WATER CULTURE OF THE FUTURE

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1. Introduction

It is said that one cannot live without water for more than 11 days. While ancient Indians attributed divinity to water, modern civilization has made water a mere commodity or a resource and as such exploitable and marketable! Ever since the industrial civilization has started in the West more than two hundred years ago, it is generally believed that the way to progress for any country is only to catch up with the West. We were also told that increase of per capita consumption of water is a sign of progress of a country. The world believed it. Politicians came out with grandiose plans for increasing water resources and usage. Scientists toed their line naively or knavishly making people believe that we need to use more water to be called a developed country. However, the path of development the developed countries chose and propagated all over the world turned out to be not only unsustainable as vindicated by the growing scarcity of water and uncontrollable environmental problems surfacing of late but also by the economic melt of 2008.

Fresh water, which has become now more precious than ever in our history for its extensive use in agriculture, high-tech manufacturing, and energy production, is being recognized as a resource requiring better management for sustainable use. The once ubiquitous water has now become a strategic global resource globally and also an important issue of political confrontations. With a decreasing supply to demand ratio, water is assuming the importance of oil. Thus countries rich in water may soon become a sort of economic super powers.

Although water scarcity is always attributed to the population explosion, the present crisis of water all over the world is as much due to the Western concept of development as due to the population growth. The clever concept of globalization coupled with the addiction to high technology promoted by the West for its own benefit is leading the developing world to greater and greater misery. The condition of the developing world is like that of a person who is tied to a galloping horse by his nose. Of course he has a choice either to run with the horse or not, but either way it hurts him. Each country has its own resources, population density and above all culture and as such has to develop its own brand of science and technology instead of aping the West mindlessly [1]. One should not miss the point that while the density of population of USA is less than 40/sq.km and that of China is less than 150/sq.km, India's population density is as high as 361/sq.km. India is four times more populous than US and three times smaller in area and that makes it illogical to make plans of any development based on American model. Is it not as simple as that, with a monthly salary of say Rs. 50,000 a family of 10 cannot live the way a family of 2 lives?

2. World Scenario

The availability of drinking water per capita is inadequate and shrinking worldwide dangerously. The world population is predicted to grow from 6.9 billion in 2010 to 8.3 billion in 2030 and 9.1 billion in 2050. Food demand is predicted to increase by 50% in 2030 and by 70% in 2050 [2]. The United Nations Development Program sums up world water distribution in the parts of Middle East development report: "One part of the world sustains a designer bottled water market that generates *no tangible health benefits*, another part suffers acute public health risks because people have to drink water from drains or from lakes and rivers." More than 2.2 million people died in 2000 from diseases related to the consumption of contaminated water or drought. In 2004, the UK charity Water Aid reported that a child dies every 15 seconds from easily preventable water-related diseases, which are often attributed to lack of sewage disposal.

Water scarcity is not only the problem of poor and developing countries! With the kind of usage of water, even a vast and resourceful country like US is going to face severe water shortage. The Colorado River, is beginning to run dry in places. The huge body of water like Lake Mead in Arizona, which currently supplies water to 22 million people, may be dry by 2021. Some researchers claim that Lake Mead,. By 2030, China may no longer be self-sufficient in food due to water scarcity. According to a UN climate report, the Himalayan glaciers that are the source of Asia's biggest rivers

- Ganges, Indus, Brahmaputra, Yangtze, Mekong, Salween and Yellow - could disappear earliest by 2035 and latest by 2050 as temperatures rise. Approximately 2.4 billion people live in the drainage basin of the Himalayan Rivers. Palmer Drought Severity Index –PDSI [3], predicts for 2030-39 decade a more severe draught situation in southern North America, northern South America, southern Europe, northern Africa, Middle East, Southeast Asia and parts of Australia than the rest of the world. Interestingly these are more developed parts of the world than others.

The world has experienced a boom in groundwater use, more than doubling the rate of extraction during the last 50 years. Augmentation of groundwater is becoming increasingly difficult because over exploitation has already led to a serious drop in groundwater table all over the world. Water supplies will begin running out in critical regions where they support cities, industries and food production — including in India, China and the Middle East — by 2030 due to over-extraction of groundwater, scientists warn. A recent satellite study has revealed falling groundwater tables in the US, India, China, Middle East and North Africa, where expanding agriculture and cities have increased water demand.

* Scores of countries are over pumping aquifers as they struggle to satisfy their growing water needs, including each of the big three grain producers—China, India, and the United States.

* In the United States, the USDA reports that in parts of Texas, Oklahoma, and Kansas—three leading grain-producing states—the underground water table has dropped by more than 30m!

* A survey, conducted by the Geological Environmental Monitoring Institute (GEMI) in China reported that the deep aquifer was dropping nearly 3 to 6 meters (10 feet) per year.

* Some Saudi farmers are now pumping water from wells that are more than a kilometer deep.

* In the search for water, the Yemeni government has drilled test wells in the basin that are 2 km, which failed to yield water.

* Everyday Libya is tapping millions of litres of even palaeowater from aquifer systems below remote areas in the southern Sahara and transporting the same to the Mediterranean coast away through pipelines.

Virtual water: With globalization there is an increase in world trade with countries exporting and importing several commodities. Every country producing/manufacturing a commodity spends certain amount of water to do so. When it is exporting a commodity it amounts to exporting a corresponding amount of water and when it is importing it amounts to importing corresponding amount of water. This 'flow' of water is called *virtual water flow*. Incidentally to grow a ton of grain requires 1,000 tons of water; to produce a ton of beef it takes 15,000 tons of water; to make a single hamburger requires around 4940 liters of water; a glass of orange juice needs 850 liters. It takes enormous quantities of water to raise animals for food. Virtual water flow is calculated in two ways: the amount of water actually required to produce a commodity in the producing country and the amount of water actually would have been needed in the country of import if it had opted to produce that commodity. However, it is a complex calculation and the use of virtual water estimates offer very little guidance for policy makers seeking to allocate scarce water resources to deserving areas. Another term introduced is *water footprint* (analogous to carbon footprint) which is an indicator of how much water we use directly as well as indirectly in the form of goods and services.

Table 1. Virtual water trade balances (in billion m3 per year). [4]

Country	Gross virtual water import	Gross virtual water export	Net virtual water import
India	3.9	38.4	-34.5
China	34.3	14.9	19.4
USA	57.4	221.4	-164.0

From the table it can be seen that India's virtual water export is ten times more than the virtual water import. That means we are indirectly exporting so much water. But our economists may be looking only at the foreign exchange earnings of the country.

3. Indian Scenario

India has 20 percent of the Earth's population, but only four per cent of its water. The average annual per capita availability of water in the country, as per the 2001 census was 1816 cubic meters, while it is only 1545 cubic meters as per 2011 census. According to the International Water management Institute, Sri Lanka Research Report 123 [5], India's water requirement for various needs is going to increase by more than 30% by 2025 and double by 2050 of the present day demand. The mighty Indus and Ganges are tapped so heavily that, except in rare wet years, they no longer reach the sea. Nine river basins, comprising 75% of the total population, will be physically water-scarce by 2050. Ganges provides water for drinking and farming for more than 500 million people.

The Himalayan glaciers are melting and retreating at a rate of 10-15m/year leading to a reduction of their area from the present from 500,000 sq km to the projected 100,000 sq km by the 2030s

India has the largest water withdrawal out of all the countries in the world and Table 1 [6] shows the usage pattern of India, China and the USA. Ninety per cent of the water in India goes to support agriculture. That heavy use is dictated in large part by what people eat and of course in India we eat a lot of rice and wheat. But unfortunately India's crop water productivity is very low at present and varies widely across regions and over different land use patterns. Rice farmers in India typically get less than half the yield per unit area and they use 10 times more water than their counterparts in China do.

Table 2. World Bank data (2011) on freshwater withdrawal by some countries and sectors [6]

Country	Total fresh-water Withdrawal (km3/yr.)	Per Capita Withdrawal (m3/yr).	Domestic (%)	Industrial (%)	Agricultural(%)	Density of population /sq.km
India	761.0	1184	7	2	90	361
China	554.1	2093	12	23	65	150
USA	478.4	9044	14	46	40	39

It can be seen from the table that:

- the per capita consumption of water in USA is more than four times that of China and about 8 times more than India. It may also be noted that against the world average of 10-15 lts/day Americans reportedly use 500 lts/day (or 130 gallons)
- the USA spends 40% and 46% of water on agricultural and industrial uses respectively while these figures are 90% and 2% for India and 65% and 23% for China. One can imagine the condition of Indian water and environment if our industrial growth tries to catch up with China or USA)
- in spite such large area and higher food production China uses only 65% of water for agriculture against India's 90%.

4. Developing and Saving Water Resources

There are apparently several ways of augmenting water resources namely: 1. Construction of dams and more dams 2. Interlinking of rivers (ILR) 3. Exploration for deeper and deeper groundwater resources 4.Transportation of water from water rich to water poor areas 5. Desalination of sea water 6. Rain water harvesting 7. Recycling of water 8. Drastic changes in water culture. But each one of them naturally has its own problems.

Table 3. Strategies to overcome future water scarcity

S.No	Method	Problems/Comment
1	Construction of dams and more dams	Poor monsoons, sedimentation, fluorosis, rehabilitation problems, lack of funds for maintenance, diminishing returns, evaporation losses, environmental concerns.
2	Interlinking of rivers (ILR)	Mind boggling investments, displacement of lakhs of people, destruction of large forest areas and uncontrollable environmental problems besides extremely difficult maintenance. Already sewage and waste water from rapidly growing cities and effluents from industries have turned many rivers, including major ones, into sewers.
3	Exploration. for deep groundwater resources	Already about 75% of drinking and irrigation needs of India are met by groundwater. Groundwater table is depleting dangerously. Although use of Geophysics (CSAMT, MT, SEISMIC) shows the possibility of occurrence of fresh water in some major sedimentary basins and deep fractures in hard rock areas. The depths of these water sources are large and also they may not be sustainable/renewable.
4.	Transportation of water from water rich to water poor areas	Transportation of water over short distances or through pipe lines over a few hundred kilometers is common. But transportation of water across the globe is going to be extremely expensive and unworkable as it is more expensive than desalination.
5	Desalination of sea water	Desalination of sea water is energy-intensive, making it a supply of last resort. Israel and Singapore are desalinating water for about US$0.5 per cubic meter. Desalination also affects the eco-system.
6	Rain water harvesting	This is an excellent technique and must be followed everywhere. But water that can be harvested through this is too small compared to the huge demand and as such it can be only of complementary nature.
7	Recycling of water	Ion exchange resins can purify wastewater to make it ultra-pure. They can remove organic agents, oil and dirt from industrial wastewater to render it pure for other industrial applications. But public resistance and mental blocks need to be removed to use recycled water.
8	Drastic changes in Water Culture	Innovation in agricultural practices, urgent changes in lifestyle based on ancient Indian wisdom, including slow de-Westernization, discrete industrialization, compulsory RWH and recycling of water, heavy penalties for pomp and wastage.

4.1 Construction of dams and more dams

Construction of dams has been tried worldwide. In India also since independence we have built several dams (including the huge Bhakra –Nangal) across all the rivers. Although this has been successful with a lot of short term gains, failure of monsoons, sedimentation, fluorosis, rehabilitation problems, lack of funds for maintenance, diminishing returns, environmental concerns have been haunting us. Further the hydrological cycle also is interrupted because very little river water is reaching the sea. With rivers drying up due to failure of monsoons the very purpose of damming a river is greatly defeated. Thus we find that while the life of a dam is not more than a few decades several long term and permanent damages are caused to the land and people. The guide at the world famous Hoover dam in USA jokes ‘Please bring a bucket of water next time you come’.

4.2 Inter Linking of Rivers

Even during the British rule, the famous engineer Sir Arthur Cotton had sought to link the Ganga and the Cauvery to improve connectivity for navigation purposes. But due to the increased railway connectivity among the areas, the idea was shelved. In general, India has water abundance in the north and east, and water scarcity in the west and south. In 1982, the National Water Development Agency (NWDA) was formed as an autonomous body entrusted with the task to carry out the water balance and feasibility studies of the river linking program. ILR involves transfer of water from the Ganga-Brahmaputra (10m MSL) and its tributaries by pumping water over the Vindhya Mountains (300m MSL) to regions in the south (Deccan Plateau 250 m MSL). The project, estimated to cost approximately $112 billion USD (in 2002 price level), has attracted more debate than consensus in India.

In Feb 2012, Supreme Court, gave its go-ahead to the interlinking of rivers and asked the government to ensure that the project is implemented expeditiously although it appears to have no constitutional power to issue such a mandate. No doubt ILR is a highly controversial project involving bitter controversies, mind boggling investments, displacement of lakhs of people, destruction of large forest areas and uncontrollable environmental problems besides extremely difficult maintenance. Understandably while states with so called surplus waters oppose the move, the ones that are going to benefit are those states which are poorly traversed by rivers. There are also international ramifications involving the neighboring countries.

What seems sensible and practicable is to try connecting the flowing water bodies on a local and regional scale, study its economics as well as impact on environment and take appropriate action to extend the concept to a national level.

4.3 Augmentation of Groundwater

India is the largest user of ground water in the world, with an estimated use of 230 cubic km of ground water every year—more than a quarter of the global level. Now, groundwater supports around 60 per cent of irrigated agriculture and more than 80 per cent of rural and urban water supplies. Water tables are dropping fast in several parts of India both in agricultural areas as well as outside. In the northern part of Gujarat, one of the fast developing states in the country, the water table is falling by 6 meters per year. Reportedly "Out of a total of 5,723 ground water blocks in the country, 1,615 are classified as semi-critical, critical or overexploited, and regulatory directives have been issued by the Central Ground Water Authority for 108 blocks. However, neither the authority nor the state ground water agencies have the resources or the personnel to oversee the enforcement of these regulations."

Exploration for deeper groundwater resources are generally confined only to thick sedimentary basins, with large areas of hard rock left behind. Deep geophysical surveys comprising CSAMT, MT, Seismics etc have already been done in most of the sedimentary basins like Ganga, Narmada, and Godavari etc. More than 200 large-spread resistivity soundings have been carried out to delineate, hitherto undiscovered, deep fresh water aquifers in parts of Ganga basin. Thick pile of granular sediments has been identified along the Himalayan foothills of Uttar Pradesh. Also the existing seismic, deep resistivity, magnetotelluric and borehole log data from other agencies have been used to identify fresh water aquifers up to a depth of 2000m bgl in the Recent alluvium and underlying Tertiaries- the Siwaliks [7]. In hard rock areas also more attempts can be made to locate deep saturated fractures using the various geophysical techniques cited above.

Failure to locate new groundwater resources can be three-fold. Deposit Failure, Technological Failure and HRD Failure [8]. Here Deposit Failure is the absence of groundwater in the area of search, Technological failure is the lack of necessary technology and talent to locate the groundwater resource. And finally the HRD Failure is due to lack of right approach to locate groundwater in spite of the availability of resource and necessary technology! Taking care all these factors, it may be necessary and advisable to re-visit some of the potential areas unsuccessfully covered earlier, again with a sense of urgency.

4.4 Transport of water across the Globe

We are aware of transportation of water to the needy areas through water tankers over short distances and through pipelines over a few hundred kilometers. Singapore gets water from Malaysia and of course Hong Kong gets water from the mainland China. Now this transportation of water may soon take place on a global scale through thousands of kilometers using specially designed ocean liners. There is already a proposal by S2C global Systems, San Antonio, Texas [9] to transport 12 billion gallons (over 45b liters) of water per year from the Blue Lake reservoir in Sitka, Alaska to a "World Water Hub" on the west coast in Maharashtra. But the cost of water is going to be naturally very high (according to one report $ 18/m3 -.several times more expensive than desalination. But it is no surprise if bulk water transport becomes a big business in the near future. However, apart from the complex logistics and pricing, there are going to be political pressures as well. Canada, which owns more freshwater resources than any other country, is planning to ban bulk exports. On the other hand Greenland, Iceland and New Zealand are apparently searching for business opportunities.

4.5 Desalination of Sea water

Desalination, a well-known process for purifying water on a small scale has now become a major source of water supply for water starved coastal areas. Desalination of water is done by 1. Conventional distillation, 2. Multiple stage flash (MSF) Evaporator, 3. Reverse Osmosis (RO), 4. Electro-dialysis by means of ion exchange membranes. One Kamalesh Sirkar [10] seems to have developed a direct-contact membrane distillation (DCMD) system that can efficiently wring drinking water out of up to 20 percent-salt-concentrated brine. Sea water has 3.5% of salt. Sirkar claims that his recently patented system can deliver about 80 liters of drinking water per 100 liters of seawater against 41lts of a comparable reverse-osmosis system.

Already several countries in Middle East, Singapore, Spain and parts of USA are having major desalination plants. Singapore and Israel are producing a cubic meter of fresh water for about half a dollar by desalination. Besides high costs, a draw back to desalination is the brine sludge that forms during the treatment process, which is invariably dumped back in the ocean potentially effecting the local eco system.

4.6 Rain Water Harvesting

Apart from the major options cited above, a cheap and responsible way of augmenting water resources on a local scale appears to be rain water harvesting (RWH), which is the process of collecting, filtering and storing water from roof tops, paved and unpaved areas for multiple uses. The harvested water can also be used for potable purposes after testing and treatment. The surplus water after usage can be used for recharging ground water aquifers through artificial recharge techniques. This low tech method has been in practice since centuries in India and it should be further intensified. Rajendra Singh winner of 2001 Ramon Magsaysay Award for Community leadership, who is also known as the Waterman of Rajasthan helped countless villages in Rajasthan through RWH. Recharging the groundwater by construction of *Kunds* (Thar Desert), *Johads* (Alwar), *Bandha*, *Rapats* (Mewar) and *Pats* (Jabhua, Madhya Pradesh) has been a practice for centuries in the country. Starting 1984, there was a revival of some 3000 *johads* spread across more than 650 villages in Alwar district, Rajasthan. This has resulted in a general rise of the groundwater level by almost 6 meters and a 33 percent increase in the forest cover in the area. Five rivers that used to go dry immediately following the monsoon have now become perennial, such as the River Arvari. Admittedly RWH can only be a supplementary source, with limited supplies.

4.7 Recycling of Waste Water

A good complement to RWH is recycling of waste water. Recycled waste water on primary, secondary and tertiary treatments can be used efficiently for different purposes depending the purity required. These techniques include membrane filtration, ozone disinfection, UV disinfection, heat treatment, sand filtration and open recirculation of cooling towers. Selection of the technique depends on the type of industry. In the paper industry water is recycled by means of membrane filtration and membrane bio reactors. (MBR). For water recycling in the textile industry membrane filtration is a preferable option. By means of filtration and ozone disinfection cooling water can be recycled in poultry. Water recycling is done using UV-disinfection and membrane filtration in the food and beverage industry. Water recycling and disinfection by means of heat treatment, sand filtration and ozone and UV treatment is possible in greenhouse horticulture. By means of membrane filtration and ozone/UV treatment, oil can be removed from wastewater. The use of municipal wastewater effluent can be used in agricultural applications. Historically north western Rajasthan has been recycling a pot of water for use in several jobs, one after the other, with decreasing purity.

4.8 Change in our water culture

Last but not the least options available to us is a drastic change in our water culture. While the options 1 to 5 cited are difficult, complex and expensive and while options 6 and 7 alone cannot meet the demands of the exploding population, the most important way to fight the impending water crisis is by adopting a change in water culture. The first step in this direction is a change in our concepts of development and lifestyle, which are largely based on Western model that is clearly unsuitable for our country. External pressures and internal problems have forced us to opt for privatization and later globalization. Although apparently many short term benefits accrued because of this, in a way that was the end of India's independence and the freedom of tackling her own problems her own way.

Modern concepts in science and economics have started ruling the world. Our scientists spend enormous time and money in replicating what the West has done and been doing, to prove that we are as great as they. In the process, simple and cheap solutions that could solve our country's problems are brushed aside to make way for grandiose, expensive, high technology solutions all of which consume enormous water resources. Our economists are obsessed with Western concepts of growth rate and GDP. If the scientist says that 'technology' can conquer all forms of scarcity and if the economist says 'market' can conquer all forms of scarcity, both are not telling the TRUTH! They are misguiding the public and saying so only for their own wellbeing, if not survival. There is also a joke that only Nobel Laureates and the dying tell the truth!! More than ten five year plans and associated technological developments have not lifted a third of the population above the poverty line because of ridiculous obsession that development means catching up with the West. The scientists, like Judiciary, need to hold independent opinion, advise the government and educate the people as to the use and abuse of water, to protect the people and the land.

If all of us humans depend on bottled water and all the natural water bodies go into disuse and are polluted who will quench the thirst of other poor creatures like animals, birds and plants. How can we protect the biodiversity? We should learn to respect Nature. Let us realize that the country (or even the planet) and its resources are not meant for one or two generations. We cannot go on vandalizing the Mother Earth as if there is no tomorrow, as if there is no body to live after we depart. In fact the pollution in the world is directly related the pollution in the minds of the people. So if we want fight the pollution outside, we have to first fight the pollution inside our minds. To quote an eminent Indian philosopher "It is no measure of health to be well adjusted to a profoundly sick society."

Kalle Lasn who is the founder of Adbusters magazine and CEO of the Adbusters Media Foundation points out all of the errors that the American society has made in the process of creating their culture. He says 'The media has become the people. People live through "brands, products, fashions, celebrities, entertainments." These things "are our culture now and the people's role is mostly to listen, buy and live as told". He tells the corporate America "You are the cause of our suffering". Today we have reached a stage when our elders says we don't believe, if our scriptures are quoted we don't believe. But if it appears in a second rate newspaper or TV channel we take it seriously and start quoting everywhere and act accordingly [11].

Economic growth rates, cutting edge technologies and sickening scientific jargon alone do not and cannot solve the problem of water. We have to get rid of this megalomania. We should try to live a natural and eco-friendly life to the extent possible. We should try to make our villages self-reliant to the extent possible. Now who will educate the people about all this? Once upon a time there used to be pundits and scholars who are highly knowledgeable and selfless, who led a simple and eco-friendly life and guided the society as to what is right and what is wrong. While this breed of people is hardly to be found now, the scientist was given that status. Anything he said is a scripture for the society. But it looks as though the present day scientists have not much say. They have become passing spectators *vis a vis* the powerful economists who guide the destinies of the countries all over the world. And both of them play a subservient role to the governments and finally all over the world we know the influence of Multi-National Corporations on governments and people. And for MNCs it is what they call Business-As-Usual (BAU). The taste of money is like the taste of blood. We know about sharks and cannibals!

5. Conclusions and Recommendations

If the aforesaid arguments are convincing, then:

- We can make it top priority to keep on educating the students as well as the masses about the impending water scarcity.
- We can cut down on wastage of water resources in agriculture by introducing improved techniques.
- We can save a lot of water by changing our Westernized lifestyles.
- We can follow simple and eco-friendly living, guided by our ancient wisdom and use only minimum technology to solve our problems
- We can introduce less complex educational *Gurkul* type education system at least up to high school level.
- We can promote Yoga and Naturopathy clinics all over the country for basic health care and opt for advanced and sophisticated medicare only when it is essential.
- We can learn to use minimum technology to solve our problems and opt for higher technology only when it is essential.
- We can develop a strong and independent scientific opinion, like Judiciary, which will protect the interests of people and the land.

Mahatma Gandhi who said that there is enough for every body's need but not greed, has also said "The difference between what we do and what we are capable of doing would suffice to solve most of our problems".

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