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PRESUMPTION OF USING SYSTEM DYNAMICS TO EXPLORE THE WATER SUPPLY

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ABSTRACT

All living organisms on the earth depend on water. It is also most common universal solvent and coolant for industrial and domestic applications. It is the key to socio economic development of the country. About 70 percent of the total water available on earth is fresh water. Out of this, only 1 percent is accessible as surface freshwater while the rest 2 percent is locked away in the form of ice caps and glaciers in the Polar Regions, for distant from human habitation. The availability of water is governed by hydrological cycle. Water pollution increased due to industrial activities, growth of population and increasing requirement of water for the agricultural sector have led to a situation wherein access to safe drinking water in many parts of the country has become a problem. Although only 8% of the fresh water is used in the domestic sector, there is a stringent demand of the quality of this water. Effective management of water resources though a perceivable reduction in water use in different sector along with appropriate technologies and strategies is needed to ensure equitable access of water to the entire population as it is the basic necessity of life.

Key words : Water, polar regions

INTRODUC TION

As the population is increasing, fresh water resources are under heavy pressure. A very small fraction, about 3 percent of the available water resources is available as fresh water. Drinking water shortage is expected to become one of the biggest problems for humanity. Many developing countries like India have given topmost priority to fresh water supply in their rural development plans. The timely availability of drinking water in right quantity and quality at the right place is severe in many under developed and developing countries. At many places the water available is too saline, or, not potable due to the presence of toxic chemicals like arsenic and fluoride beyond permissible limits. The problem is very severe in many rural areas. About 28 percent out of the total 0.575 million villages in India were identified as problem villages. Many villages have scarcity of drinking water.

The availability of fresh water is diminishing continuously day by day because of global warming and climate change. Same time, its requirement is increased rapidly all over the world due to rapid growth of population. Therefore, the availability of good quality of drinking water is the major challenge in front of developing as well as developed countries. About 97.5% of the total water available on the earth having salt and harmful bacteria, nearly 2% is frozen in glaciers and polar ice caps (Kumar et al., 2015). This water cannot be directly used for drinking purpose, if so; it causes a serious damage to health. Here is the need of technology for distilling of brackish and saline water to purify drinking water. The solar still is one of the prominent, cheapest and environmental friendly methods. Number of designs have been suggested and constructed to improve the purified water output per unit area. Many researchers have shown their interest to enhance the performance by maintain the higher temperature difference between solar still basin and glass cover, so that the rate of vaporisation can be increased (B. Sarkar et al., 2018). Tiwari and co-authors (Semiat et al., 2015) have reported an improvement by increasing the temperature of water in the basin using active and passive methods or by decreasing the temperature of the glass cover or combination of the both. Dimari et al. (2008) have discussed the effect of thickness of glass cover and different condensing cover material. They have suggested that glass is the best performed material for solar still. Abdullah (2013) reported comparative study of experimental performance between stepped solar still coupled with solar air heater over the conventional solar still. They also study the effect of the water flow on the glass cover. It was examined that water productivity increased by 112% over conventional still, Hijleh and Mousa (2018) have numerically investigated the effect of water film cooling parameters on the performance of the solar still. Improvement in performance was reported in still efficiency up to 20%. It is also investigated that the ambient wind velocity has significant effect on the still efficiency. Tenthani et al. (2012) have conducted experiments on two solar stills with different colour paint on inner surfaces. One is painted white and another is painted black on the inside walls of the solar still. It is concluded that white painted solar still was found 6.8% more efficient. The productivity of single slope solar still can also be enhanced by coupling a shallow solar pond (SSP) to the still (El-Sebaii et al., 2011). In some research Glass has been used as a preferable choice of material for its use as a condensation surface in solar still as it gives higher water yield than other materials (Bhardwaj et al., 2013).

DYNAMICS OF WATER SUPPLY AND DEMAND:

At the current trend of growth, global population is expected to reach 8 billion by 2025 and the per capita water available will come down. The average amount of fresh water per capita may still be enough to meet human needs, if it is properly distributed. But equitable distribution is not possible due to mainly two reasons. The first is: two-thirds of the global population (around 4 billion) lives in areas receiving only one- fourth of the global annual rainfall and the second is that the rainfall is not uniform through out the seasons and from year to year. Supply of potable water to all is the biggest challenge before the world today. Limited resources have resulted in water shortage in 88 developing countries across the world containing 50% of the world's population. Further water supply in these countries cannot meet urban and industrial development needs as well as associated changes in lifestyle.

India is a case in point. From a per capita annual average of 5,177 m^3, fresh water availability in India dropped to 1,820m^3 in 2001. It is predicted that by 2025, per capita annual average fresh water availability will be approximately 1,340 m^3 (CPCB (2000)). As the demand for water increases so does the cost. Caught between the growing demands for fresh water on one hand, and increasing pollution of water on the other, India is one of the countries in the world facing a severe water crisis. This crisis has already affected one third of its population in terms of spread and severity. The central Government adopted a minimal norm of 40 liter per capita per day (lpcd) for human needs assuming that it would fulfill its requirements for Drinking (3 lpcd), Cooking (5 lpcd), Bathing (15 lpcd), Washing utensil and house (7 lpcd) and for Ablution (10 lpcd).

Households account for 8% of global water consumption (WWDR (2003)). The agricultural sector is the largest user of water globally and accounts for about 70% of the total fresh water available. However, it is predicted that industrial uses will demand much more water incomming future. Water consumption by industries is increasing in fact, in high income countries and industrial water use already accounts for as much as 59% of the total fresh water consumption; almost twice the amount use in agriculture. It is likely, then, that will become a global trend as more and more nations begin to choose industry over agriculture, as a key to economic growth.

This will result in significant increase in use of water by industries in developing countries. Industries not only consume water but also pollute it (WWDR (2003)). Report shows that in developing countries 70 percent of industrial wastes in disposed off back into Nallahas and rivers without treatment, thereby polluting the usable water badly. Therefore, the issue of industrial water use relates to two crucial interlinked problems, water use and water pollution.

DRINKING WATER AND HEALTH ISSUES

The human body contains 70 percent water by mass. Even with the loss of one percent fluid, human feels thirsty and with near 10 percent loss, there is risk of death (Glieck (1996)). Without water, survival of human life is impossible. Use of poor quality water in developing countries causes 80-90% of all the diseases and 30% out of it to deaths. The water contaminants may comprise suspended solids, dissolved solids and microbes which may be disease causing. In the present work the focus is on dissolved solids such as salinity which may be present at high concentration and also other toxic chemicals which even in very low concentrations affect health.

Total Dissolved Solids (TDS) below 500 ppm is recommended as safe by Bureau of India Standards (BIS). The Fluoride content in drinking water should be 1-1.5 ppm. Fluoride which is a dissolved impurity, even with very less percentage may cause fluorosis. Similarly, toxicants such as Arsenic, Cadmium, Cyanide, Lead and Selenium can be tolerated only in the fractional ppm range (0.01-0.05 ppm) and mercury upto 0.001 ppm. Arsenic is a unique human carcinogen in that case; it causes lung cancer by exposure through ingestion (through drinking water) as well as through inhalation. A major increase in the number of disease would be caused by arsenic if the population continues to drink arsenic-contaminated water in Bangladesh and in Bengal in India. General health is affected due to different chemicals contaminants as indicated by Bureau of India standard. Thus, presence of such dissolved salts and toxic chemicals beyond the permissible limits make water unfit for drinking. There are several areas in India where water is contaminated by toxic chemicals such as arsenic and fluoride. The number of habitations affected with non availability of quality drinking water in India is given in Table 1.1.

Table 1.1
Number of Habitations and Population affected due to non availability of Quality Drinking Water

Parameter	No of affected Habitations	Total Population(in crores)
Iron	1,40,000	7.00
Fluoride	37,000	1.85
Arsenic	3,700	0.19
Salinity	33,000	1.65
Nitrate	10,000	0.50
Other reactions	1,500	0.31
Total	**2,25,200**	**11.50**

REMOVAL OF DISSOLVED CHEMICALS

It may be noted that besides drinking, pure water is also required in many enterprises related to food, pharmaceutics and electronics etc. Physical and biological quality of water can be ensured using conventional treatments. But removal of dissolved salts and toxic chemicals especially at part per million (ppm) levels is one of the most difficult problems. For example, water can be made microbiologically safe for drinking though flocculation, filtration and chlorination process, but these treatments may not make noticeable change in the dissolved solids content in water, including toxic chemicals. There are many methods of water purification which are based on the membrane separation such as Reverse Osmosis (RO) and Electro dialysis (ED), or phase change methods as distillation are also available to remove dissolved chemicals. These may be categorized according to the type of energy used.

The methods can also be categorized as membrane based separation (e.g.RO, ED) and phase change based (MEF,VC, MED). Each of these methods has its own merits and demerits. The choice of the method depends mainly on the type of impurity in feed water, source of energy and type of contaminants present (Khan (1986)).

TREATMENTS FOR DISSOLVED SALTS:

Drinking water standards are prescribed by various agencies such as World Health Organization (WHO), U.S. Environmental Protection Agency (EPA), European Union (EU) and Bureau of Indian standards (BIS), etc. Water with total dissolved solids (TDS) content below 600 parts per million (PPM) has good palatability and water with TDS above 1200 PPM is generally unacceptable to many, although acceptability may vary according to local circumstances (WHO, 2015).

In India, TDS up to 2000 ppm is permitted in drinking water if no alternate source present or, no toxic pollutants are present in the available water. However, TDS below 500 ppm is recommended (BIS 1991) .The Fluoride content in drinking water should be within 1-1.5 ppm, above which it may cause fluorosis. Similarly toxicants such as Arsenic, Cadmium, Cyanide, Lead and selenium may be tolerated only in the fractional ppm range (0.01— 0.05 ppm) and mercury up to 0.001 ppm such dissolved chemical contaminants are the most difficult to remove.

Water with high TDS or toxicants may be made biologically safe for drinking through filtration, and chlorination process, but these treatments may not make noticeable change on the dissolved solids contents of water. There are many methods of converting brackish water into potable water. Some of the processes which are now commercially employed are:

- Reverse osmosis: In this process saline water is pushed at high pressure through special membranes allowing water molecules selectively to pass and not the dissolved salts.
- Desalination: In desalination the brackish or saline water is evaporated using thermal energy and the resulting steam is collected and condensed as final product.
- Vapour compression: In the process of Vapour compression distillation water vapour from boiling water is compressed adiabatically and vapour gets superheated. The superheated vapour is first cooled to saturation temperature and then condensed at constant pressure .This process is derived by mechanical energy.
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These water purification processes have their own merits and demerits. The choice of the method depends mainly on the level of feed water salinity, source of energy and type of contaminants present. RO is a globally accepted technology for treating feed water with TDS in the range of 5000-10000 ppm. Recent advances in membrane technology and construction materials have made it an attractive option for large scale desalination. However, RO membranes used are sensitive to pH change. ED is designed to remove only about 50-75 percent salts in one stage, so it is more suitable in treating brackish water ED can compete with distillation in economic terms , where feed water salinity is less than 5000 ppm, and also with RO, for salinity up to 10000 ppm. Distillation can be applied to remove all types of contaminants at any Concentration level. Energy requirements in distillation are virtually independent of initial feed water salinity.

CONCLUSION

The small water productivity is also an important issue to be tackled. The grain crops dominate irrigation in most basins. However, the water productivity of grain crops is about one-third of the non-grain crops. There is a substantial potential for increasing overall water productivity through reallocation of water resources. A slight reallocation of irrigation water to non-grain crops has the potential to generate substantial surpluses in overall crop production. Because of India's position in the world's agriculture production, substantial deficits in production in grain crops or substantial production surpluses in non-grains crops would have significant effects on prices and hence both the consumers and producers needs careful attention. One alternative option is to have substantial surpluses or deficits at basin level but have overall self sufficiency at national level. An important policy issue here is which basins to have substantial surpluses or deficits in grain or non-grain crops. The all important question of "How much more irrigation in the future?" for India depend on several factors. The potential growth in productivity in both existing irrigation and rain-fed lands, potential reduction in non-process depletion and un-utilized return flows, potential for groundwater development, environment flow requirements, all play a major role.

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