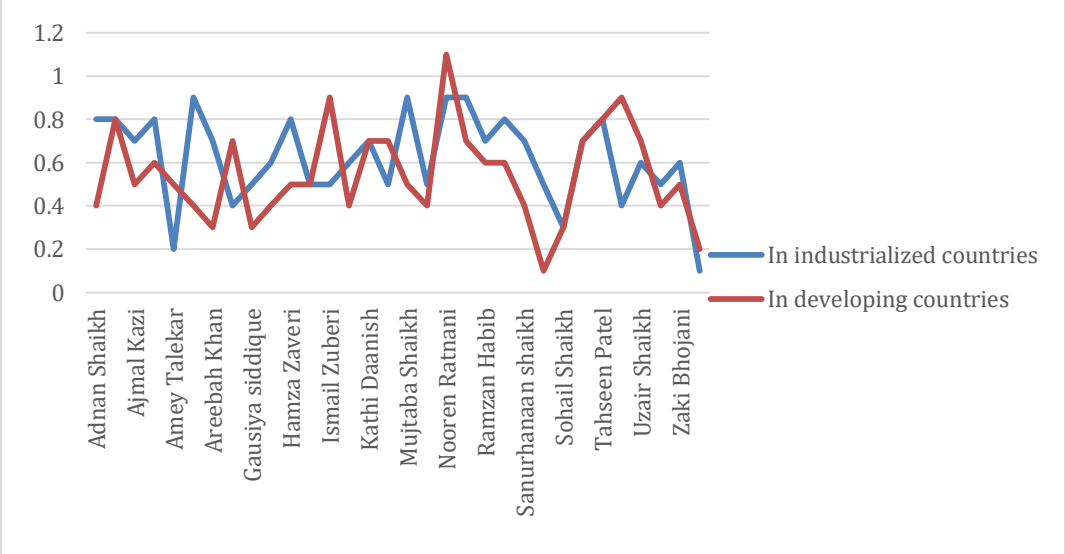
Q5) How much of India's electricity is produced by hydro-power?

Ans: The line chart below shows a constant range of 0.5 to 0.6 which means hydro-power produced upto **50% to 60% of total energy** production. Some shows deviation above 0.7 or 0.8



Q6, 7) In developing countries and industrialized countries how much percentage of water is used everyday per person ?

Ans: The Line chart below shows that there more use of water in developing countries than that of industrialized countries.



Q8) What is your monthly water bill?

Ans: Average water bill **is 2606 rs** in most of the region, while the maximum bill is of **Rs. 5400.**

Grand Total	2606.575758

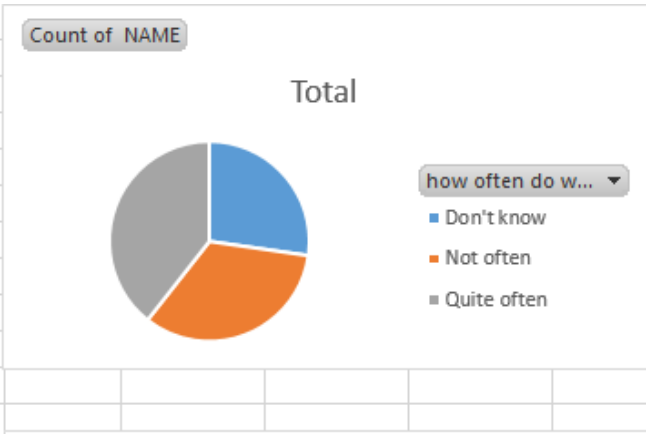
Q9) How would you evaluate the quality of your drinking water.

Ans: Satisfactory by 34% of people, while 24% says it's **not good**.

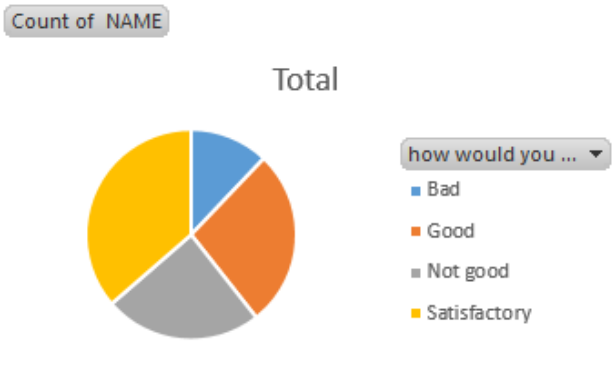
Q10) How often do we here about water conservation in the media

Ans: 13 from 33 students says they here about water conservation in media **Quite often.**

Row Labels	Count of NAME
Don't know	9
Not often	11
Quite often	13
Grand Total	33



Row Labels	Count of NAME
Bad	4
Good	9
Not good	8
Satisfactory	12
Grand Total	33



B] Questionnaire on the topic: **"Water consumption at home"**

A survey was taken by our group on college level to collection the information of much of water is consumed each day

Conclusions college basis survey

The questionnaire has to be filled by 25 boys and 25 girls, about 18 -25 years old from each partner school

	Question	Answer	Boys	Girls
1	Does your family use drinkable water for watering a garden?	Yes	4	3
		No	13	17
		No garden	8	5
2	Does your family use drinkable water for a swimming pool?	Yes	3	4
		No	6	7
		No swimming pool	16	14
3	Does your family use a dishwasher?	Everyday	6	8
		Sometimes	9	6
		never	10	11
4	Do you usually drink water from the tap or bottled water?	Always from the tap	9	0
		Only bottled water	10	12
		both	6	13
5	Do you usually leave the water run while brushing your teeth?	Always	0	4
		Sometimes	2	3
		never	23	18
6	Where does the tap water in your area come from?	A lake	0	0
		A river	0	0
		Springs	2	1
		other	11	8
		I don't know	12	16
7	How far from your home is that water source?	Less than 10km	9	9
		More than 10km	1	5
		I don't know	15	11
8	Have you ever had any medical problems in your area connected with bad quality of drinkable water?	Never	20	22
		Very seldom	2	0
		Quite often	2	1
		I don't know	1	2

9	How expensive is water in your area?	Cheap	2	1
		Medium	10	13
		Expensive	2	2
		I don't know	11	9
10	Do you believe that expending water is a serious environmental problem?	Yes	6	8
		No	12	9
		I don't care	7	8
11	Do you believe that the greenhouse effect is going to lead to scarcity of safe water?	Yes	12	11
		No	6	7
		I don't care	7	7
12	Are you interested in being informed and using rules about saving water at home?	Yes	10	5
		Maybe	12	16
		Not at all	3	4
13	Do you clean dirty water in a biologic cleaning system in your town?	Yes	19	14
		no	2	1
		I don't know	4	10
14	Do you use a shower or you fill the tub with water?	Shower	5	5
		Tub	6	2
		both	14	18
15	How often do you have a bath or a shower?	1-2 times/week	12	2
		3-4 times/week	5	18
		more	8	5
16	Do you use the washing machine or the dishwasher only if they are full of clothes/dishes, or sometimes when they are half empty?	Full	14	18
		Half empty	5	2
		I don't know	6	5
17	Do you repair any damage of water tubes or taps as soon as possible?	Yes	21	18
		No	0	1
		I don't know	4	6
18	What is the quantity of water you consume at home according to the water company bill? (Per family/per month in m3).	0 – 20	10	7

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Glossary

1. Pausanias-

(2nd century), Greek geographer and historian. His Description of Greece (also called the Itinerary of Greece) is a guide to the topography and remains of ancient Greece and is still considered an invaluable source of information.

2. Mundane-

1. lacking interest or excitement; dull.
2. of this earthly world rather than a heavenly or spiritual one.

3. Amphitheatres-

(especially in Greek and Roman architecture) an open circular or oval building with a central space surrounded by tiers of seats for spectators, for the presentation of dramatic or sporting events.

4. Baroque period-

The historic period from about 1600 until 1750 when the baroque style of art, architecture, and music flourished in Europe

5. Mont-oriol book-

Guy de Maupassant (1850-1893), born in Paris, is a French writer. Linked to Gustave Flaubert and Emile Zola, he left his mark on French literature with his six novels, including Une Vie in 1883, Bel Ami in 1885, Pierre et Jean in 1887-1888, but especially by his short stories (more than 300), sometimes called tales, like Boule de Suif in 1880, Les Contes de la Becasse in 1883 or Le Horla in 1887. These works hold attention for their realistic force, the important presence of the fantastic and the pessimism that emerges from them. more often but also by stylistic mastery. Guy de Maupassant's literary career is limited to a decade - from 1880 to 1890. Recognized during his lifetime, Guy de Maupassant retains a leading reputation, renewed again by the many filmed adaptations of his works. Other works include: La Maison Tellier (1881), Monsieur Parent (1885), Fort Comme la Mort (1889), La Vie Errante (1890) and L'Inutile Beaute (1890).

6. UNDP-

The United Nations Development Programme (UNDP) is the United Nations' global development network. It promotes technical and investment cooperation among nations and advocates for change and connects countries to knowledge, experience and resources to help people build a better life for themselves. The UNDP provides expert advice, training and grants support to developing countries, with increasing emphasis on assistance to the least developed countries.

7. Escherichia coli-

an enterobacterium (Escherichia coli) that is used in public health as an indicator of fecal pollution (as of water or food) and in medicine and genetics as a research organism and that occurs in various strains that may live as harmless inhabitants of the human lower intestine or may produce a toxin causing intestinal illness

8. Millennia-

a period of a thousand years, especially when calculated from the traditional date of the birth of Christ.

9. Greenhouse gas-

A gas that contributes to the greenhouse effect by absorbing infrared radiation. Carbon dioxide and chlorofluorocarbons are examples of greenhouse gases.

10. Phenological-

Phenology is defined as the study of the timing of recurring biological events, the causes of their timing with regard to biotic and abiotic forces, and the interrelation among phases of the same or different species (Leith 1974).

11. Agro-meteorology-

Agrometeorology is the study of weather and use of weather and climate information to enhance or expand agricultural crops and/or to increase crop production. Agrometeorology mainly involves the interaction of meteorological and hydrological factors, on one hand and agriculture, which encompasses horticulture, animal husbandry, and forestry.

12. Vermiculture-
The cultivation of earthworms, especially in order to use them to convert organic waste into fertilizer.

13. Dilution-
A dilution is a liquid that has been diluted with water or another liquid, so that it becomes weaker.

14. Capetonians-
A native or inhabitant of the South African capital Cape Town.
Relating to or characteristic of the South African capital Cape Town or its inhabitants

15. Hemándo cortes-
Spanish conquistador who defeated the Aztecs and conquered Mexico (1485-1547)

16. Karachi water and sewerage board (kswb)-
Karachi Water and Sewerage Board (KWSB) is responsible for production, transmission and distribution of potable water to the citizens of Karachi, Sindh, Pakistan.
Karachi Joint Water Board constituted in 1953 was the first body which was created to expand Karachi water supply system from the Indus River it was transferred to the KDA in 1957 after its formation

17. Hydrologist-
Hydrology is the study of water and hydrologists are scientists who study water.

18. Absolute scarcity-
Absolute scarcity is where the supply of a good is naturally limited. In other words, there is nothing humanly possible for us to increase supply. However, absolute scarcity is where the number of goods cannot diminish. For example, we have an absolute scarcity of 24 hours each day.

19. World economic forum-
The World Economic Forum is a Geneva-based international organization that discusses issues concerning the global political economy. The organization is funded through its

own membership, which includes industry leaders, politicians, thinkers, and academics, as well as celebrities and interested individuals.

20. Un report-

UN bodies publish flagship reports to share information about the work of the organization with the public. These reports usually come out annually to report global or regional statistics on a certain topic. They often have a theme for the year

21. UNESCO-

The United Nations Educational, Scientific and Cultural Organization: is a specialised agency of the United Nations (UN) aimed at promoting world peace and security through international cooperation in education, the sciences, and culture.

22. Cholera -

Cholera is an acute diarrhoeal infection caused by ingestion of food or water contaminated with the bacterium Vibrio cholerae. Cholera remains a global threat to public health and an indicator of inequity and lack of social development.

23. Typhoid-

An infectious bacterial fever with an eruption of red spots on the chest and abdomen and severe intestinal irritation.

24. NITI Aayog-

The National Institution for Transforming India, also called NITI Aayog, was formed via a resolution of the Union Cabinet on January 1, 2015. NITI Aayog is the premier policy 'Think Tank' of the Government of India, providing both directional and policy inputs.

25. India's GDP-

Gross Domestic Product, abbreviated as GDP, is the total value of goods and services produced in a country. ... Hence, the GDP growth rate of India is an essential indicator of the country's economic development and progress.

26. Afforestation-

Afforestation is the establishment of a forest or stand of trees in an area where there was no previous tree cover. Many government and non-governmental organizations directly engage in programs of afforestation to create forests, increase carbon capture.

27. CWMI-

The National Institute for Transforming India (NITI) Aayog has developed the Composite Water Management Index (CWMI) to enable effective water management in Indian states in the face of extreme water stress. The Index and this associated report are expected to:

(1) Establish a clear baseline and benchmark for state-level performance on key water indicators;

(2) uncover and explain how states have progressed on water issues over time, including identifying high-performers and under-performers, thereby inculcating a culture of constructive competition among states; and,

(3) Identify areas for deeper engagement and investment on the part of the states.

Eventually, NITI Aayog plans to develop the index into a composite, national-level data management platform for all water resources in India.

28. World water day-

World Water Day, held on 22 March every year since 1993, focuses on the importance of freshwater. World Water Day celebrates water and raises awareness of the 2.2 billion people living without access to safe water. It is about taking action to tackle the global water crisis.

29. Affermages-

Affermage contracts are generally public-private sector arrangements under which the private operator is responsible for operating and maintaining the utility but not for financing the investment.

30. EECCA-

Eastern Europe, Caucasus and Central Asia (EECCA) is a block of countries that includes Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

31. OCED-

The Organisation for Economic Co-operation and Development is an intergovernmental economic organization with 37 member countries, founded in 1961 to stimulate economic progress and world trade.

32. EUWI-

The European Union Water Initiative (EUWI) was launched as a political process in 2002 in Johannesburg at the World Summit on Sustainable Development and the following provides an account of its functioning and achievements.

33. MoLIT-

Ministry of Land Infrastructure and Transport (Japan)

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