

Final Report

Sea Water Conversion into Fresh Water: A Detailed Study for Technology

As a Field work for Course

Environmental Studies (CHE 110)

By

Sr. No.	Registration No	Name	Roll No	Total Marks	Marks Obtained	Signature
1	12006129	Sukhman Singh	RK20KRB81	30		



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Submitted To

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INTRODUCTION

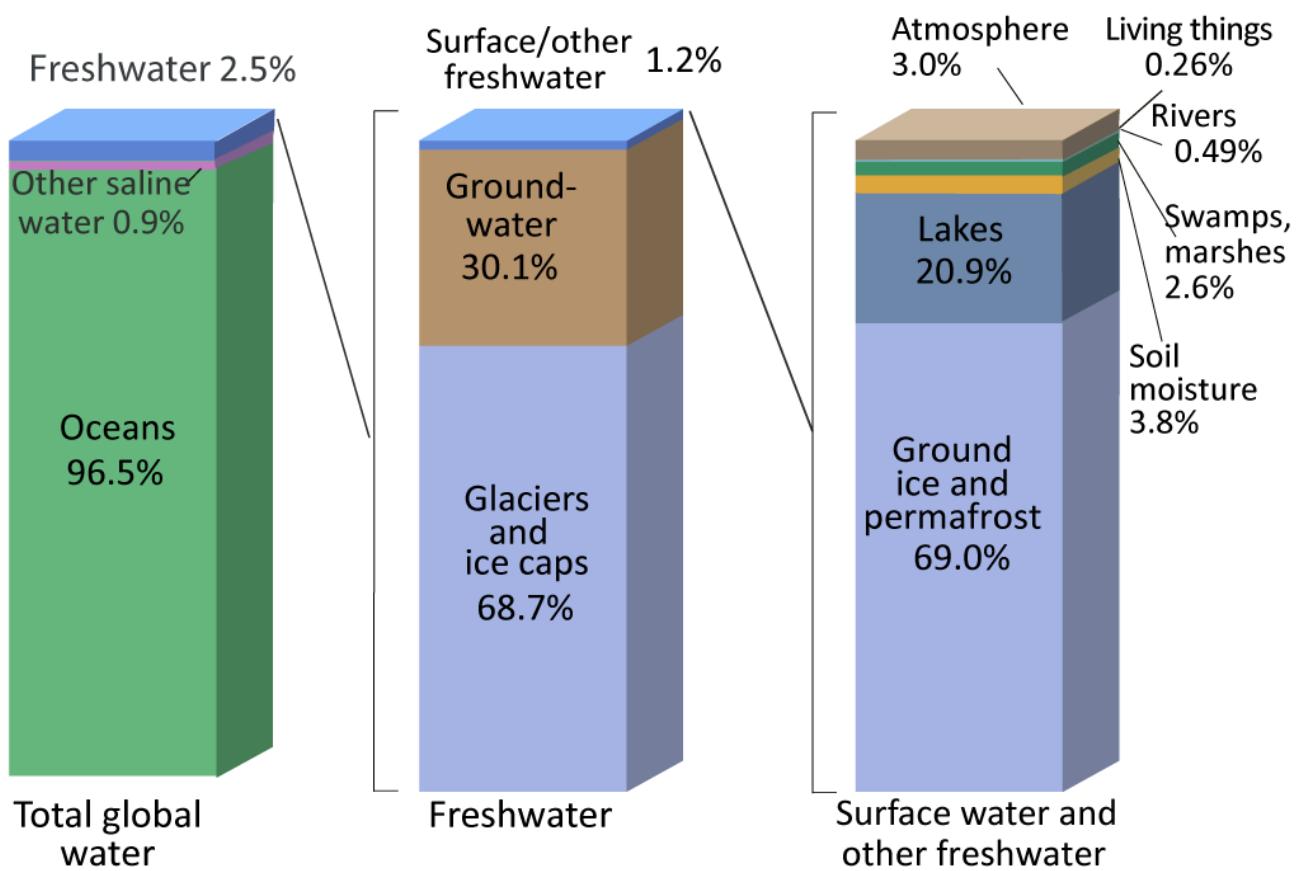
On earth, water is everywhere in clouds, inside organisms, in fact 70% of our body is water, water is present in the form of rain, lakes, oceans, etc and this is a very important realm of our earth. i.e., the Hydrosphere.

The Hydrosphere is the combined mass of water found on, under & over the surface of the earth. About 71% of Earth's surface is covered in water. The oceans contain most of the Earth's surface water. Most fresh water is frozen into glaciers and the most available freshwater is stored underground as ground water.

Out of 71% of earth's water \rightarrow 97% is ocean and 3% is fresh water of which accessible fresh water is just 1%. So since water is an essential part of our life and present in a limited quantity. It is very important to use it wisely. But still various parts of the world face scarcity of water every year and to many of them clean drinking water has become a thing of the past now!

One might ask if we have 97% 71% of earth's surface covered in water then why do we face a shortage of it. The reason is that 97% of it is in oceans i.e. in the form of

Where is Earth's Water?



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources. (Numbers are rounded).

salt water, and drinking it would be very harmful.

Then one might say that why can't we just filter out all the salts and create an excess amount of fresh drinkable water. It turns out it is not that easy as it is said. Converting salt water into fresh water is a challenging process which demands money, energy and has a huge impact on our environment.

In this report I will try to cover the various technologies used to create fresh water and its pros and cons.

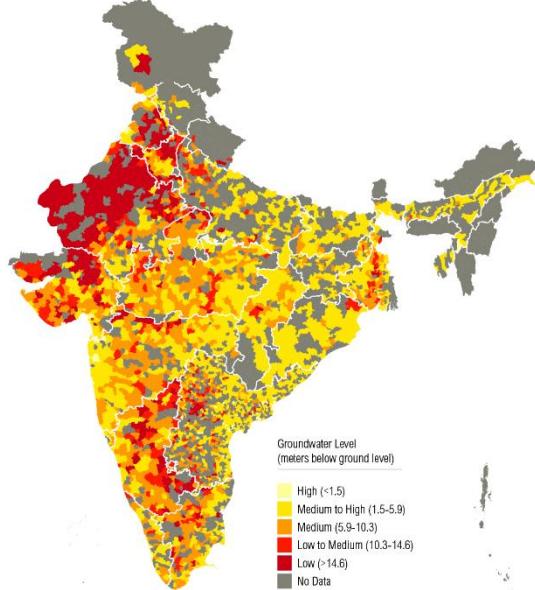
DATA ANALYSIS

Situation in India —

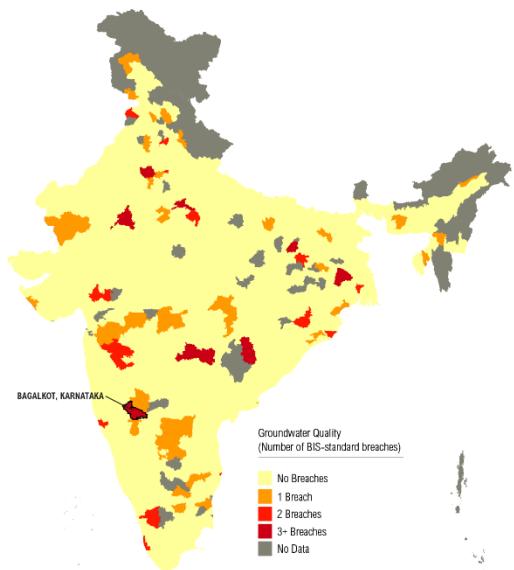
In a fast growing country like India, the average exponential rate of population growth in India needs increasing amounts of fresh water for the basic needs. This might result in water scarcity as the overall population is expected to increase to 1.6 Billion by 2050. It has been estimated that by 2040, India will rank 40th in the world in terms of water scarcity. To meet this demand desalination is an intelligent and sustainable option for India, which has a long coastline of 7,517 Km.

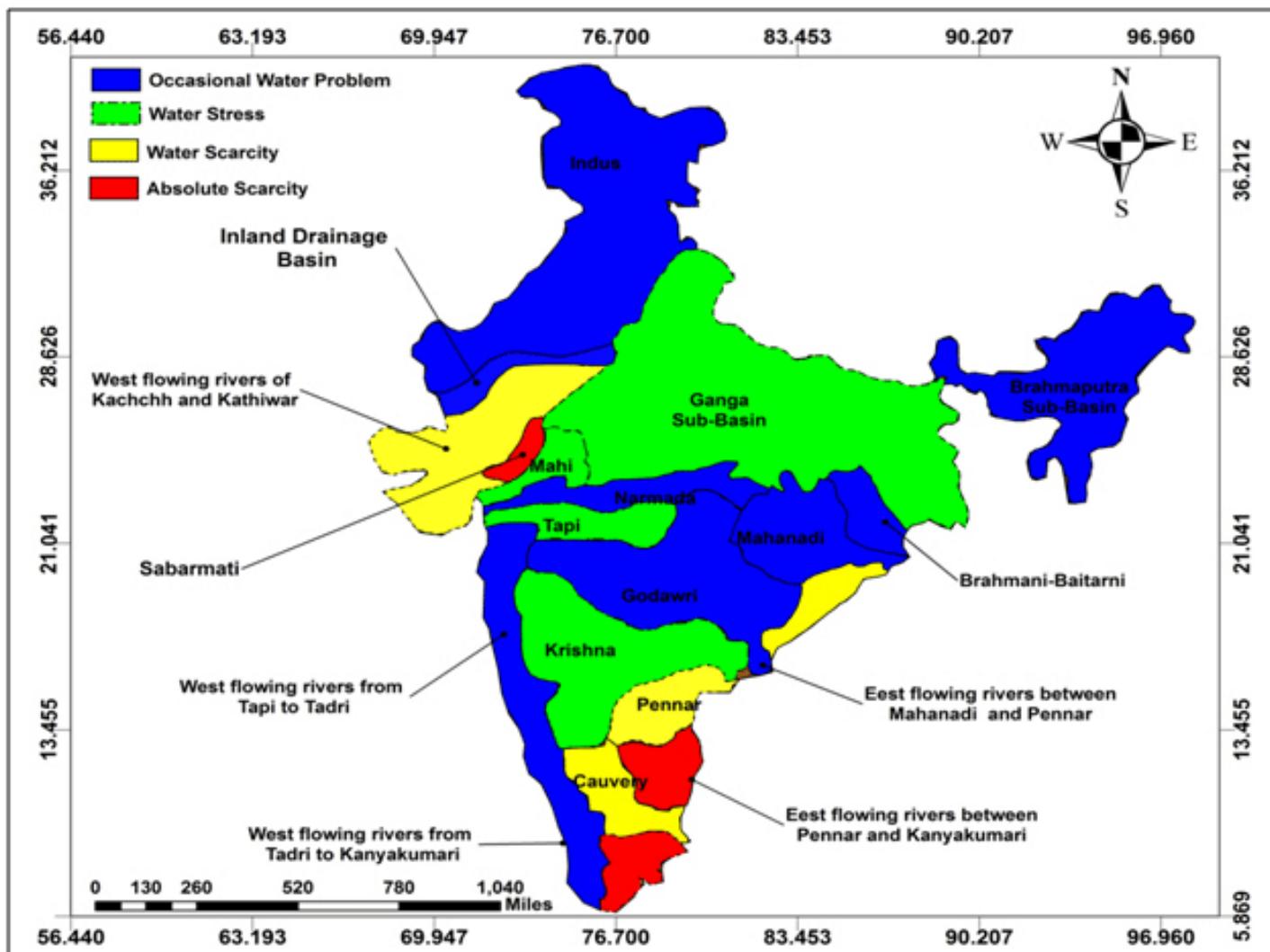
- 54% of India faces high to extremely high water stress.
- 54% of India's ground water wells are decreasing.
- more than 100 million people live in areas of poor water quality.

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India's Water Crisis:-

- 70% of India's water is contaminated.
- 75% of households do not have drinking water on the premises.
- 84% of rural households do not have access to piped water.

Currently there are two desalination plants each of capacity of 100 million litre per day (MLD) catering to the 10 lakh residents of north chennai & 9 lakh of south chennai.

The Minjur Desalination Plant is an RO plant at Kattupalli village, Chennai (north), India. Built on 60 acres, it is the largest desalination plant in India.

Natural Beauty

- Evaporation of water over the oceans in the water cycle is a natural desalination process.
 - The formation of sea ice produces ice with little salt, much lower than in seawater.
 - Seabirds distill seawater using countercurrent exchange in a gland with a rete mirabile (a complex of arteries and veins). It helps them to convert brine water into drinkable water. Birds like pelicans, albatross, gulls, terns, penguins have this gland.
 - Mangrove trees grow in saltwater, they secrete salt from roots, where animals like crabs eat it. Additional salt is removed by storing it in leaves that fall off. Some types of mangroves have glands on their leaves, just like seabird glands. Salt crystals are formed on leaves which then fall off.
 - Willow trees and reeds absorb salt and other contaminants, effectively desalinating the water. This is used in artificial wetlands, for treating sewage.
- It is a natural process → salt water, when it turns into vapour, leaves the salt behind and the condensed water is pure and drinkable with no salt in it.

Mangrove leaf with salt crystals 



Desalination - Sea Water to Fresh Water

It is a process of removal of salts & minerals from a substance like saline water. It is used to produce water suitable for drinking. Its by-product is known as brine.

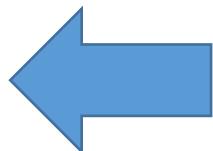
It is a very energy intensive in some cases so it is a costly method. However, we have a huge reserve of salt water.

Currently 1% of world's population depends on desalinated water for daily needs.

Just two countries UAE and Saudi Arabia produce $\frac{1}{4}$ th of the world's desalinated water. But there are many concerns like energy consumption, costing and impacts on environment.

When we think of ocean life, we think of all the big stuff, but if we see the pyramid of numbers vast majority of ocean life is really tiny, and the process of desalination may kill many ecosystems of organisms.

The methods can be divided into membrane-based and thermal based.



A floating solar still is used to Desalinate small amounts of seawater, Using evaporation and condensation.

Various Techniques Used —

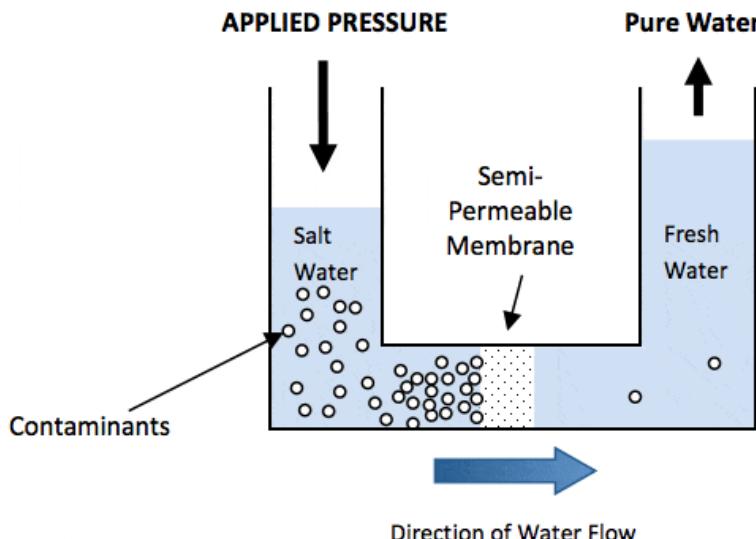
Reverse Osmosis (RO) —

In simple terms, water, containing dissolved salt molecules, is forced through a semi-permeable membrane (SPM) in which the larger salt molecules do not get through the holes but ~~do~~ water does flow through. RO is effective but it is very energy intensive and expensive than other methods. Also, it generates large amt. of waste water i.e., Brine which, if discharged carelessly can cause a lot of damage to the environment. Even our household RO's waste a huge amount of water than they filter.

Forward Osmosis (FO) —

FO also uses an SPM but it uses natural energy ~~to~~ in the form of osmotic pressure. In this a sol. of lower solute concentration flows on one side of membrane while a sol. with high conc. flows on other side. The entire process can be run without additional hydraulic pressure.

Reverse Osmosis



A view across a reverse osmosis desalination plant in Barcelona, Spain.

Energy Recovery Device -

One of the latest technology is of the Pressure Exchanger. It transfers pressure energy from a high pressure fluid stream to a low pressure fluid stream. Many industrial processes like RO operate at elevated pressures and have high pressure waste streams.

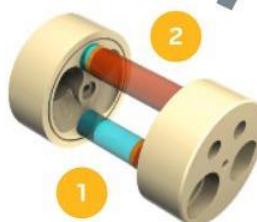
The way to overcome this is to transfer the waste pressure to a low pressure stream using a pressure exchanger.

It is a very efficient method and recovers 60% of the wasted pressure i.e it increases the efficiency of the system by 60%.

It has a 3in1 design, which consists of an induction motor, an isobaric pressure exchanger which efficiently transfers brine's hydraulic pressure directly to the feed with minimal mixing and leakage. And the Net energy transfer can be as high as 95%, which drastically brings down the cost, it also consists of a positive displacement of booster pump.

Sealed Phase

Two fluids on opposite sides of PX; rotor duct is sealed, isolating high, low pressure fluid streams



1. Low pressure driven fluid that will be pressurized and sent into system
2. High pressure motive fluid

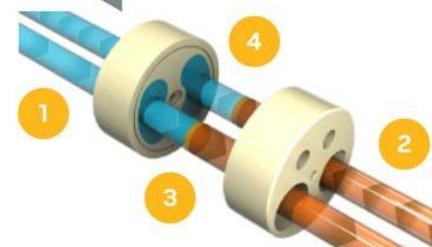
Rotor duct rotates to pressure exchange phase

HOW PRESSURE EXCHANGER (PX) TECHNOLOGY WORKS

Rotor duct rotates to sealed phase

Pressure Exchange Phase

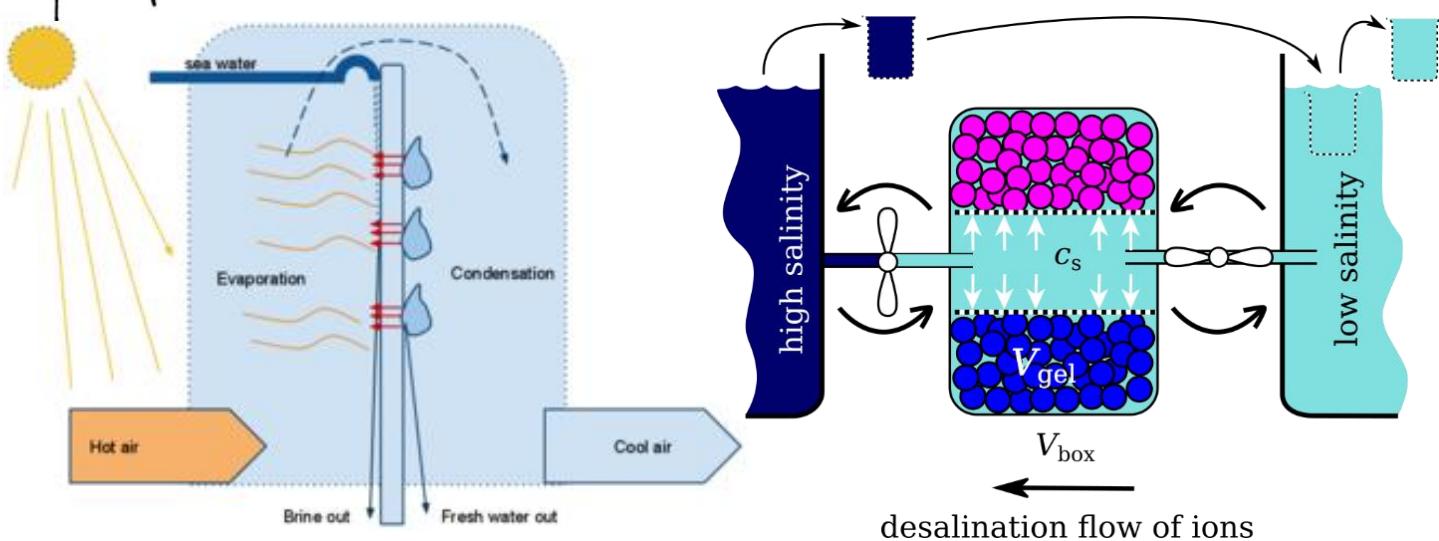
1. Low pressure driven fluid enters the rotor duct
2. High pressure motive fluid enters the rotor duct



3. Low pressure driven fluid contacts motive fluid, expelling it at low pressure
4. High pressure motive fluid contacts driven fluid, expelling it at high pressure

Dewvaporation

It is a unique desalination method developed by Arizona state university. The system has relative low installation costs and low operation and maintenance requirements. The process uses air to carry water vapour to the dew-forming channels. Heat flowing through the barrier allows evaporation energy requirement to be fully satisfied by heat released by condensation on the dew forming side. The process uses the heat of evaporation of water/enthalpy of vaporisation.

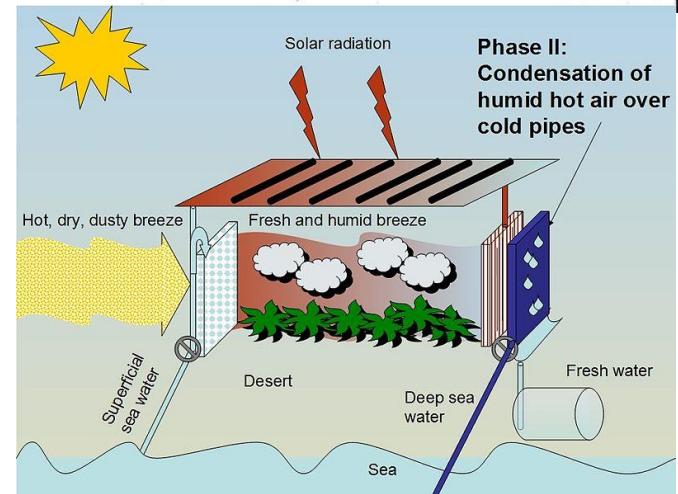
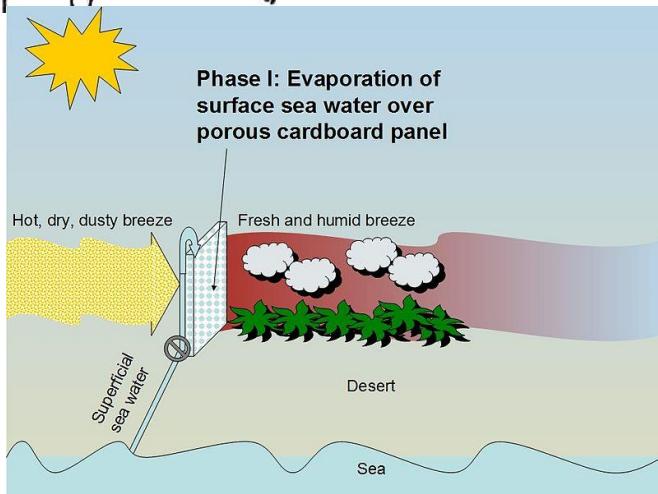


Hydrogel

When the hydrogel comes in contact with a salt solution, it swells absorbing a solution with a different ion composition. This salt can be easily squeezed out. The compression of gel in closed system lead to change in salt concentration, whereas the compression in open system, this led to change in no. of ions. This compression and swelling in open and closed system mimics the reverse Carnot cycle of refrigerator machine. Only difference is, instead of heat, salt ions are transferred from bulk of low salinity to high salinity. The cycle is fully reversible and can compete with RO method.

Sea-water Greenhouse —

It is a greenhouse structure that enables the growth of crops in arid regions, using seawater and solar energy. The technique involves pumping seawater to an arid location and then subjecting it to two processes: first, it is used to humidify and cool the air, and second, it is evaporated by solar heating and distilled to produce fresh water. Finally, the remaining humidified air is expelled from the greenhouse and used to improve growing conditions for outdoor plants.



Freeze - Thaw —

It is seen that fresh water is stored in the form of glaciers & iceberg and ice sheets. In large quantities even as they are present in the salty sea. Similarly, freeze-thaw desalination using freezing to remove fresh water from salt water. Salt water is sprayed during freezing conditions into a pond where an ice-pile builds up. When there is a warm season, naturally desalinated melt water is recovered. Another way to freeze water can be in a vacuum.

Water Survey

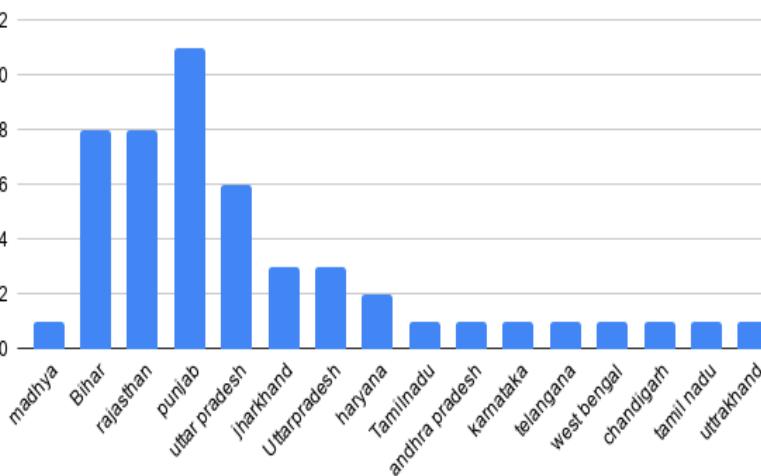
For my survey 50 people participated, aging from 16 to 55 years, but majority of them being 16 to 19 yrs old. It was conducted on google forms and it had participants from all over India from states like, Andhra Pradesh, Haryana, Jharkhand, Karnataka, Telangana, Tamil Nadu, Uttar Pradesh, Uttarakhand, West Bengal, Chandigarh, Madhya Pradesh and majority being from Punjab, Rajasthan and Bihar.

According to my survey people are concerned about lack of safe drinking water and they agree that saving water & using it efficiently is extremely important.

66% people are aware of a significant water pollution in their area and 81.7% people believe that their state will face water scarcity in the future and that their state is using water carelessly and excessively.

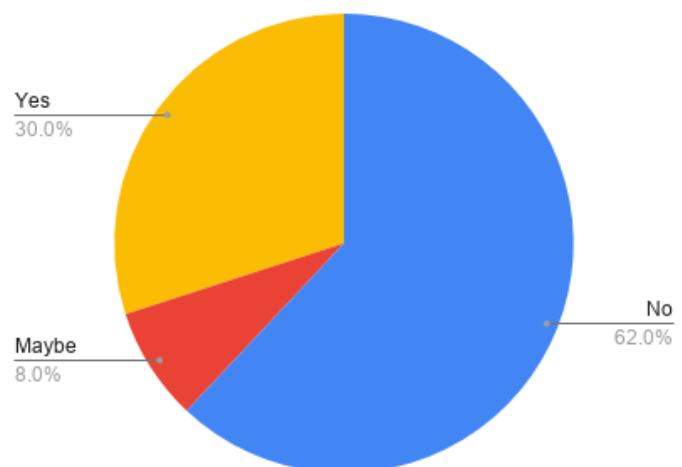
About To solve this water crisis 66% believe that we individual citizens are responsible for it and 15% believe that govt. should make an effort and 10% believe that the Industrialists can make it happen.

which state are you from?



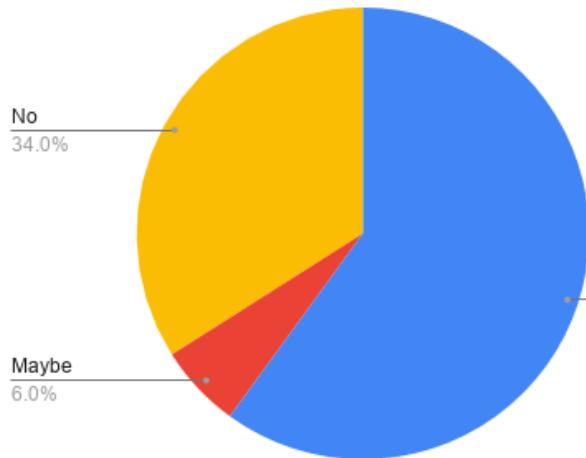
Count of which state are you from?

Are you experiencing water shortages in the area where you live?

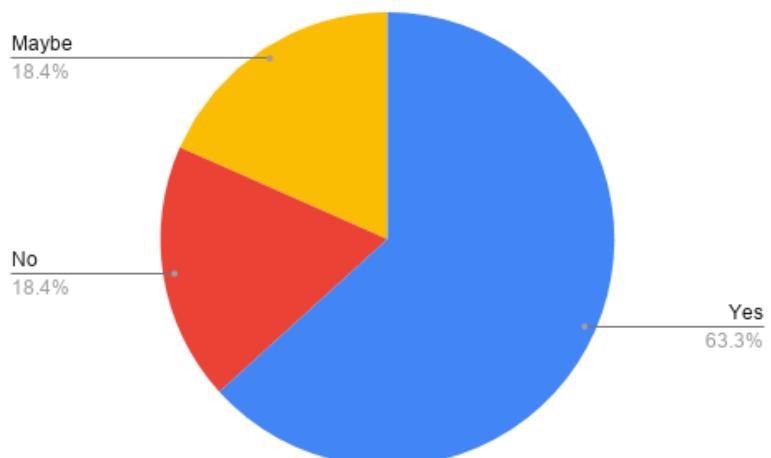


Water Survey

Are you aware of any significant water pollution in the area where you live?



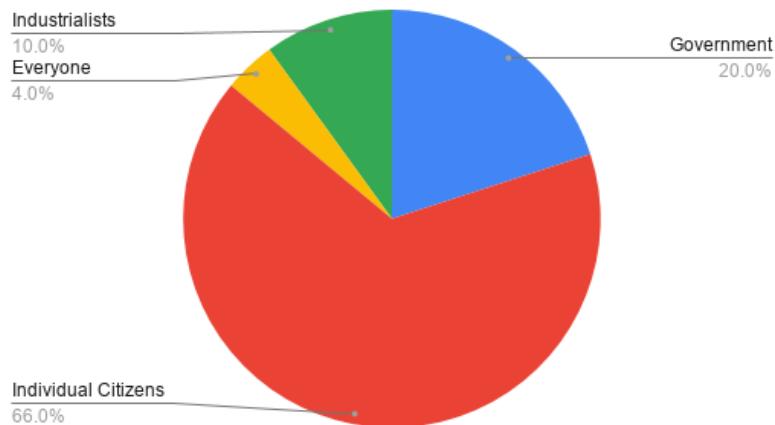
Do you think your state will face water scarcity in the future or is your state using water excessively?



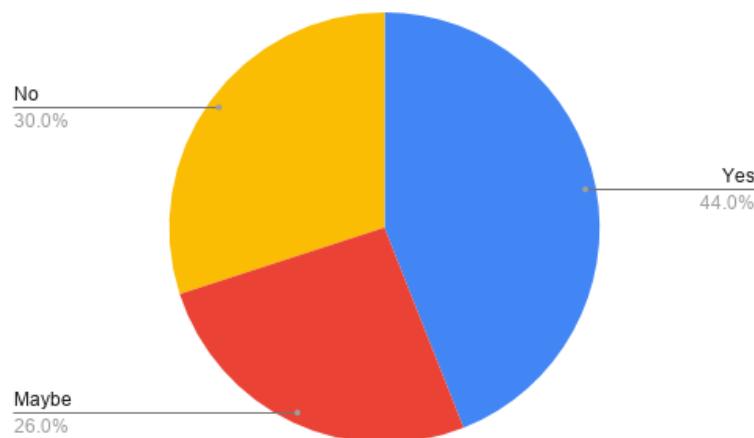
70% people believe that due to COVID-19 water consumption has increased. Even acc. to the Times of India, In July, there was a 15% increase in water consumption in Ahmedabad. and acc. to The Economic Times, water consumption in Bundelkhand, UP was up by 60%. Majority of people bathe everyday and $\frac{1}{4}$ th of them use a shower amounting to a lot of wastage of water. Many have suggested to use rain-water harvesting and that more awareness is required in the society. The survey concludes that how small things add up to big results and how dripping tap water can consume up to 10,000+ gallons of water. This put more emphasis on how important it is to save water.

Water Survey

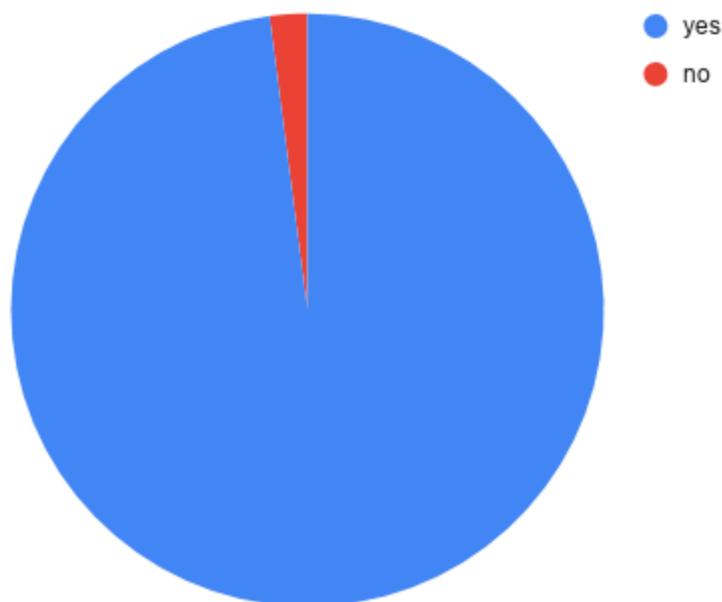
Who do you believe is responsible for solving the world's water crisis?



Do you think due to covid-19 water consumption has increased?

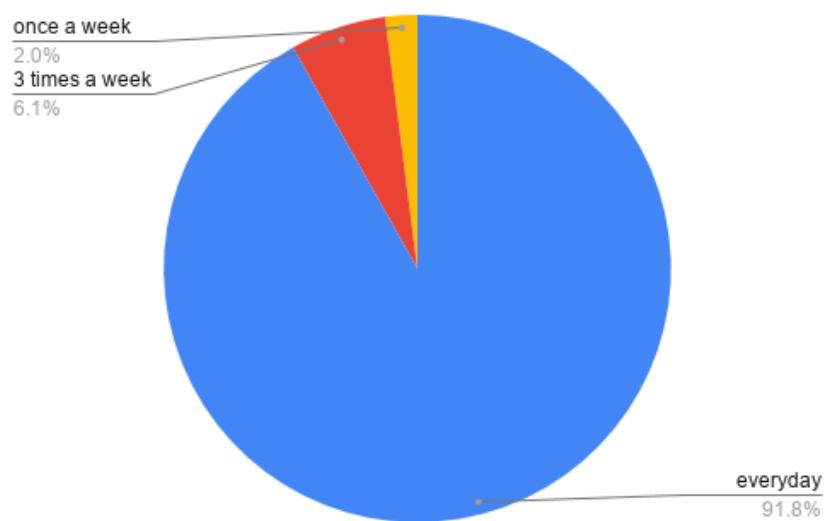


Do you turn off the tap while brushing

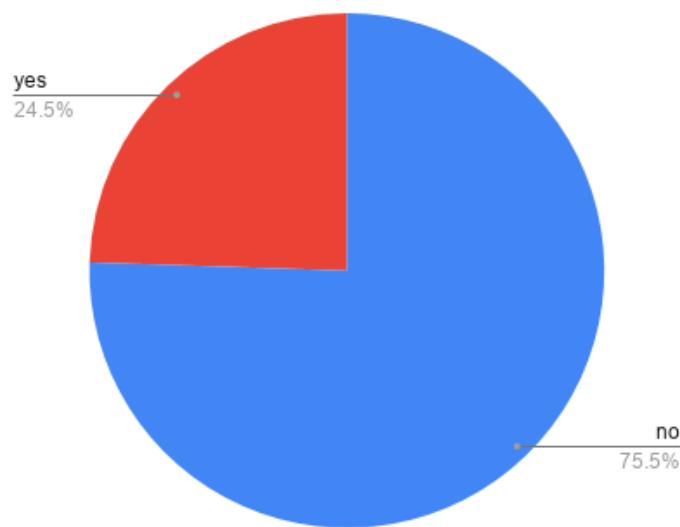


Water Survey

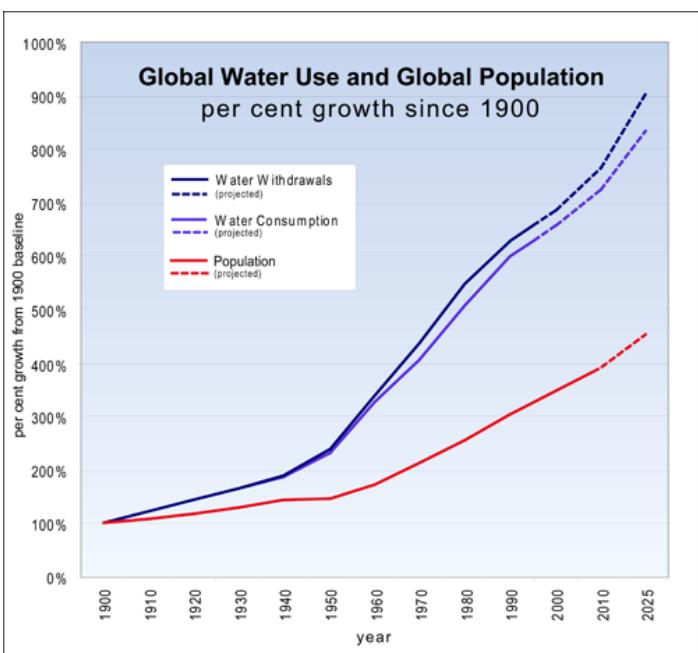
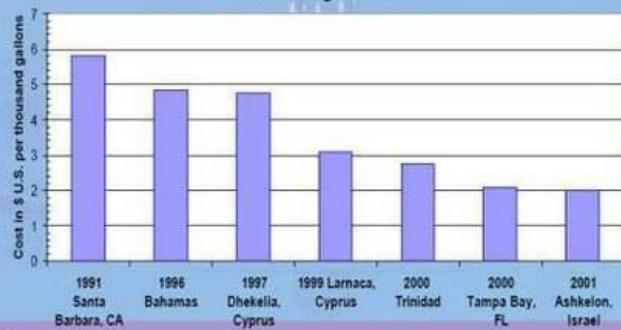
How many times a week do you take a bath



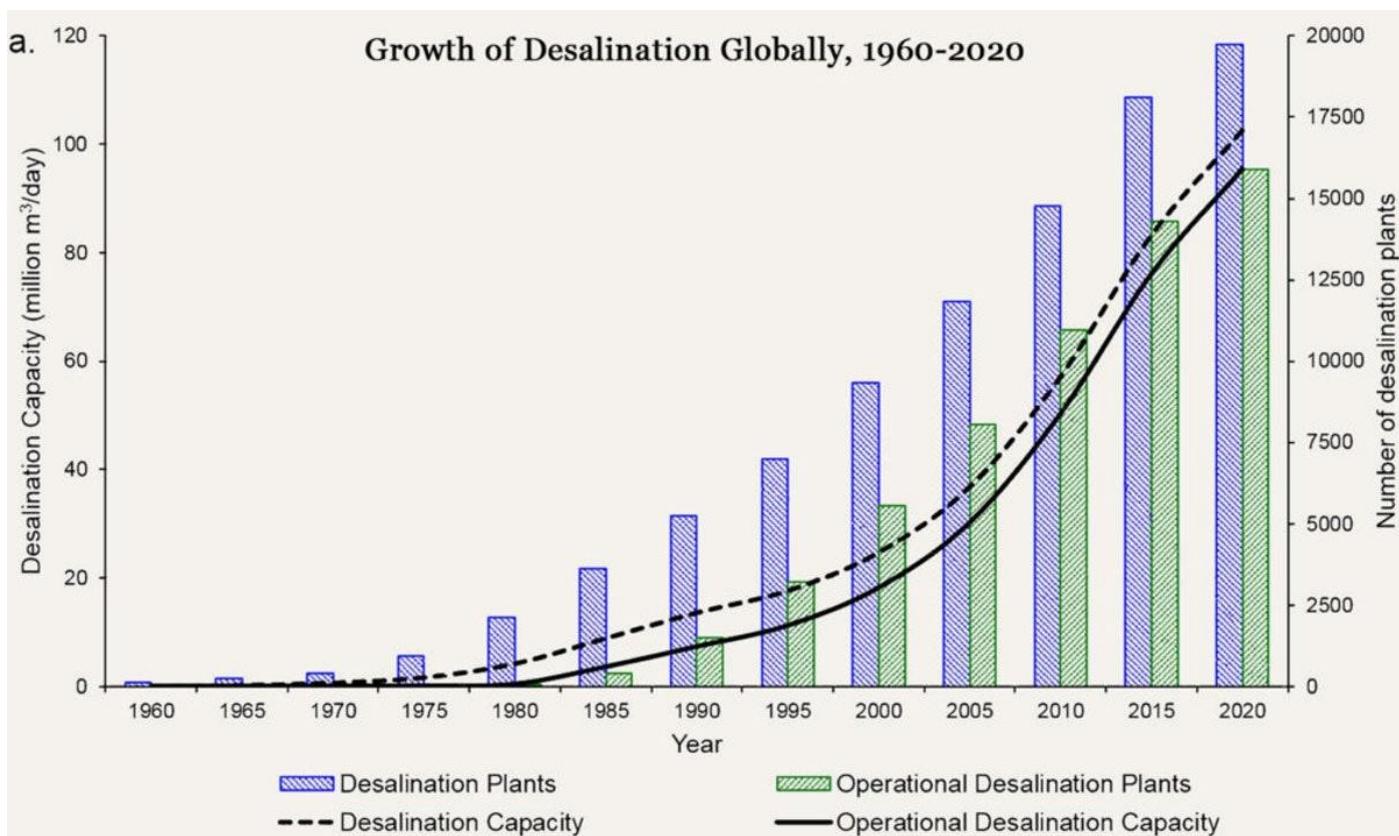
Do you use a shower?



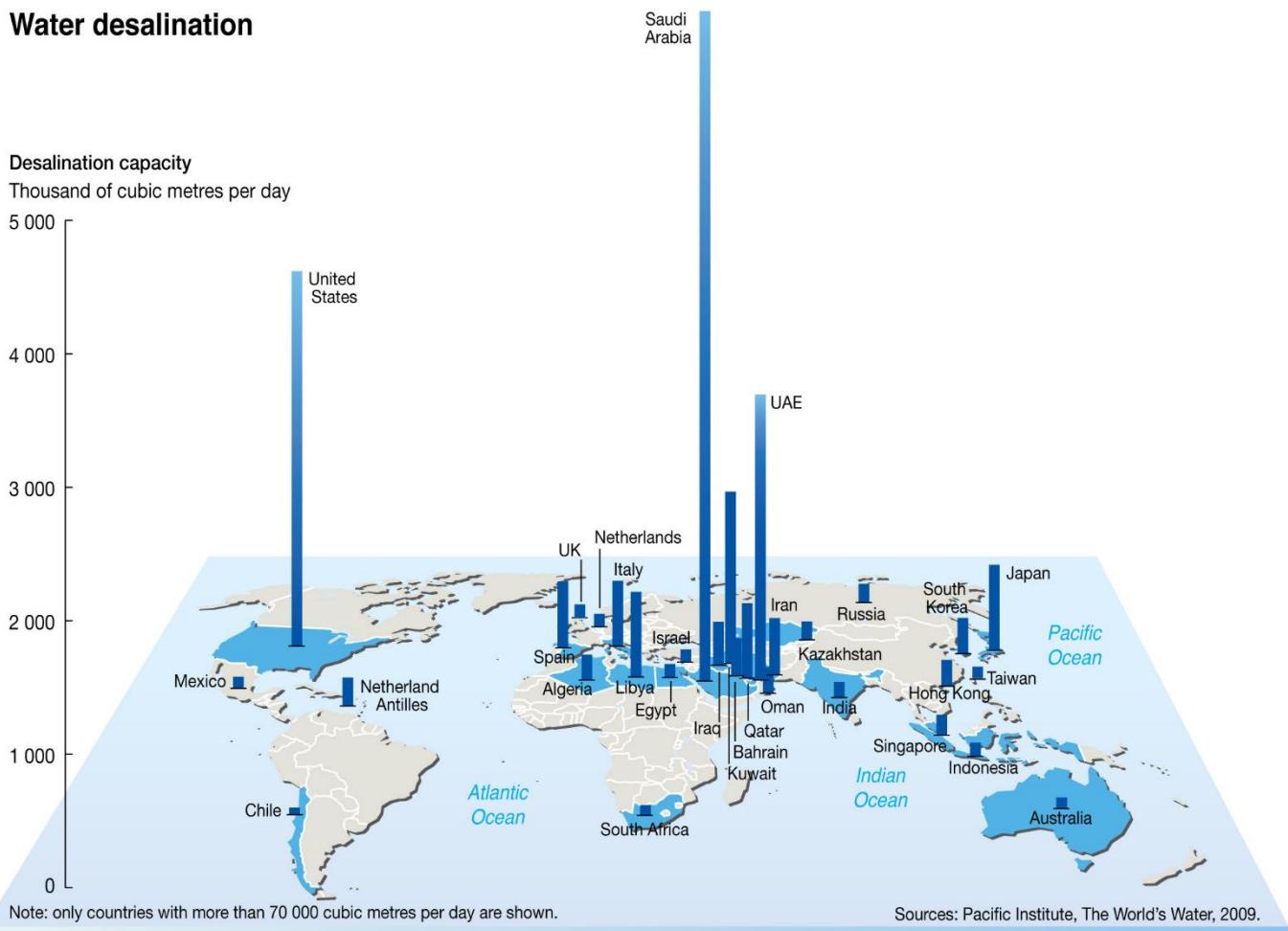
Decline in Seawater Desalination Costs Represents Evolution in Technology and Facility Size



Water Survey



Water desalination



Conclusion

Water is an essential but limited resource. It is estimated that by 2030 54% population of world will face water scarcity. Without it life is not possible, and we should do ~~any~~ everything to save it. As we are already facing a shortage of water which is drinkable. It is imperative that conversion of salt water into fresh water be done in an effective manner as desalination is an energy intensive process and only with innovation we can reduce the efficiency & costs. The various technologies I discussed here are a step towards a common goal i.e. that is to produce fresh drinking water. While making this report I too learnt many things and that has definitely added value to my knowledge base. . .

Reference

- www.youtube.com
- www.google.com
- <https://www.wikipedia.org/>
- www.scholar.google.com