

Strategies for Increasing Fresh Water Supplies in Deficit Areas at India

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ABSTRACT Over population, pollution, deforestation and natural disasters are among the major problems faced by the world today. The increasing population and industrial development have put further pressure on the supply of fresh water. Water stress is thus on the increase and it has been predicted that by the year 2025, 40% of the developing countries that are facing a population explosion will experience water stress. Agricultural and other economic activities can only be successfully carried out if there is sufficient fresh water. This paper explores the use of new and innovative techniques such as Remote Sensing, GIS, and GPS in identifying areas, which need to increase its fresh water supply. India suffers from water shortage in the summer season due to very few spells of rainfall. Fresh water demand is peak in summer. Existing methods of fresh water generation are reviewed and recommendations made about the adoption of these technologies. The usage of seawater is becoming popular nowadays because of the inability to meet the ever-increasing demand for fresh water is increasing daily. The E-Still Steam distillation equipment is an example to get distilled water for drinking in the rural areas where fresh water is insufficient. This is useful to engineers and planners who have to plan and provide adequate fresh water supplies to sustain life in deficit areas. GIS as a computer-based tool for mapping and analyzing spatial data and events that take place in this earth is also a useful tool for water management aspect. GIS and RS can help us locate the area where there is acute shortage of water and whether the area is near the sea. This information can be presented clearly in the form of maps with reports allowing the decision makers to have a complete scenario of the problem and can hence focus on the real problems and other issues.

INTRODUCTION

India, the seventh largest country in the world and the second largest in Asia, has a total geographical area of 3,287,590 sq km. The mainland stretches from 8°4' N to 37°6' N and 68°7' E to 97° 25' E. It has a land area of 2,973,190 sq km and water area of 314,400 sq km and the entire length of the Indian coastline is 7000km (http://www.photius.com/wfb2000/countries/india/india_geography.html).

India is a large country, covering a whole variety of terrain including high mountains and vast plains. Due to this range of terrain, a variety of climatic conditions exists the northwest plains contain areas of desert, while the northeast has fertile rice fields. India suffers from water shortage in the summer season due to very few spells of rainfall. The coastlands are largely tropical in nature while snowfields can be found in the north (<http://www.gov.sg/metsin/holiday/asia/india.html>).

Climate: India has three major seasons winter, summer and monsoon. The winter months (November-March) are pleasant throughout India with bright sunny days. In the Northern plains, the minimum temperature drops steeply and there is snowfall in hills. In

south and eastern India, however, December and January are pleasantly cool, never very cold. The summer months (April-June) are hot in most parts of India. The Monsoon (June-September) is the time where there are few spells of rain. The southwest monsoon usually breaks about the beginning of June on the west coast and reaches elsewhere later. With the exception of the southeastern areas, India receives the major share of its rainfall between June and September and hence the demand for fresh water is peak in summer. (<http://www.indolink.com/Discover India/climate.html>).

Global Water Stress: The major problems with world water today are population growth, pollution, deforestation and natural disasters. Water as the most important source in this world is getting scarce due to mismanagement, increase in population and industrial development. Issues concerning water sharing have brought neighboring countries into disputes. In the year 1995 the World Bank stated that the global demand for water has historically increased at the rate of 2.3% a year, doubling every 21 years. Water experts agreed that something must be done urgently to save the world from water catastrophe. These experts decided on the exploitation of seawater usage.

The map below indicates the fresh water stress in the world for the year 2025. This water stress can be considerably reduced if we could exploit seawater for usage. It is better to have seawater than no water. Many countries have realized this and they have started to convert seawater to potable water. Most of the methods employed for this conversion are very expensive. Scientists are carrying out research to simplify the methods using technology to make it more economical. The E-Still has paved the way for this economical production of portable water. In certain cases, it maybe necessary to construct sea canals such as the canal cutting across Dubai and the Buckingham canal in India. Constructing a canal is a major project and it is expensive. Constructing canals can bring more income to the people and the country. Canal construction is normally carried out with the help of the government and by small investment from the rural communities where there is an acute shortage of water or no water.

India is listed as a country that will suffer from freshwater stress in the year 2025 which is shown in figure 1 and comes under the category of more than 40% area from the above map. Nevertheless

the demand for water is high. India has problems with water for the past few years. Rainfall is less and people depend on rainwater for domestic purpose. Southern part of India suffers due to less rainfall and most of the rivers are dry in the summer. In order to increase freshwater supply, the government has to take the initiative to exploit seawater.

Major Disputes for Water: The Cauvery River and its tributaries form definitely the most contentious, if not the most important, watershed in southern India. About half of the watershed is in Karnataka, the rest is in Tamilnadu. The Cauvery, like her multi-state and multinational cousins —the Mekong (Southeast Asia), the Colorado (Western U.S.), and the Okavango (southern Africa), is peaceful river in times of good rain, but when the rains fail peace fades. The most recent of these failures occurred when the monsoons failed to feed the Tamilnadu side of the watershed in late 1995 and early 1996. Threats of violence advanced to violence and national level intervention was eventually needed to solve the problem.

Singapore obtains half of its water needs from Malaysia under agreements running until 2061

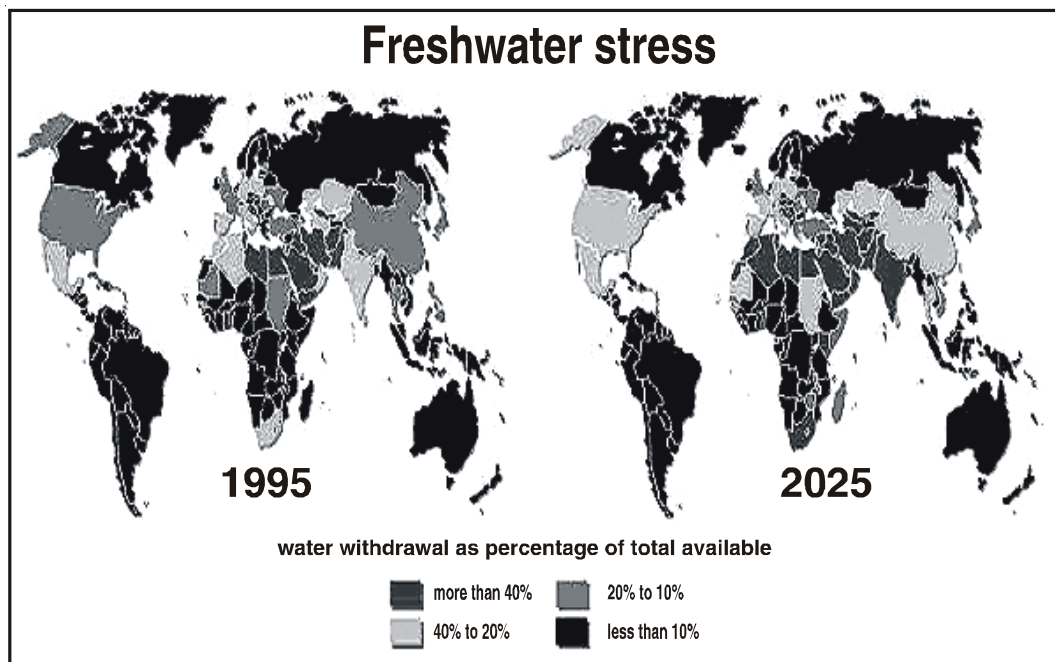


Fig. 1. Global water stress for the year 1995 and 2025.

and 2062. The Malaysian state of Johore provides 350 million gallons of water per day to Singapore at \$0.007 per 1000 gallons, while Singapore has to resell a minimum 17 million gallons per day of treated water to Johore at \$0.13 per 1000 gallons. The price differential has prompted calls from numerous Malaysian politicians that Singapore is profiteering from the deal (<http://www.thestar.com.my/>).

In 1980 war erupted between Iran and Iraq that resulted in hundreds of thousands of casualties and a tremendous loss of oil revenues for both countries. The war eventually ended in 1988 but animosities have persisted. While the causes of the conflict were numerous and varied, one of the principals was access to, and control of, the Shatt-al-Arab waterway. Control of the waterway and its use as a border has been a source of contention between various states since The Peace Treaty of 1639.

Geographical Information System: GIS is a computerized system for management of natural resources, developmental planning, environmental monitoring and disaster management. GIS can be used to store, retrieve and display geographically referenced data of the area where there is acute shortage of water.

In recent years the rapid development of aerospace, telecommunication and computer technology have improved our ability to accurately and comprehensively observe the earth. Above all this it has provided a large amount of reliable information to reflect the changes over the earth and to meet the requirement of the social and economic development.

Water resource management using GIS has been viewed as a critical solution to solve the water management problem (Fowler, 1994). There are many research carried out using GIS to solve the water management problems. The application of GIS in this study will provide efficient database system of water management for identifying the problems, monitoring, future planning and decision-making. The GIS is useful in identifying places where there is acute shortage of water. For instance a village or town, which is near to the seacoast but suffering from shortage of water. Remote Sensing and GPS will play a major role in assessing the place through satellite images.

Advantages of GIS in This Study: GIS is an elaborate subject, which deals with geographically referenced data. The process of

drawing maps with GIS is much more flexible than the traditional manual one and cartography. In the context of water management the advantages of GIS are:

1. It helps to identify and locate the area or place suffering from acute shortage of water and whether the area is near the seacoast.
2. It has the power to create maps, integrate information, visualize scenarios, solve complicated problems, present good ideas and develop ultimate solutions.
3. It helps to show the existing rivers, lakes, ponds, reservoirs and other man made water bodies.
4. It helps to show the direction of flow of water.
5. It helps to locate the places where there is very little rainfall.
6. It helps to locate the places where there is no access to fresh water.
7. It gives the details such as topography, rainfall, evaporation, evapotranspiration and types of soils of the specific area.
8. It is useful in future planning and for monitoring purpose
9. Spatial data of the specific area can be stored, retrieved and updated whenever required.
10. Maps drawn and the reports, which are given, are most consistent and reliable.
11. Maps drawn have a very good graphic quality compared to other systems.
12. It has the capability of transforming the original spatial data in order to answer the user-specified queries.

Satellite Remote Sensing: Remote Sensing by satellite is an important tool for monitoring and managing water resources. In many cases, digital image classification, including data manipulation, preprocessing and enhancement, is used to process the satellite data (Rango, 1994). Remote Sensing can be defined as the technique of obtaining information about objects through the analysis of data collected by instruments that are not in physical contact with the objects of investigation. The data plays a major role and hence GIS comes into picture to form a good combination with RS to give better solutions for critical problems. The unique feature of RS compared to others is that it can be used to collect data for baseline inventory and future monitoring purposes. RS can also be integrated with other tools for further analysis.

The Digital Elevation Model (DEM) is defined as "any digital representation of the conti-

nuous variation of relief over space” (Burrough, 1986). It can be created from stereopairs derived from RS data or aerial photographs, or can be generated from digital terrain elevation data.

METHODS TO CONVERT SEA WATER TO POTABLE WATER

Studies have shown that 97 % of all water on the earth is seawater and about 3 % is fresh water. Only 0.8 % of all water is usable from rivers or underground sources. Converting seawater to potable water by desalination process has been attempted for a long time. Scientists are now finding better ways to desalinate the seawater. There are many methods and processes involved in desalinating seawater. Reverse osmosis, Evaporation, Chemical reactors, Bioreactors, Solar energy and Thermo evaporation are some methods of performing desalination. The Reverse osmosis (RO) in particular, consumes the least amount of energy to give better results at higher cost (Kneen, 1995).

Canals such as Buckingham canal in South India and the canal cutting across Dubai offer a long-term benefit. The canal will be a permanent structure and many practices can be performed. The idea of exploiting seawater by constructing canals should be encouraged and implemented as early as possible. Constructing a canal is not an easy task and it is very expensive too.

PROJECT ESTIMATE TO CONSTRUCT A CANAL WITH RO PLANT

Another approach of creating fresh water is through the RO method. However, the construction of a RO plant is a major investment as it involves different types of equipment. Maintenance of the plant is also expensive compared to the E-Still equipment. Hence RO process will increase production cost of water and it will be difficult for poor people to afford it.

The unit cost of the brackish-water reverse osmosis desalination, including the construction of an 85 km drainage canal, is roughly estimated to be US\$0.48/m³. This includes the following four cost elements, assuming a construction period of three years for the reverse osmosis plant and an interest rate of 8 per cent:

- Capital cost: US\$211,518,000
- Design and construction management:

US\$52,911,000

- Financial expenditure: US\$68,672,000
- Annual operation and maintenance costs: US\$20,551,000

The operation and maintenance costs of reverse osmosis desalination would likely be reduced by using less expensive off-peak electricity and by developing low-pressure, high-efficiency membrane modules. The above rates are for 1996 (*Source*: <http://www.unu.edu/unupress/unupbooks/uu18ce/uu18ce0c.htm>)

The cost to construct a canal can vary from country to country since it depends on the nature of the area and the specific design details of the canal. There will be a huge difference in labor and material costs from one area to another. The cost for small canals is approximately \$15 to \$20 USD per sq m for 50mm lining thickness not including the material cost (Waganoor). As said earlier the material cost will vary from place to place and the rates prescribed here are not the present rates.

What is E-Still

Areas near the sea and suffer from water shortage can use the E-still steam distillation equipment to convert seawater to potable water. This E-Still steam distillation equipment is not expensive and can produce water of very good quality and standard for drinking and domestic purposes.

The E-Still is unlike Filtration and Reverse Osmosis (RO) that require disinfectant of the Filter, Membrane and Entire System with Iodine or a Silver Solution to kill trapped Micro-Organisms, all Steam Water Distillation Systems are Self-Sterilizing, whether they be Non-Electric or Electric, and the *steam provides sterilization*. Steam distillation is the most effective method of Water purification. Steam distillation is the simple process of Removing water (Steam) from Contaminants versus the unnecessarily complicated and ineffective methods of Chemical Treatment, Reverse Osmosis (RO) and other types of Filtration to remove contaminants from water.

The E-Still equipment looks very simple and it is not expensive. The name “E” stands for economy and “still” stands for fixed still equipment once the process begins. It can be transported and carried easily anywhere since it is compact. E-Still equipment can be

manufactured easily. The Pure Survival E-Still easily distills any *Type of Contaminated Water* including Raw Seawater, removing over 99.99% of all impurities, producing High Purity Distilled Water while Killing Biological Organisms and leaving such contaminants behind in the boiled water.

Filtration and reverse osmosis trap but do not kill bacteria, viruses and other biological organisms. Steam water distillation kills all forms of biological organisms and is 99.9% effective in removing all contaminants from raw polluted water even seawater! The scientific world recognizes steam water distillation as an effective method of water *purification* whereas filtration and reverse osmosis only provide water *treatment*. With a pure survival E-Still equipment, pure sterile distilled drinking water can be produced whenever needed.

A leading independent testing laboratory [Midwest Laboratories, Omaha, Nebraska. Lab Report Project 21525], evaluated the Pure Survival E-Still on 11 January 1999 using Raw Sea Water. The Pure Survival E-Still was proven to be effective in reducing the Total Dissolved Solids [TDS] of the Raw Sea Water from 33,000 Parts Per Million [ppm] to only 8 ppm with Hardness reduced from 284 Grains Per Gallon [gr/gallon] to Zero [0] gr/gallon.

The table 1 shows how effective E – Still removes the contaminants from seawater. It is one of the most effective and cheapest means to convert seawater to potable water and this can probably be used in small scale for drinking and domestic purposes. E – Still will enable us to create and produce our own pure sterile distilled drinking water when it is required. The cost of E –

Still is affordable, it serves the purpose for long duration and there is no maintenance required. The cost of producing the water will be low and it could be much useful in the rural areas where there is acute shortage of water, which are near by the sea.

HOW DOES E-STILL WORKS

1. Contaminated Water [including Raw Sea Water] is placed in the Lower Pan.
2. The Water is brought to a boil.
3. Steam rises through the Patent-Pending Stainless Steel Discs, leaving contaminates behind.
4. The steam contacts the underside of the Top Pan that contains cooler water to dissipate the heat in the steam.
5. High Purity Water Droplets form on the underside of the Top Cooling Pan.
6. Water collects in the Stainless Steel Collector Disc and drains through the Discharge Spout.
7. The Distilled Water passes through an Activated Charcoal Fill into container for Drinking and Cooking Uses.

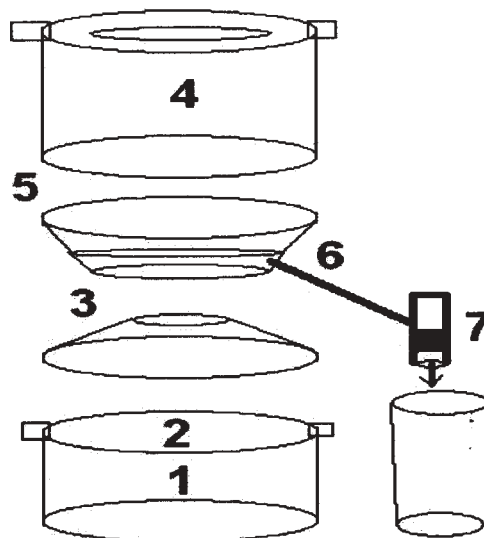


Fig. 2. Distillation process using the E-Still equipment

E - STILL DESCRIPTION

Height: 13.5" [34cm]

Diameter: 9.5" [34cm]

Weight: 5 pounds [2.3 Kg]

Table 1: Effectiveness of the E-Still

Contaminants PPM (Parts Per Million)	Seawater Before passing through the Pure Survival E-still	Seawater After passing through the Pure Survival E-Still
Total Dissolved solids (TDS)	33000 ppm	8ppm
Calcium	297	0.48
Magnesium	1001 ppm	0.05 ppm
Sodium	10370 ppm	0.4
Chloride	1983	none detected
Sulfates	2540 ppm	3 ppm
Fluorides	37 ppm	none detected
conductivity	49.20 mmhos/cm	0.013 mmhos/cm
Hardness(grains)	284	0

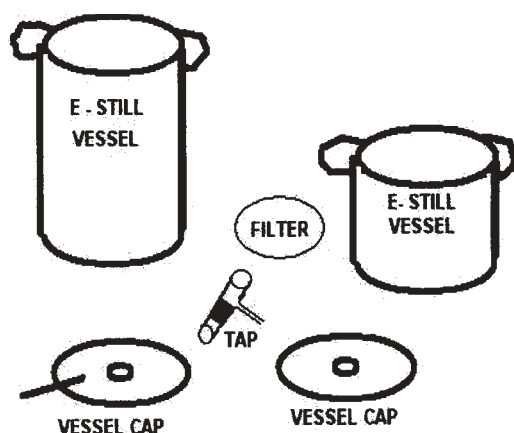


Fig. 3. The E-Still components

Shipping Weight [Single Unit]: 8 pounds [3.6 Kg] Box Size [One Unit]: 12" x 12" x 12"

Shipping Weight [Master Carton of 8 Units]: Approximately 65 pounds [33.5 Kg].

Cost of E-Still Equipment: The Manufacturer's suggested U.S. Retail Price is \$159 – with a 5 Year Limited Warranty on the Patent Pending Stainless Steel Discs.

CONCLUSION

This paper highlights the methods that can be used to convert seawater to potable water by utilizing GIS and RS techniques for better results. There will be an acute shortage of water in the years to come. There are many alternatives to solve this problem. The best solution will be exploiting the seawater. GIS and RS will play a key role in locating the places of water shortage and giving the geographically referenced information.

The E-Still equipment is affordable and it can be utilized to produce pure sterile drinking water for domestic purposes. The Indian private sector and government can take the initiative to produce a new version of the equipment and can market them to benefit the people. Exploiting seawater will be the best alternative to overcome scarcity of fresh water for domestic use.

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