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WATER SCARCITY AND WATER SECURITY

A PROJECT REPORT SUBMITTED UNDER THE COURSE OF
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TO
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ABSTRACT

Clean water is an essential ingredient of a healthy human life, but 1.2 billion people still lack access to water. Water scarcity is a rapidly growing concern around the globe, but little is known about how it has developed over time. The world population currently stands at 3.76 billion and is expected to reach 9 billion by 2024-2030, placing pressure on water supplies. According to recent estimates from the International Water Management Institute cited in "The World's Water: Volume 8", two-thirds of the world's population may be facing water shortages and water demand is forecast to increase by 40%. This trajectory is due to the given the challenges of population growth, unchecked growing consumption, growing pollution, and changes in weather patterns due to global warming. Many countries and major cities worldwide are facing increasing water scarcity in the 21st century. Addressing this issue should be our utmost priority.

Our report focuses on these problems, its causes, and possible solutions. In this report we first introduce the reader with the basic terminologies like water scarcity, water stress and water security. Following this we enlist the nations and different regions facing water scarcity and try to plot the same on a world map. Our report includes two main case studies. First case study revolves around Libya. Shortage of drinking water is looming in Libya especially in the western parts of the country. Our case study does a continuous assessment of all possible reasons for this water shortage. It also discusses about the consequences faced by the citizens of Libya. Our case study also includes the initiatives and policies taken by the United Nations and the Libyan Government. The second case study in our report is that of Haryana, which is supposedly the worst hit states in India in terms of water shortage. In this case study, we discuss about the reasons behind this water shortage followed by the impact it has on the people of Haryana and also on the neighboring states. We also discuss the actions taken by the Indian government to get rid of this crisis.

Our team has also conducted a short survey to understand the daily consumption of people living in urban areas. After detailed analysis of the results, we have highlighted the daily activities which contribute the most in exhausting the water resources. Lastly after thorough discussion, we have put up domestic solutions as well as long based plans to promote water security.

INTRODUCTION

Water covers 70% of our planet, and it is easy to think that it will always be plentiful. However, freshwater, which 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.

BASIC TERMINOLOGIES

Water scarcity

Water scarcity already affects every continent. Around **1.2 billion** people, or almost one-fifth of the world's population, live in areas of physical scarcity, and 500 million people are approaching this situation. Another 1.6 billion people, or almost one quarter of the world's population, face economic water shortage (where countries lack the necessary infrastructure to take water from rivers and aquifers).

Water scarcity is among the main problems to be faced by many societies and the World in the 21st century. Water use has been growing at more than twice the rate of population increases in the last century, and, although there is no global water scarcity as such, an increasing number of regions are chronically short of water.

Water scarcity is both a natural and a human-made phenomenon. There is enough freshwater on the planet for seven billion people but it is distributed unevenly and too much of it is wasted, polluted and unsustainably managed.

Water stress

Hydrologists 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 meters "absolute 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.

Types of Water Scarcity

1. **Economic water scarcity** may arise in a situation where *"... human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands."* Economic scarcity of water is characterised by insufficient investment in infrastructure meant to supply and distribute water equitably in areas where inhabitants do not have the monetary wherewithal to use a source of water that is adequate for them. These areas are especially vulnerable to seasonal fluctuations causing floods and drought. In some cases, there is infrastructure for the equitable distribution of water, but it is not undertaken by the political machinery.
   There is economic scarcity of water in most of Africa and parts of the Indian subcontinent. Jordan and Libya are also water stressed. There have been protests in Jordan already due to massive power cuts because of the inability of hydraulic power plants to produce enough electricity.

2. **Physical scarcity of water** is a situation in which *"...water resources development is approaching or has exceeded sustainable limits."* In this situation the supply of water for human needs and the ecosystem is not nearly equal to the demand. Physical water scarcity often arises in dry, arid regions of the world. It could also happen in areas where there is enough water but just not enough to meet the growing needs of the human population like irrigation and energy generation for which there is overdevelopment of hydraulic infrastructure. It is characterised by severe and widespread environmental degradation and a decline in groundwater levels. In some regions, one group is preferred over others when it comes to allocating water. Extensive areas in Central Asia, parts of North Africa and South Australia face a physical scarcity of water.

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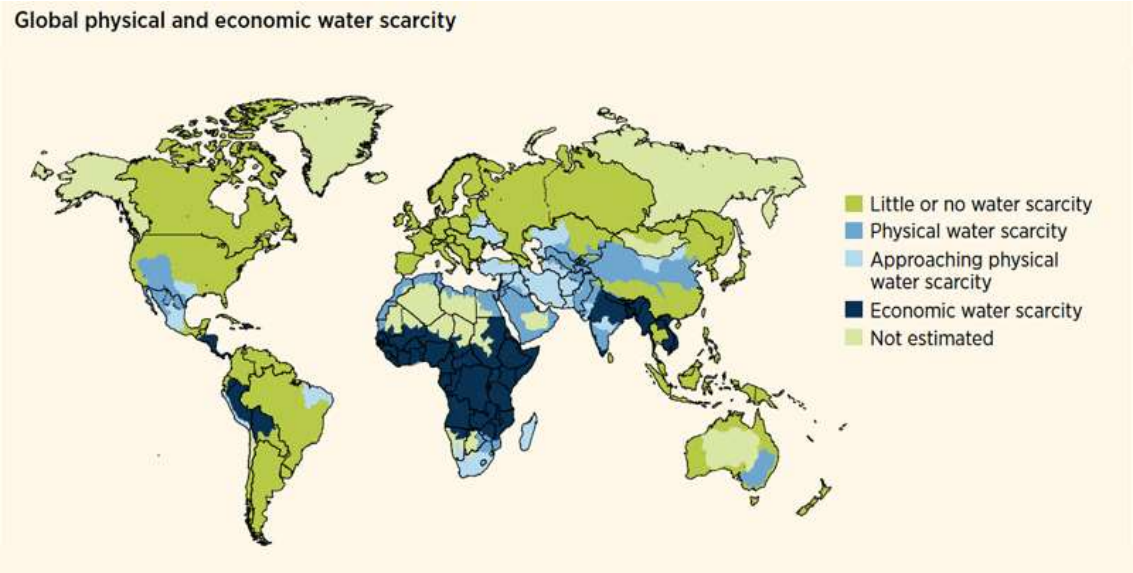
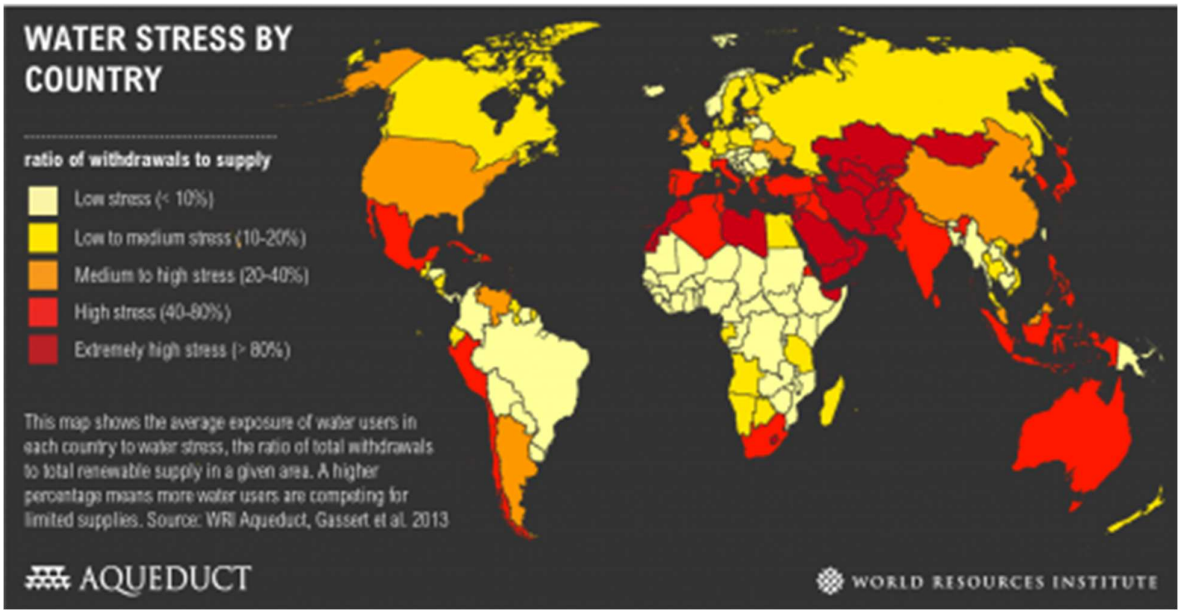


- Around **700 million** people in 43 countries suffer today from water scarcity.
- By 2025, **1.8 billion** people will be living in countries or regions with absolute water scarcity, and two-thirds of the world's population could be living under water stressed conditions.
- With the existing climate 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.



The analysis finds that 37 countries currently face "extremely high" levels of water stress, meaning that more than 80 percent of the water available to agricultural, domestic, and industrial users is withdrawn annually.

- By **2040**, roughly 1 in 4 children worldwide will be living in areas of extremely high-water stress.
- **Inadequate sanitation** is also a problem for 2.4 billion people—they are exposed to diseases, such as cholera and typhoid fever, and other water-borne illnesses.
- Humans are **over-consuming** natural resources at an unsustainable rate.
- Around **3.5 planet Earths** would be needed to sustain a global population achieving the current lifestyle of the average European or North American.
- Over 80 per cent of wastewater worldwide is not collected or treated, and **urban settlements** are the main source of pollution.

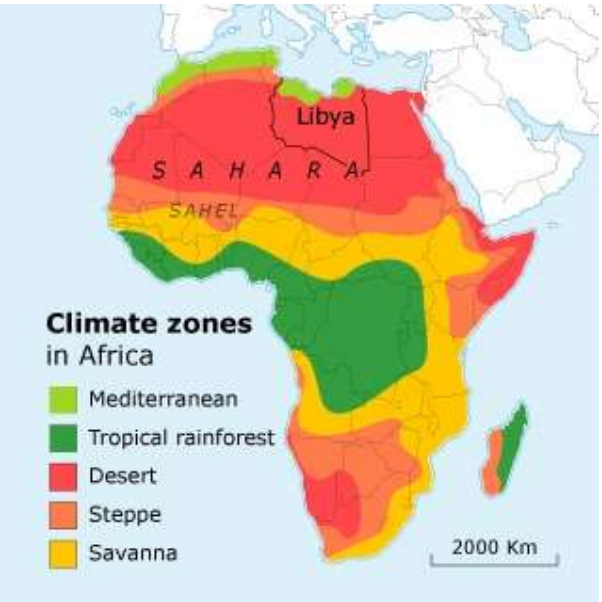
CASE STUDY 1

LIBYA WATER CRISIS

Introduction and background:

Geographic Background:

Libya is one of the driest countries in the world. Temperatures are extremely high. The rainfall in the northern part of the country varies between 100–500 mm/year but the southern section receives only as much as 10 mm/year and some parts are completely rainless. The total population amounts to about five million. The total water withdrawal for agricultural, domestic, and industrial purposes is estimated at 3843 million cubic meters in the past few years. Agriculture has the highest consumption quantity (85%) but the domestic and industrial sector withdrawals only (11.5%) and 3.5% respectively. These practises lead us to a water deficit nation.



Historic Background:

Libya's water problems have become common during eight years of unrest following the ouster of former leader Muammar Gaddafi. Even before the unrest, Libya suffered from low water supplies. The country sits in a desert with low rainfall but has high water demand for use in agriculture and industry . But current fighting between warring forces seeking control of the capital, Tripoli, is causing a wider water crisis. The battles involve forces sent by two competing administrations seeking to take control of all Libya

Reasons for Water Crisis in Libya:

1. Unchecked Exploitation of Water Resources:

The continuous population growth and corresponding increase in water requirements for the domestic, industrial, and agricultural sectors has resulted in a water deficit nation. According to statistics, water deficit was amounting to about 1154 million cubic meters in the past few years and water demands between (8200) and (8840) million cubic meters have been forecasted for the year 2025 with deficits of about 4339 million cubic meters assuming the present water use practices are continued. The water supply and demand situation in Libya is summarised in the following table:

Available water	Million m^3	Water consumption	Million m^3
Groundwater	2557.62	Agricultural	3259.27
Surface water	61.00	Domestic	448.30
Desalination	47.86	Industrial	135.64
Waste water	24.16		
Total	2689.64	Total	3843.21

2. Civil War and Chaos

The country of Libya has suffered from civil war since the violent removal of its former dictator Muammar Gaddafi. Challenges with the country's water supply was of the many humanitarian problems that have risen due to this conflict. Since Gaddafi was toppled in 2011, the country has descended into chaos. In western Libya, finding clean water has become difficult because both the power and water control systems have been heavily damaged. Continued fighting and looting have made the situation worse. Armed groups have even used water as a weapon of war.The Great Man-Made River Project Authority was funded by the Gaddafi government. On 22 July 2011, during the first Libyan civil war, one of the two plants making pipes for the project, the Brega Plant, was hit by a NATO air strike. During the second Libyan civil war, lasting from 2014 to 2020, the water infrastructure suffered neglect and occasional breakdowns. As of July 2019, 101 of 479 wells on the western pipeline system had been dismantled.

3. Pollution:

Increased levels of pollution from oil drilling and the saltwater contamination of natural aquifers, however, have strained the water quality in Libya and made an already scarce water supply increasingly difficult to attain. Rising sea levels and increased oil drilling have particularly plagued Libya and exposed its already limited and crucial water supply to pollutants and contamination. Since the 1950s, the sea level in Libya has advanced approximately one to two kilometres inland due to global warming and rising ocean levels. The slow move inward has caused a dramatic increase in the salinity of groundwater found in natural aquifers. As a direct consequence, the amount of water available and the water quality in Libya is becoming increasingly stretched. The increase in standard drilling procedures and techniques such as fracking have exposed the vast natural aquifers to contaminants and chemicals, another negative effect on the water quality in Libya. The combined impact of sewage, oil by-products, and industrial waste threatens Libya's coast and the Mediterranean Sea generally. Libya has 0.8 cu km of renewable water resources with 87% used in farming activity and 4% for industrial purposes. Only about 68% of the people living in rural areas have pure drinking water. Libya's cities produce about 0.6 million tons of solid waste per year.

4. Seawater intrusion:

This shortage of water does not mean that the aquifers are emptying, but rather that they are becoming contaminated by seawater intrusion. The extraction of freshwater has caused seawater to invade the aquifers. Due to the intrusion of seawater since the 1930s, it is alarming that no one knows exactly how much freshwater remains in the aquifers. Further, records have determined that seawater intrusion has compromised about 60 percent of freshwater wells. The freshwater in these aquifers cannot replenish either, meaning that every drop must count for use.

5. Excessive groundwater exploitation

Libya is an arid nation, mostly desert, in which freshwater is perpetually scarce. Rainfall is meager—only five percent of the nation receives more

than 100 mm of rain each year. Libya has long relied on groundwater reserves to quench its thirst. It accounts for more than 98% of the total water consumption. The current policy of becoming self-sufficient in food, resulted in over-exploitation of fossil groundwater resources for irrigation and yet more depletion of water resources, since most of the country's groundwater resources are non-renewable.

6. Decreased annual average of rainfall

Libya can be affected by the Ghibli, a hot and dry wind, which is able to raise dust and cause sudden increases in temperature; this phenomenon is even more evident along the coast, where it also produces a sudden drop in relative humidity, which here is generally high because of the influence of the sea. In these cases, the temperature can exceed 40 °C (104 °F) thereby causing a decrease in the average rainfall.

7. Intensive agricultural activities in the coastal plains

Another reason for the Libyan freshwater shortage is the expanding agricultural industry. Some crops demand vast amounts of water; typically, this extensive use results in water waste throughout agricultural production and processing. In fact, Libya uses about 93 percent of its water for agricultural purposes.

- **Lack of Access to Drinking Water**

  The biggest problem of water scarcity is that people are not able to get fresh, clean drinking water. The human body can hardly survive so long without water. This water crisis has resulted in several deaths especially in children who need water during their early years of development.

- **Food Scarcity**

  Water scarcity has a huge impact on the food production. Without water people do not have a means of watering their crops and, therefore, to provide food for the fast-growing population. According to the International Water Management Institute , agriculture, which accounts for about 70% of water withdrawals, is constantly competing with domestic, industrial, and environmental uses for a scarce water supply.

- **Crippling Economy**

Water shortage has lead to a significant decline of Libya's GDP, where a considerable part of the decline is attributed to the decrease in agricultural outputs. The magnitude of the impact depends on the underlying assumptions regarding future desalination capacity.

- ## Increase in poverty

The primary people affected by these famines were the landless rural poor. But in today's environment of growing water scarcity the problem is more pervasive. An increasing number of the poor— rural and urban consumers, rural producers, and rural laborers—are coming to view access or entitlement to water as a more critical problem than access to food, primary health care, and education. The typical urban household uses water for drinking and sanitation. But rural areas use water for a wide range of purposes. Other productive uses include fishing, harvesting of aquatic plants and animals, and a variety of other enterprises such as brick making. Thus, the withdrawal of water affects the rural household, rural economy, and environment in several ways.

- ## Libya's Water Cuts Affect Citizens' Health

Safe drinking water plays a contributory role to the development of a healthy child. Access to safe drinking water stops illnesses such as typhoid, diarrhea, cholera, Hepatitis A etc. Diarrhea is one of the top three causes of child death and often caused from consuming unclean water. The main reasons of such deaths are consumption of contaminated water or suffering from dehydration due to diarrhea.

POLICIES AND INITIATIVES

- UNICEF works with government counterparts, civil society organizations and the private sector to realize its humanitarian, development, and peacebuilding strategy in Libya, while maintaining capacity for a rapid response at the onset of new emergencies.

- On 16 February 2019, the Humanitarian Coordinator for Libya, launched the 2020 Humanitarian Response Plan for Libya (HRP), which seeks US $115 million to provide life-saving assistance. The humanitarian community aims to reach about 345,000 people, out of the 893,000 people who need humanitarian assistance across Libya 's 22 mantikas or districts. The people who will receive assistance are assessed to be in acute need because of physical and mental harm, a partial or total collapse of living standards and basic services, and increased reliance on extreme measures to cope with their situation, such as reducing number and size of meals they consume every day.

- Nicosia Initiative: Since 2015, the European Committee of the Regions has developed a close political and, increasingly, a very practical relationship with Libyan cities. The relationship has the twin aims of helping to improve public services in Libya and of helping Libyan cities to enter the international community. The cooperation is a response to the political turmoil and insecurity that Libya has been experiencing since 2011, which has eroded municipal services in Libya and kept Libyan cities isolated internationally. EU regions and cities have provided or pledged support in the following areas- Water management and wastewater management, Waste management, Primary health care etc.

- UNICEF has delivered 23,000 bottles of water for emergency use in Tripoli as the situation is expected to worsen in the Libyan capital. Currently, a total of around 5 million litres of water is being procured by UNICEF from neighbouring countries to be trucked and shipped to Tripoli in the coming days.

- A UNICEF technical team is now working with the Libyan authorities to facilitate an assessment of water wells, review urgent response options and identify alternatives for water sources.

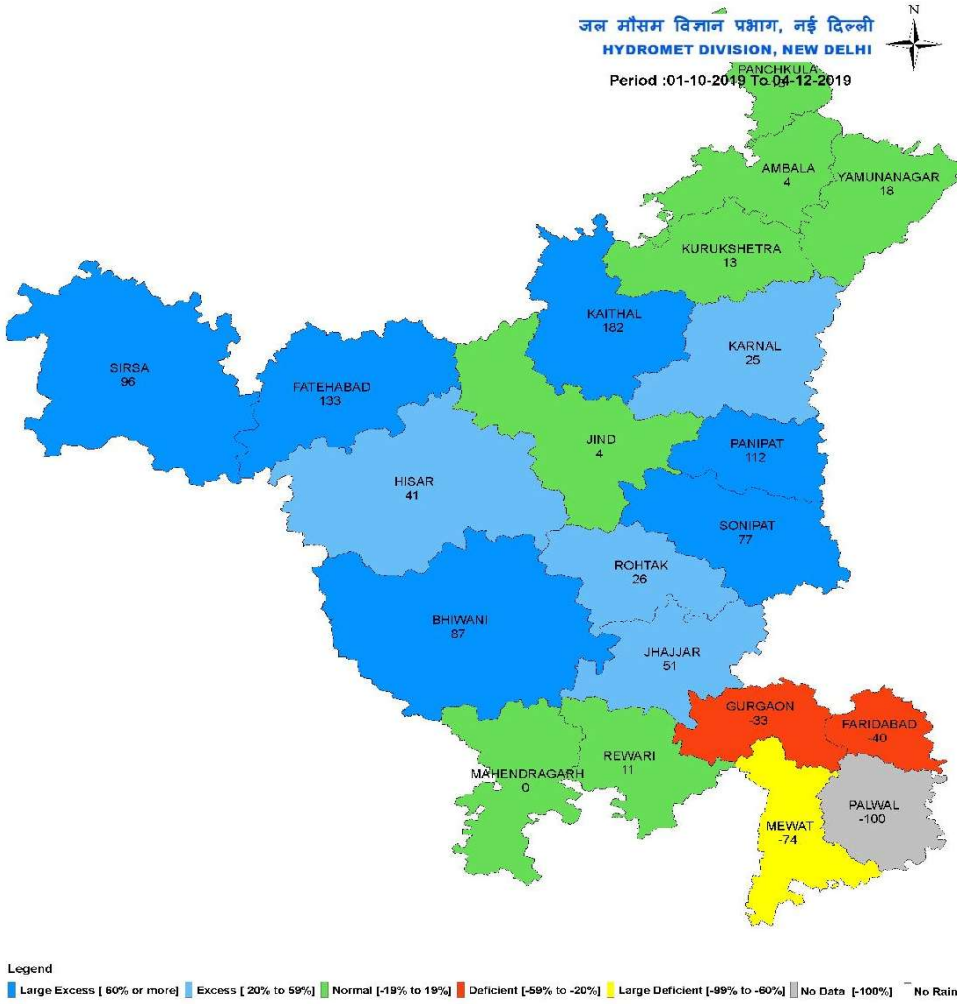
CASE STUDY 2

HARYANA WATER CRISIS

Introduction and background:

Geographic Background:

Haryana is one of India's major irrigating states, with approximately 2.9Mha under surface irrigation. Water is scarce and irrigation water demand exceeds available canal water supplies. The major challenge facing the responsible government agencies is to man- age water scarcity so as to minimize long- term damage to agriculture, fresh aquifers and soils.



DISTRICT RAINFALL DEPARTURE MAP - HARYANA

Haryana is located on the Indo-Gangetic plain in north-west India with a climate that is arid to semi-arid. It has an area of 4.4Mha of which 3.8Mha is cultivable and 2.9Mha irrigable (GOH, 2004). Annual rainfall averages 545 mm, ranging from more than 1000 mm in the extreme north-east to less than 300

mm in the arid west. Rainfall also varies from year-to-year and from season-to-season. About 80–85% occurs in *kharif* (June to September), and most of the rest in *rabi* (October to February). Evapotranspiration averages about 1550 mm so that irrigation is a prerequisite for successful cropping most of the time over most of the state.

Reasons for Water Crisis in Haryana:

1. Politics of Sutlej-Yamuna Link Canal:

Surface water comes from the Sutlej via the Bhakra canal system and from the Yamuna via the Western Yamuna system. Sutlej and other Indus allocations are regulated by the Bhakra-Beas Management Board (BBMB), which was created under the 1966 Punjab Reorganization Act. This Act and subsequent agreements govern the state shares in the three rivers (Sutlej, Ravi, Beas) assigned to India by the 1960 Indus Basin Treaty. Haryana has yet to obtain its full share and disputes continue, in particular relating to construction of the Sutlej Yamuna Link (SYL) canal, which would allow access to water from the Ravi and Beas. Yamuna allocations are governed by the Tajewala Headworks Agreement of 1954 as modified by the Punjab Reorganisation Act and other agreements.

2. Green Revolution:

In almost half of Punjab, the depletion of water resources is leading to a crisis After the Green Revolution, Punjab and Haryana have become water-scarce states due to the introduction of paddy as the main kharif crop, a massive increase in cropping intensity, and rapid urbanization and industrialization. However, the real issue of reverting to sustainable cropping patterns and improving water-use efficiency remains unaddressed. An improvement of 15% to 20% in water-use efficiency from the present level can provide each state with the increased water share it is demanding.

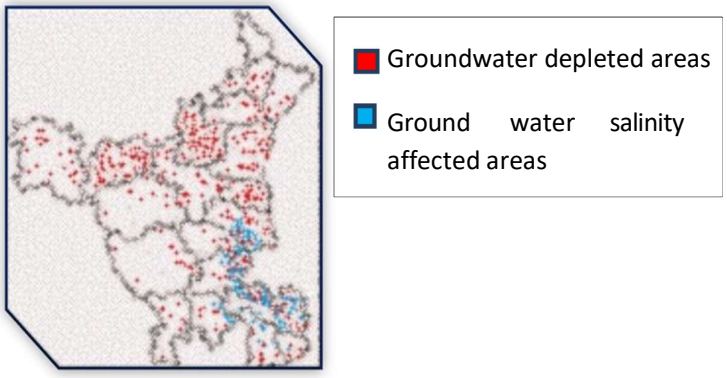
3. Agriculture:

Punjab, Haryana and Rajasthan, are facing an acute water shortage. This crisis has intensified after the Green Revolution. Roughly, 80% of the total demand for water comes from agriculture. The rest is used in domestic consumption, industry and commerce, and the power sector. Water use in agriculture has increased many times over due to the cropping intensity and the introduction of water-intensive crops such as rice, sugar cane and horticulture. Similarly, domestic, commercial and industrial demand has

increased following rapid urbanization, accelerating commercial and industrial activities, and increased thermal power generation. This has put tremendous pressure on the limited water resources in the region.

4. Individual using excess groundwater resources:

The region's water resources consist of surface water, mainly supplied by perennial rivers originating from Himalayan glaciers, and groundwater resources accumulated over centuries. The widening gap between demand and supply has caused states to compete for larger shares of surface water. Individual users are exploiting increasing amounts of groundwater resources as there is no regulation of its use. Farmers are deepening their bore wells at tremendous cost, crowding small and marginal farmers out of the race for groundwater extraction. NASA's Gravity Recovery and Climate Experiment (GRACE) has reported that "beneath northern India's wheat, paddy and barley fields, the groundwater has been disappearing" (Dhaliwal 2016). There is apprehension that large parts of the region may soon turn into desert unless radical measures are taken to check groundwater depletion. By now, there are some 600,000 tube wells that are predominantly privately owned. Well owners commonly sell water to their poorer neighbours after meeting their own needs.



In many district farmers told their problems to researcher that every year groundwater level in their fields is going down as a result farmer have to invest in submersible more and more. Farmers have to face financial problems. In many areas of the state the ground water has become salty particularly some parts of NCR districts. Those areas are shown in above map by light blue colour.

- Reduction in economic growth.
- Unavailability of water for irrigation, leading to poor production and agricultural crisis.
- Shortage in power supply.
- Scarcity of drinking water.
- Climate change.

The water shortage has declined the economic growth. Due to the water shortage, the farming occupation has also seen a decline in a graph which leads to decrease in farming export. Food prices become less stable and unpredictable, often resulting in farmer's financial condition.

Many businesses wish to have easy and convenient access to water resources. But they might not choose to go into certain areas if there is a dearth of water. They see water as a competitive advantage when it comes to their operations.

If businesses and industry do not penetrate certain areas or leave, unemployment rates can rise. This drastically impacts the local community and devastates populations. A lack of jobs and opportunities can drive down income, tax revenues, and the free flow of commerce.

POLICIES AND INITIATIVES

- The Haryana Pond and Waste Water Management Authority:

  "The Haryana Pond and Waste Water Management Authority" (HPWWMA) has been established under the obligation of an Act No. 33 of 2018 notified on 23.10.2018 and further notified on 18th December, 2018, whose composition is given in the Notification itself.

  The main objective of constitution of "The Pond and Waste Water Management Authority" was to promote/monitor the development, protection, rejuvenation, conservation, construction and management of ponds & utilization of pond water after treatment thereof and for management and utilization of treated effluent of sewage effluent treatment plants for the purpose of irrigation, thereby reducing stress of over exploitation of ground water and for matters connected therewith or incidental thereto.

  The definition of the pond as per act is "a tank or lake or any other inland water body having an area of 0.5 acre or more, whether it contains water or not, and mentioned in revenue records as talab, johar, tank or by any other name and includes green belt and the peripheral catchments areas, main feeder inlet and other inlets, bunds, weirs, sluices etc. but does not include wet lands as notified by the Government from time to time". The scope of the Pond Authority is to repair / restore / rejuvenate the ponds along with development of periphery of the pond with greenery and to preserve the aquatic life of ponds for conservation of bio-diversity.

- Haryana Preservation of Subsoil Water Act:

Rice is a water-intensive crop and is usually transplanted before the onset of monsoons, resulting in drawing groundwater for irrigation. The Haryana state introduced the '**Haryana Preservation of Subsoil Water Act**', in 2009 banning transplantation of the crop before the onset of monsoon to conserve groundwater. This decree considerably reduced the period between rice harvest and wheat sowing. As a result, the burning of crop residues intensified in this narrow period, escalating the problem of air pollution.

The current study used satellite data from NASA to understand the changes in the rice cropping patterns. It found that for the six rice seasons before 2009, approximately 40% of rice was harvested by late October. However, after the law was enforced, this number declined to 14%. The analysis revealed that before 2009, there were about 490 fires per day during late October. Following the law, this number increased to 681 fires per day, peaking around early November. The weather conditions during this time discourage the dispersion of particulate matter. Hence, the average daily PM2.5 concentrations in November were found to be 29% higher after the groundwater acts were passed.

- Suggestions:

We should adopt efficient irrigation practices like drip and sprinkle irrigation; free eccentricity should be stopped because it mainly causes indiscriminate use of groundwater in agriculture. Rainwater is a prominent source of water that can be alternatively conserved for using in agriculture and recharge of groundwater reservoir. Crop diversification is an important substitute to sustain agriculture and farmer. We must adopt scientific methods of agriculture like sowing less water consuming crops, dry farming.

Finally, reduction of groundwater pumping can be achieved through strict state government groundwater regulation.

LITERATURE REVIEW

Water Scarcity and Water Security are the major global crisis. Water Scarcity has significantly threatened the world on a global scale confronted by the world today.

In a Survey carried by the **World Economic Forum (WEF)** called 'Global Risks 10th Edition', water crisis is number one in regards to having the biggest impact globally. This suggests that water scarcity is a very important issue and must be acknowledged as a global crisis.

In reference "**Water: Abundance, Scarcity, and Security in the Age of Humanity"**, Schmidt traces the development of interdisciplinary approach to water from its nascent years in the early twentieth century in the United States to its global reach today. How water is managed today is the culmination of a century of ideas on natural resources and US resource management and conservation techniques. Seeing water as a resource replaced alternative ways of managing water and this narrative has framed our understanding and conceptualization of it.

Optimizing DMAs' formation in a water pipe network: the water aging and the operating pressure factors by **Apostolos Chondronasios** suggests an implementation policy is to form DMAs, which is often a challenging problem to tackle. During the last 15 years, many solutions have been proposed by researchers. The paper presented a novel method, where GAs are used through EPANET and Matlab software tools to offer the optimal DMAs' formation in the case study. In conclusion, DMAs' formation is strongly suggested to optimally reduce the water age, thus keeping the water as 'fresh' as possible.

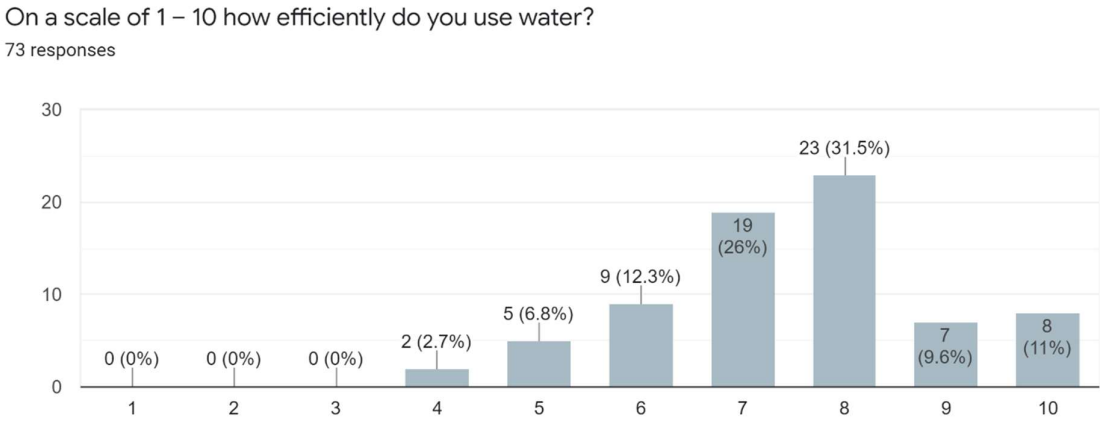
An alternative solution of the water shortage problem in Libya a research paper by **Ronny Verhoeven** suggests that as the Libyan population grows, more water will be required to satisfy its needs. This very much-needed water in the future might come at a high finical and ecological price. Currently, the water demand exceeds the conventional water resources capacities markedly creating an urgent need for integrated water resources management with special focus on non-conventional water resources namely, sea water desalination and wastewater reuse.

In a journal published Groundwater Pumping Irrigation in Haryana: Issues and Challenges, India by **Ashok Kr Duhan**. The strategies for reducing indiscriminate uses of groundwater in agriculture by adopting scientific methods of agriculture are mentioned in the journal.

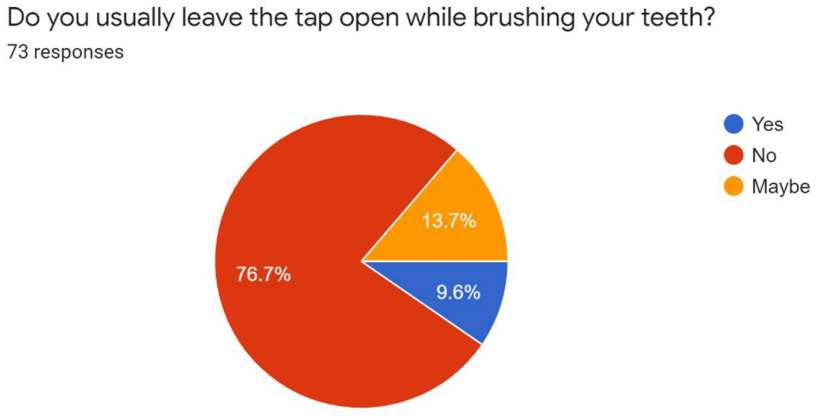
GOOGLE SURVEY AND ITS ANALYSIS

Introduction: This is a short survey including 72 participants. The purpose of the survey was to understand the consumption pattern among people. It helps to understand the present scenario for water scarcity. Analysing, the data from the survey the possible solutions are listed.

Analysis:

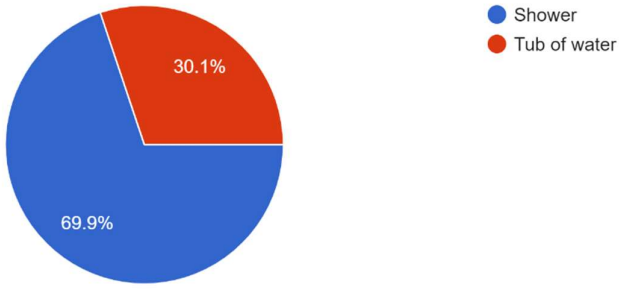


Considering the baseline to be 8, approximately 35 out of 73 people are using water inefficiently. Scaling up to a large town or city, this number will be quite significant. According to our findings, 50 people live in urban areas, 18 people live in suburban areas, 5 people live in rural areas.



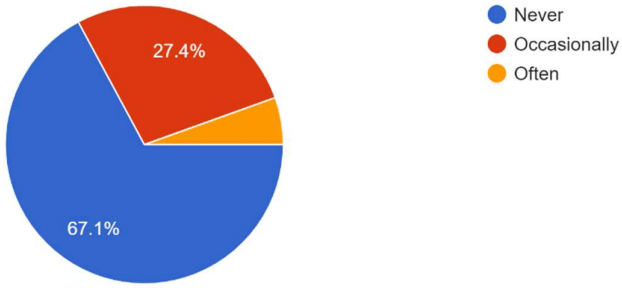
Do you use a shower or a tub of water?

73 responses



How often do you use a Bath Tub?

73 responses



Our survey includes questions related to some daily habits:

- Out of the 73 participants, 77% avoid leaving the tap open while brushing whereas 9.5% leave it open. The rest of the percentage are not aware of having this habit.
- 69.9 % take a shower on daily basis whereas the 30.1 % prefer to use a bucket of water.
- 67.1% do not use a bath tub, 27.4% use it occasionally and the remaining 5.5% use it on daily basis

According to our findings, out of 73

- 25 people have average bath time <10 minutes.

- 45 people have average bath time of 10-20 minutes
- 3 people have average bath time >20 minutes

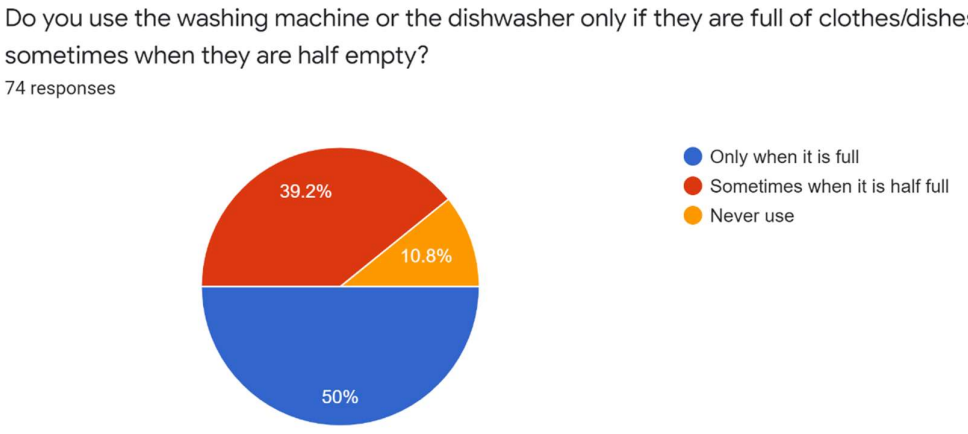
An average bath uses 2.5 gallons a minute, or 25 gallons for 10 minutes. So, exceeding a bath time of 10 minutes, 48 people are wasting more than 25 gallons of water every day.

These findings are important because when considering a larger crowd, these small percentages add up to a huge number.

- The EPA (Environmental Protection Agency) stated that leaving the water running while brushing your teeth wastes an average of four gallons each time. In a four-person household, where each person brushes twice each day, that's 32 gallons of water wasted.

- According to the U.S. Environmental Protection Agency (EPA), a full bathtub requires about 70 gallons of water, while taking a five-minute shower uses 10 to 25 gallons.

82.4 % people do not have a dishwasher whereas 17.6% have one. We use up to 27 gallons of water by hand versus as little as 3 gallons with an ENERGY STAR-rated dishwasher.



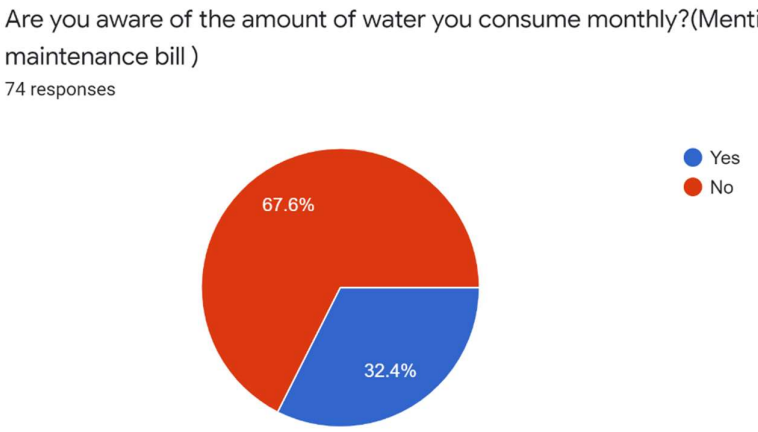
50 % use a washing machine only when it is full, 39.2 % use it when it is half-full, 10.8 % do not have a washing machine.

- On average, washing machines use 19 gallons of water per load, however when we use half load it uses approximately 14 gallons.
  For the average household that runs between 5 and 6 loads per week, adds up to 5,605 gallons of water for full load whereas, for half load it adds up to 4130 gallons of water per year.

Washing a full load of laundry is the most water-efficient choice. Selecting the right cycle for each load will save water and improve your cleaning results.

21.7% of people do not repair water leakage from taps or pumps time to time.

Only a small drip from a worn faucet washer can waste around 75 liters of water per day. Thus, we need to check all the water pipes and fittings regularly to assess their operational status and any leak occurring should be urgently repaired or replaced.



Fresh water scarcity has become a concern worldwide, between 2.7 million will face water shortage by 2050. In these times, people should be aware about the amount of water consumed by them. 67.6% people are still unaware of their consumption.

This situation can potentially compromise the social development of our society as well as the water bodies' status in terms of water quantity and quality.

WATER SECURITY AND POSSIBLE SOLUTIONS TO WATER CRISIS

1. **Sustainable water management**

   - Improving water infrastructure must be a priority. Optimizing of water distribution in District Metered Areas (DMAs) to prevent water loss due to leakage and poor pressure management system.

   - Solar desalination and smart irrigation systems are great examples of clean technology for water efficiency and control. That obviously applies even more to the agriculture and farming sector - the largest consumer of water.

2. **Reclaimed water**

   - Rainwater harvesting and recycled waste water also allow to reduce scarcity and ease pressures on groundwater and other natural water bodies.

   - Groundwater recharge, that allows water moving from surface water to groundwater, is a well-known process to prevent water scarcity.

3. **Pollution control & better sewage treatment**

   - Without proper sanitation, the water becomes full of diseases and unsafe to drink. That is why addressing pollution, measuring and monitoring water quality is essential.

   - Besides, improving the sewage systems in specific areas is another way to prevent water scarcity from becoming any worse.

4. **Awareness & Education**

   - Education is critical to solve the water crisis. In fact, in order to cope with future water scarcity, it is necessary to radically reform all forms of consumption, from individual use to the supply chains of large companies.

5. **Government's role with the use of Technologies**

   - Develop and enact better policies and regulations

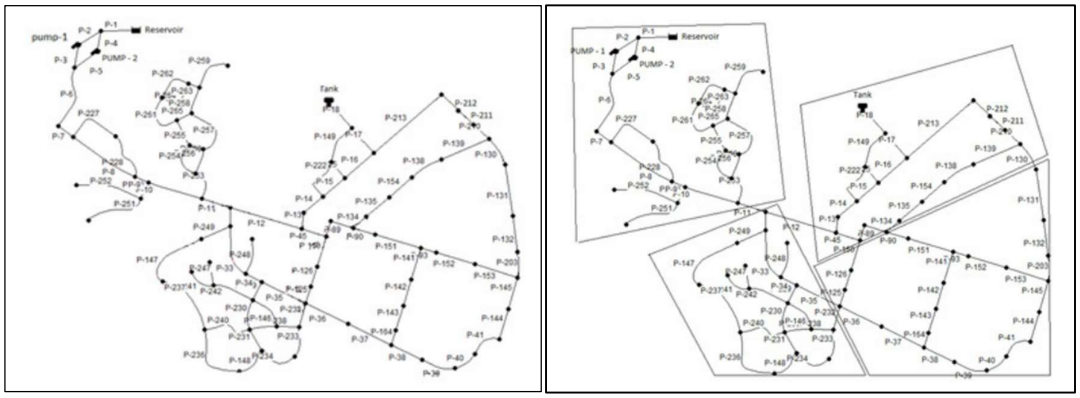
   - Shrink corporate water footprints

- Build international frameworks and institutional cooperation
- Water projects in developing countries / transfer of technology

I. POSSIBLE SOLUTIONS

- **Optimizing of water distribution in District Metered Areas (DMAs)**

  One of the main concerns of water utility managers in the past few decades is reducing the water loss rate which often exceeded 30% or even 40% of the system input value. Nowadays, the problem of water losses in water distribution networks (WDNs) and their reduction, is gaining more attention. Thus, most of these water utilities are focused on implementing pressure management (PM) policies to reduce bursts and leak rates occurring in their WDNs. To implement an efficient PM, WDNs have to be divided into district metered areas (DMAs). DMAs are smaller parts of the network and their formation aims at its more accurate management and better inspection. Formation of the DMAs' boundaries has greater significance when other PM measures are considered too, such as the installation of pressure reducing valves. Forming DMAs can be very challenging, especially in large networks where numerous variables exist. To optimally divide a network into DMAs, many parameters need to be considered, and as well, a lot of scenarios need to be tested. Water demand allocation and network pressure constraints along with water quality and fire requirement constraints, are some of the main factors of the optimization problem's complexity. By dividing the water network into DMAs, installing properly selected gate valves and flow meters along the network, the detection of the WDN for leakage is easier, water losses are reduced, and the quality of water is improved. The main idea is to combine two different phases, a phase of dividing and a phase of clustering.



This is an example of dividing a large area in district metered areas to optimize water distribution.

Geographic information systems (GIS) have become essential tools in the spatial and statistical analysis of water resources for more effective management. GIS provides a consistent environment for viewing of the display model and the input/output data results. For a better management of a water distribution network (WDN) it is also possible to combine in a GIS database information, such as water quantity and quality in a specific territory. It is thus important to collect in the same computer support all the information related to a water system based on geographical location. This precise knowledge of the network will improve efficiency at both the technical and administrative management levels and will enhance the quality of service provided.

CONCLUSION

The world faces an unprecedented crisis in water resources management, with profound implications for global food security, protection of human health, and maintenance of all ecosystems on Earth.

Therefore, this case study goes deeper into how exactly increased efforts will be needed to plan and manage water supplies in future, through increased monitoring and understanding of the interrelationships between population size, climate change and water availability.

Individuals need to accept that as a species our lives are based on a linear system in a planet that only has access to finite resources. It is therefore so important that we cannot continue pumping water from the ground without thought to how it may be restored in years to come.

The human race faces a challenge that could see the end of life on Earth. We need to adopt the approach of environmental justice to discourse by prioritising the rights of nature as being of equal importance to human rights.

Fortunately, the human race has a reputation for having the irrepressible ability to adapt in times of great adversity by rising to meet great challenges. We need to realise that it is not too late to make the necessary changes and that even in our own personal capacity, we have the ability to change the world.

It is therefore necessary to prevent this crisis by making best use of the available technologies and resources to conserve the existing water resources, convert them into utilizable form and make efficient use of them for agriculture, industrial production and human consumption.

Imposing regulatory measures to prevent the misuse of water and introducing rewards and punishment to encourage judicious use of water, will be helpful to conserve water.

Finally, awareness and orientation of all the water users to change their lifestyle to conserve water, can help the country to tide over the water crisis in the future. The challenge is manageable provided we have favourable policies and mechanisms to persuade our people to change their lifestyle.

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