
Emerging Challenges of Water Scarcity in India: The Way Ahead

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"The earth, the air, the land and the water are not an inheritance from our fore fathers but on loan from our children. So we have to handover to them at least as it was handed over to us."

-Mahatma Gandhi

Abstract: *"Water touches every aspects of life, and in India uncertainty over access to and the availability of this basic resources may be reaching crisis levels. As India continues to undergo dramatic shifts caused by a growing economy and population, competing demands for this limited resources coming from households, industry and agriculture have wide-ranging implications for the country's future. Should no action be taken, there could be dire consequences. The W.H.O. estimates that 97 million Indians lack access to safe water today, second only the China. As a result, the World Bank estimates that 21 percent of communicable diseases in India are related to unsafe water. Without change, the problem may get worse as India is projected to grow significantly in the coming decades and overtake China by 2028 to become the world's most populous country. Water is life because plants and animals cannot live without water. Water is needed to ensure food security, feed livestock, take up industrial production and to conserve the biodiversity and environment. Although, India is not a water poor country, due to growing human population, severe neglect and over-exploitation of this resource, water is becoming a scares commodity. While this is a growing concern all over the world, India is most vulnerable because of the growing demand and in-disciplined lifestyle. This call for immediate attention by the stakeholders to make sustainable use of the available water resource to ensure better quality of lives".*

Keywords: *Water Scarcity, Over Exploitation, Infrastructure, Emerging Challenges, Diseases, Conflict, Governmental Access.*

1. INTRODUCTION

Since independence, India has made significant progress in developing its water resources and supporting infrastructure. Post-independence years have witnessed large-scale investments in water storage structures which have contributed considerably in making India a self-sustaining economy. Today, India has the capacity to store about 200 BCM of water, an irrigated area of about 90 Mha, and an installed hydropower capacity of about 30,000 MW (World Bank, 2005). However, due to rapid development of water, the demand for this natural resources for outweighs its supply. In addition and for a while now, the water sector in India has faced significant and problematic issues related to management. In spite of a sizeable water resources base and vast land resource, India continues to struggle to meet its water sector infrastructure requirements, including operation and maintenance costs. India has about 16 percent of the world's population as compared to only 4.0 percent of its water resources. With the present population of more than 1,000 million, the per capita water availability is around 1,170 cum/person/year (NH, 2010).¹

Water scarcity involves water stress, water shortage or deficits, and water crisis. This may be due to both nature and humans. Main factors that contribute to this issue include poor management of resources, lack of government attention, and man-made waste. 18 percent of the world's population which resides in India only has access to 4 percent of usable water sources. Official data in the past decade depicts how annual per capita availability of water in the country has plummeted significantly with 163 million Indians lacking access to safe drinking water.²

When contemplating our world's most precious resources, past conversations often centered around fossil fuels and the consequences once those become scarce. However, recent times have given us an abundance of alternative energy options and new technologies either in use or on the horizon. These innovations have turned the conversation to a resource that, on a basic level, is readily abundant and covers two-thirds of the earth's surface. Though 70% of the earth is covered in water, only 2% of it is fresh. Further complicating the issue is that 1.6% of

that freshwater is contained in glaciers and polar ice caps. Many third world and developing countries struggle with ensuring this basic tenant of our existence is both available and safe. Nowhere is this more apparent than India.

With the planets second largest population at 1.3 billion, and expectant growth to 1.7 billion by 2050, India finds itself unable to serve the vast majority of that populace with safe, clean water. Supporting 16% of the world's inhabitants is daunting enough, but it is even more so when recognizing that population is crammed into an area one-third the size of the United States. Then consider that India only possesses 4% of the world's fresh water and the crisis can be more fully realized. India may not be the only nation in this predicament, but theirs is at a stage more critical than most. Severe lack of regulation, over privatization, general neglect and rampant government corruption have led to multiple generations thirsting for more than just a few drops of hazard free water. The situation has grown to the point that regional disputes have risen over access to rivers in the country's interior. Those disputes take on a global scale in conflicts with Pakistan over the River Indus and River Sutlej in the west and north and with China to the east with the River Brahmaputra.

Surface water isn't the only source reaching a breaking point. Tracing back several generations, the critical situation in India can be linked to a myriad of causes. In modern times though, the concern has moved from the surface to the ground. And it's there where India's freshwater is under the greatest stress. Over the past 50 years, policies have allowed what amounts to a free-for-all in groundwater development and as the crisis has grown it has been met with continued neglect, mismanagement and overall indifference. Estimates put India's groundwater use at roughly one-quarter of the global usage with total usage surpassing that of China and the United States combined. With farmers provided electricity subsidies to help power the groundwater pumping, the water table has seen a drop of up to 4 meters in some parts of the country. This unfettered draining of groundwater sources has accelerated over the past two decades. With the aggressive pumping, particularly in rural areas, where agriculture provides the livelihood for upwards of 600 million Indians, Mother Nature is often the difference in a good year and a devastating one. Relying on monsoon rains without proper irrigation or water management techniques has been a recipe for disaster. Mismanagement and corruption often draw the largest headlines, but many of India's leaders have also been slow or unwilling to adapt to newer technologies or cohesive plans to address the issues. The response can at best be described as irresponsible. Consider China, a country with roughly 50 million more people, uses a quarter less freshwater.

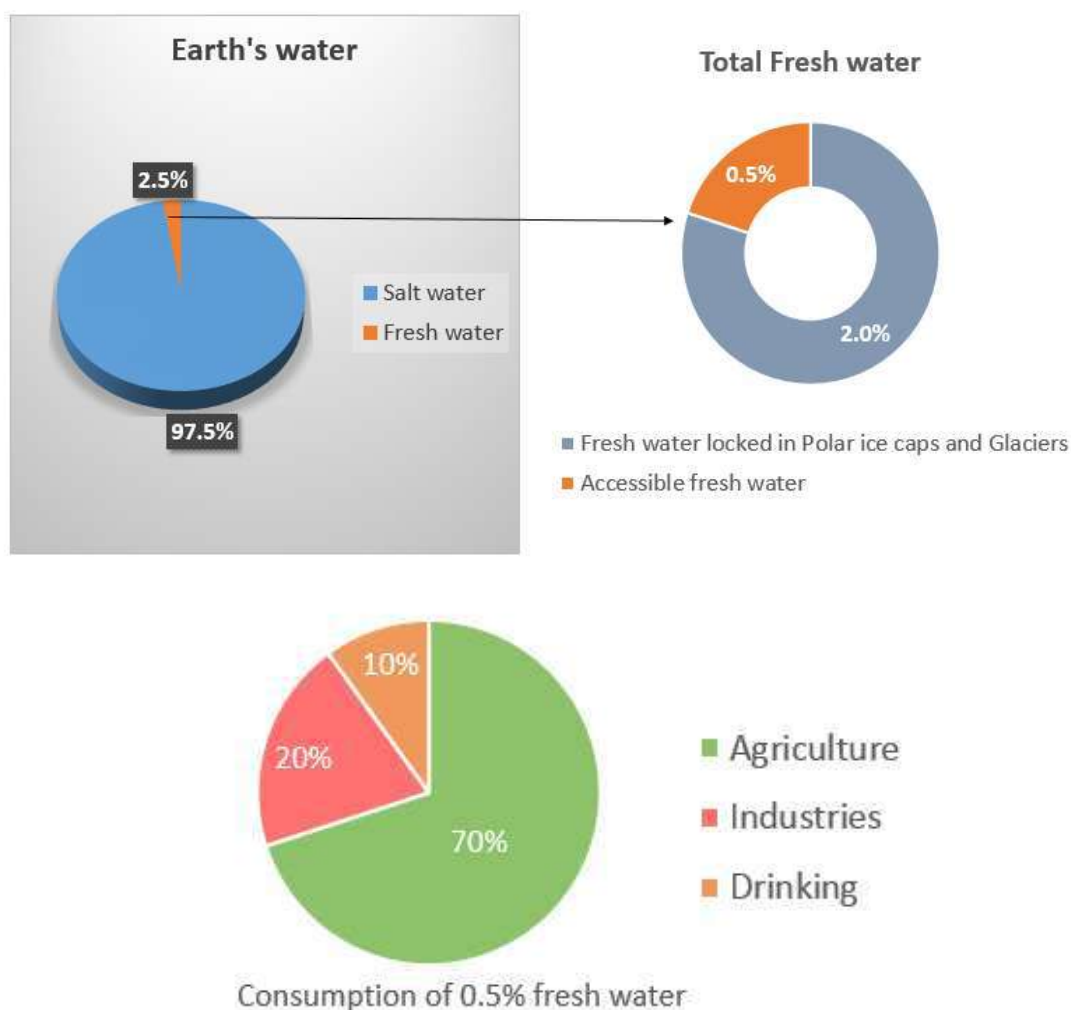
Not only is India the world's second most populated country, but it has a fast growing middle class that is raising the demands on clean, safe water. Then consider close to half of the country practises open defecation and you have a dichotomy of two very different populations desperately pulling at the same limited resource. One group wanting to grow and flourish and the other wanting to survive. A few numbers from the World Bank highlight the plight the country is facing: (1.) 163 Million Indians lack access to safe drinking water (2.) 210 Million Indians lack access to improved sanitation (3.) 21% of communicable diseases are linked to unsafe water (4.) 500 children under the age of five die from diarrhea each day in India.³

More than half of the rivers in India are highly polluted with numerous others at levels considered unsafe by modern standards. The waters of the Yamuna, Ganga and Sabarmati flow the dirtiest with a deadly mix of pollutants both hazardous and organic. Aside from commonplace industrial pollution and waste, India's rivers are open use across much of the country. From dumping human waste as previously noted to bathing to washing clothes, the human element contributes to the epidemic of health related concerns.

Adding to the human toll is the reliance on seasonal rains, which are often sporadic in some years and over abundant in others. Rain totals can vary greatly and do not always arrive in the places they are needed most. The drought and flooding that results from this inconsistent cycle often leads to crop failures and farmer suicides. Much of the above affects rural citizens where poverty is rampant, but even more developed urban areas face their own challenges. Even with a robustly growing middle class, when combining rural and urban populations, over half of India still lives at or below the poverty level. Furthermore, no city in India can provide clean, consumable tap water full-time. Should the crisis continue unabated, the scarcity of water will have a negative impact on the industrial health of the country. Recent drops in manufacturing jobs can be tied to companies being unable to access clean water. Along with the inability to properly cultivate agriculture areas and the water crisis quickly becomes an economic one.

It may seem a foregone conclusion that the water will soon enough dry up and along with it India as a whole. That need not be the case. There are even bright spots in the current environment. The Rivers Narmada and Chambal run clean with water fit for consumption. Several projects are currently underway that aim to move water to areas that need it the most. But it will take a long-term commitment of the Indian government not previously shown and the heavy assistance of outside resources. Common sense practices and training will also aid in reducing the damage done to groundwater sources.⁴Teaching farmers updated irrigation techniques, such as drip irrigation, and utilizing more rainwater harvesting are small, effective steps in stemming the loss of freshwater sources. Much of India will also need modern sanitation policies that both conserve and wisely utilize water sources. Recognizing physical and economic growth directly ties to the amount of safe, usable water is another step in right direction.

Accessible Fresh Water Across the Earth



As you can see in the above picture, 97.5% of the total earth's water is salt water and only 2.5% is fresh water. Out of that 2.5% fresh water, 2% is locked in polar ice caps and glaciers and only 0.5% fresh water is left which is used for drinking, agriculture, industries etc.⁵

2. SIGNIFICANCE OF WATER

Water is Life. Water is power. Water is the new oil of the contemporary era. Water is becoming, rapidly, scarce across the globe through overuse and contamination. As this issue becomes more acute, tensions will escalate and this will affect us all. But unlike oil, water is essential for survival of humanity. In the coming years, every country, including India, will have to determine how to treat water as an economic good, a human right, and a depleting resource. As we all know that water covers 70 percent of our planet and it is easy to think that it will always be

plentiful. However, freshwater, the stuff we drink, bath, irrigate our farm fields, is incredibly rare. Only 3 per cent 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. As a result, a total of 2.7 billion people find water scarce for at least one month of the year. Inadequate sanitation is also a major problem for 2.4 billion people and they are exposed to diseases such as cholera, typhoid and other water-borne illnesses. 2 million people, mostly children, die each year from diarrheal diseases alone. Rivers, lakes and aquifers are drying up or becoming too polluted to use. More than half the world's wet lands have disappeared. Agriculture sector consumes more water than any other source and wastes much of that through inefficiencies. Climate change is altering patterns of weather and water around the world, causing shortages and droughts in some areas and floods in others. At the current consumption rate of water, the situation will only get worse in the future.

Water is essential for agricultural production and food security. It is the lifeblood of ecosystems, including forests, lakes and wetlands, on which the food and nutritional security of present and future generations depends on. Yet, our fresh water resources are decreasing at an alarming rate. Growing water scarcity is now one of the leading challenges for sustainable development. These challenges will become more pressing as the world's population continues to rise; their living standards increase, diets change and the effects of climate change intensify. Water scarcity is expected to intensify as a result of climate change. It is predicted to bring about increased temperatures across the world in the range of 1.6^oc to as much as 6^oc by 2050. For each 1 degree of global warming, 7 percent of the global population will see a decrease of 20 per cent or more in renewable water resources. More frequent droughts are having severe impact on agricultural production, while rising temperatures translate into increased crop water demand. In addition to improvements in water use efficiency and agricultural productivity, we must take action to harvest and reuse our fresh water resources and ensure the wisely use of waste water. The issue of water scarcity is at the very core of sustainable development. We need to act now to preserve this precious resource so it can be available for future generations.⁶

Look to the Future



3. RESEARCH MATERIALS AND METHODS

To identify studies for the review, the researchers conducted descriptive study and secondary data was used for the study. Basically, the required material has been derived from various Journals, articles from newspaper, magazines, and web-sites which deal directly or indirectly with the topics related to make in India with real challenges and opportunities were included in the study. After searching the important newspaper and web-sites, relevant information was down loaded and examined to address the objectives of present study.

4. AIM AND OBJECTIVE

In order to achieve this vision we have identified seven scientific and applied objectives:

1. To demonstrate the application of a risk-based approach to the management of droughts and water scarcity, and to promote the uptake of the research, through the analysis of real and synthetic droughts at catchment and national scales, in partnership with stakeholders in government, business and NGOs.

2. To explore, and where appropriate, quantify drought impacts from environmental, economic, social and cultural perspectives.
3. To provide enhanced scientific understanding and modelling capability to represent drought processes, and analysis of the frequency of droughts at catchment and national scales, in present and future climatic conditions.
4. To examine the socio-technical framing of droughts and water scarcity, and inherent controversies, from the perspective of multiple stakeholders.
5. To analyse governance arrangements for management of droughts and water scarcity and explore the opportunities to introduce alternative management arrangement.
6. To analyse how in competitive and/or collaborative situations, accompanied by information asymmetry, the behaviours to different actors can modify the risks of water scarcity.
7. To develop a dashboard for communicating the multiple impacts of water scarcity and evaluating the effectiveness of drought management options and trade-offs for a range of stakeholders.

5. REVIEW OF LITERATURE

David Zetland, (Living with Water Scarcity, (Aguanomics Press, Amsterdam, 2014), this book presents a comprehensive review of the concept of water security, including both academic and policy Literature. The analysis indicates that the use of the term water security has increased significantly in the past decade, across multiple disciplines. The paper presents a comparison of definitions of, and analytical approaches to, water security across the natural and social sciences, which indicates that distinct, and it times incommensurable, methods and scales of analysis are being used.

Chellany, Brahma, (Water, Peace, and War: Confronting the Global Crisis, Oxford University Press, New Delhi, 2014) Natural resources can contribute to economic growth, employment and fiscal revenues. But many resource-rich and resource-development countries are, in fact, body of literature is devoted in the issue of intrastate resources conflicts. These studies can be broadly divided into two groups: studies which focus on resource characterized by disappointing growth rates, high inequality and wide-spread impoverishment, bad governance, and an increased risk of civil violence. A vast scarcity and conflict, and studies that analyse the relationship between resource abundance and conflict. While studying resources and intrastate conflict is anything but new, we show that the main findings from the literature, which are often conflicting, are difficult to compare due to a lack of adequate, and conflict, we discuss the central terminology and approaches to measuring independent and dependent variables (resources and conflict).

Chellany, Brahma, (Water: Asia's New Battleground, Harper Collins India, 2019) Those of today are over energy but the battles of tomorrow may be over water. Nowhere is that danger greater than in water-distressed Asia. Water stress is set to become Asia's defining crisis of the twenty-first century, creating obstacles to continued rapid economic growth, stoking interstate tensions over shared resources, exacerbating long-time territorial disputes, and imposing further hardships on the poor. Asia is home to many of the world's great river and lakes, but it huge population and exploding economic and agricultural demand for water make it the most water-scarce continent on a per capita basis. Many of Asia's water sources cross national boundaries, and as less and less water is available, international tensions will rise. The potential for conflict is further underscored by China's unrivalled global status as the source of trans-boundary river flows to the largest number of countries, ranging from India and Vietnam to Russia and Kazakhstan; yet a fast-rising China has declined to enter into water-sharing or cooperative treaties with these states, even as it taps the resources of international rivers.

Goel, P.K., (Water Solution: Causes, Effects and Solutions, New Age International Publishers, New Delhi, 2006) Water represents an essential elements for the life of all who inhabit our planet. But the random nature of this resources, which is manifested by the alternation of wet periods and dry periods, makes it even more precious. The top priorities for urban water sustainability include the provision of safe drinking water, waste water handling for public health and protection against flooding. However, rapidly aging infrastructure, population growth, and

increasing urbanization call into question current urban water management strategies, especially in the fast-growing urban areas in Asia and Africa. We review innovative approaches in urban water management with the potential to provide locally adapted, resource-efficient alternative solutions. Promising examples include new concepts for storm-water drainage, increased water productivity, distributed or on-site treatment of wastewater, source separation of human waste, and institutional and organizational reform. We conclude that there is an urgent need for major trans-disciplinary efforts in research, policy, and practice to develop alternatives with implications for cities and aquatic ecosystems alike.

Apart from these books, many other journals have also been studied, like: Cecilia Tortajada, Udisha Saklani, and Asit K. Biswas, (*Water Scarcity and Regional Security in India, Water, Security and U.S. Foreign Policy*, Routledge, New York, 2018). Ashok Gulati, & Pritha Banerjee, (*Emerging Water Crisis in India: Key Issue and Way Forward*, Indian Journal of Economics, 2016). Shankar, P.S., H. Kulkarni and S. Krishnan, (*India's Ground water Challenge and the Way Forward*, Economic and Political Weekly, Mumbai, 2011). Jairath, Jasveen and Vishwa, Ballabh, (*Droughts and Integrated Water resources Management in South Asia*, Sage Publications, New Delhi, 2009). Luis Santos, Ian Cordery, Iacovos, Iacovides. (*Coping with Water Scarcity Addressing the Challenges*, 2002).

6. WATER AS THE NEW OIL

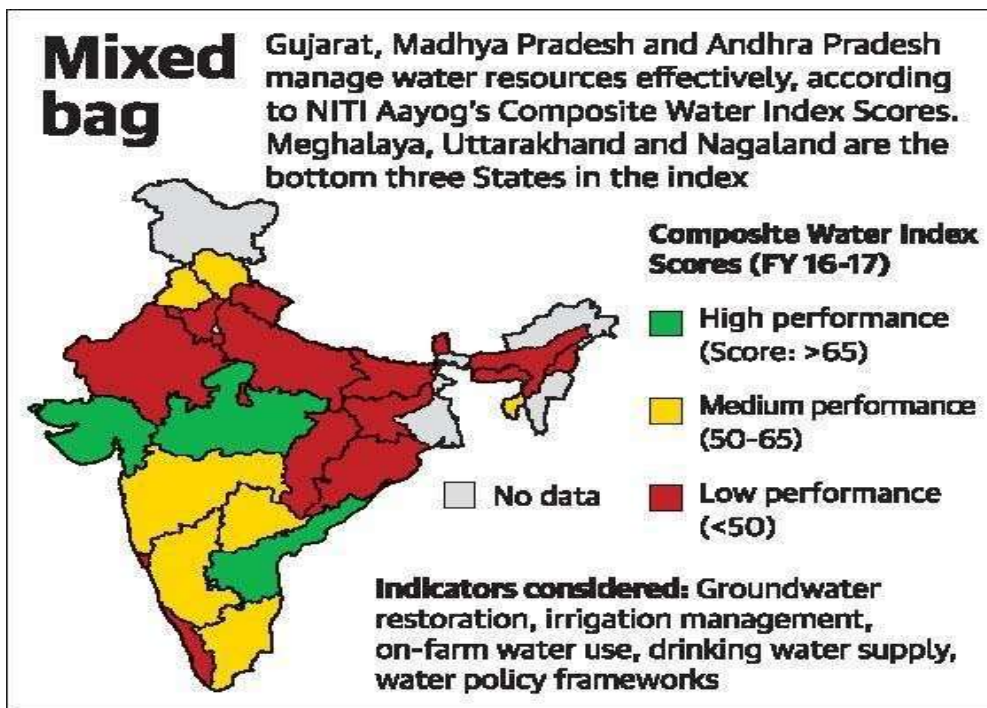
Alex Prud Homme explains in his book, *The Ripple Effect*, the basic problem is the quantity of water in the world is finite but demand is everywhere on the rise. As oil was in the 20th century, the key resource, a focus of tension, even conflict, so water will be of the 21st century, as states, countries, and industries compete over the ever-more-precious resource. So we need to figure out how to use water more sensibly as well as sustainably. Even we do not think twice when we turn on the water for a shower, a drink or to clean hands. We all enjoy access to clean, fresh water for years without a single worry, Unfortunately, this is likely to change in the coming future. Scholars claim that water is the new oil because both are finite resources that serve as the basis for conflicts. In the 20th century, the world's most important resource was undoubtedly oil. As we move towards the future, water will likely replace oil as the most valued resource simply because it is fundamental to the survival of humanity and we do not have enough to secure our future generation. Eventually, humanity will likely run out of fresh water. If humanity fails to limit population growth, wars will inevitably be fought for access to fresh water just like they were fought over oil in the 20th century.² Engineers broadly agree that humanity will eventually figure out how to fuel vehicles with a substance other than oil. Yet humanity will probably not figure out how to survive without fresh water. Politicians, economists, scientists, demographers agree that access to clean and fresh water will soon become humanity's most important challenge. This is precisely, why water will be treated like oil was in the 20th century.

7. WATER SCARCITY

Water scarcity can be defined as a lack of sufficient water or not having access to safe water supplies. Water is a pressing need in many areas of the world. Scarcity is spreading as water is needed to grow and process food, create energy, and power industry for a continually growing population. Clean, potable water is an essential ingredient of a healthy human life, but 1.2 billion people lack access to water according to recent estimates from the International Water Management Institute. By 2025, two-thirds of the world's population may be facing water shortages, according to World Wildlife Fund. Available freshwater supplies worldwide continue to decline. By 2030, water demand is forecast to increase by 40 percent. The world population is expected to reach 9 billion, placing pressure on water supplies. Water scarcity involves water crisis, water shortage, water deficit or water stress. There are two types of water scarcity: (1.) Physical water scarcity occurs when there is not enough water to meet demand. Roughly 20 percent of the world's population now lives in physical water scarcity. (2.) In the developing world, finding a reliable source of safe water is often time consuming and expensive. This is known as economic scarcity. According to An estimated 1.6 billion people around the world live in areas of economic water scarcity, with 780 million people living in areas with no basic water services.

The NITI Aayog on June 18, 2018 released the result of a study warning that India is facing its 'worst' water crisis in history and that demand for portable water will outstrip supply by 2030 if steps are not taken. Nearly 600 million Indians faced high to extreme water stress and about 2,00,000 people died every year due to inadequate access to

safe water. 21 cities, including Delhi, Bengaluru, Chennai and Hyderabad will run out of groundwater by 2020, affecting 100 million people, the study noted. If matters are to continue, there will be a 6% loss in the country's Gross Domestic Product (GDP) by 2050, the report says.⁸



Moreover, critical groundwater resources, which accounted for 40% of India's water supply, are being depleted at 'unsustainable' rates and up to 70% of India's water supply is 'contaminated', the report says. The NITI Aayog's observations are part of a study that ranked 24 States on how well they managed their water. Gujarat, Andhra Pradesh and Madhya Pradesh took the top three spots, in that order, and Jharkhand, Bihar and Haryana came in last in the 'Non-Himalayan States' category. Himachal Pradesh-which is facing one of its worst water crises this year-led a separate 8 member list of States clubbed together as 'North-Eastern and Himalayan.' These two categories were made to account for different hydrological conditions across the two groups.⁹

About 60% of the States were marked as 'low performers' and this was cause for 'alarm', according to the report. Many of the States that performed badly on the index-Uttar Pradesh, Odisha, Chhattisgarh-accounted for 20-30% of India's agricultural output. "Given the combination of rapidly declining groundwater levels and limited policy action...this is likely to be a significant food security risk for the country," the report says. On the other hand, the index noted, several of the high and medium performers-Gujarat, Madhya Pradesh, Andhra Pradesh, Karnataka, Maharashtra and Telangana-had faced droughts in recent years.¹⁰ Therefore, a lack of water was not necessary grounds for States not initiating action on conservation. Most of the gains registered by the States were due to their restoration of surface water bodies, watershed development activities and rural water supply provision.

Envisioned as an annual exercise, the Composite Water Management Index (CWMI), to evaluate States, has been developed by the NITI Aayog and comprises 9 broad sectors with 28 different indicators covering various aspects of groundwater, restoration of water bodies, irrigation, farm practices, drinking water, policy and governance. "While Jharkhand and Rajasthan may have scored low, they have made remarkable improvement when compared over two years," said Amitabh Kant, CEO, NITI Aayog. Other experts said that unless India work up to its water crisis, disaster loomed. "There is great awareness now about air pollution, however, India's water crisis does not get that kind of attention," said Rajeev Kumar, Vice-Chairman, NITI Aayog.¹¹

8. CAUSES OF WATER SCARCITY

There are millions of people all over the world who don't have access to water, or, if they have access, that water is unable to be used. About 70 percent of the Earth's surface is covered with water and 3 percent of it is actually

freshwater that is fit for human consumption. Around two-thirds of that is tucked in frozen glaciers and unavailable for our use. According to WWF, some 1.1 billion people worldwide lack access to water, and a total of 2.7 billion find water scarce for at least one month of the year.¹² Clean drinking water is scarce and there are millions of people across this glob who spend their entire day searching for it. Yet, people who have access to safe, clean drinking water take it for granted and don't use it wisely.

Water scarcity involves water crisis, water shortage, water deficit or water stress. Water scarcity can be due to physical water scarcity and economic water scarcity. Physical water scarcity refers to a situation where natural resources are economic water scarcity is a region's demand and economic water scarcity is a result of poor water management resources. That being said, what are the causes of water scarcity, what are the effects of water scarcity, and are there any solutions what we can start to explore ? Here's a quick look at all of those things in a bit more detail. William Ashworth said that, *"Children of a culture born in a water-rich environment, we have never really learned how important water is to us. We understand it, but we do not respect it."* According to experts, *"Water scarcity is the lack of sufficient available water resources to meet the demands of water usage within a region. It already affects every continent and around 2.8 billion people around the world at least one month out of every year. More than 1.2 billion people lack access to clean drinking water."*¹³

- **Overuse of Water**

It may be overused on people, animals, land or any other number of things. It may also be used for recreational activities without any care about the effects that it may have on the world around them.

- **Pollution of Water**

It is a huge problem, especially when you're looking at areas that don't necessarily have a good sewage system and it can be anything from oil, to carcasses, to chemicals, and to fecal matter. No matter what it is; it makes a lot of issues for the people who may need to use it.

- **Conflict**

If there is conflict over an area of land, it may be difficult to access the water that is located there. In the worst case scenarios, people could end up dying if they try to access the water in these areas (due to violence). This can result in a variety of other issues, including pollution, which we discussed in the previous point. Water being such an essential natural resource, it is not surprising that the World Bank predicts it will become a major cause of wars in the twenty-first century. In India, water conflicts exist at various levels from fights beside the village well to interstate water disputes. These minor water conflicts could become major water wars in the future.

- **Distance**

There are a number of areas throughout the entire world that deal with water scarcity because they just aren't close to anywhere that has water. Areas that are considered to be desert, or areas that are isolated, may not have somewhere that the people can get water easily.

- **Drought**

A drought is an area which is not getting enough rainfall to be able to sustain the life that is residing there. Some areas are in perpetual drought, whereas other areas may be dealing with a drought on occasion. Droughts are common all over the world, and there is little that can be done to prevent such things from happening.

- **Governmental Access**

In some countries, specifically those with dictatorships, the use of water may be strictly controlled by those in power, causing a scarcity for those who may be located in those areas of the world. These governments use it as a source of control over those that they are governing, which can be a huge problem.

- **Religious and caste oppression**

Often the so-called 'lower caste' communities are denied access to public drinking water wells and other water resources in rural areas. Upper caste Hindus have often ensured that lower castes and especially 'outcastes' have no

access to water. Disturbingly, such acts have been provided with religious sanction. Such oppression often leads to protests. Dr. B.R Ambedkar, the legendary leader of the Dalits, launched a Water Satyagraha (a policy of passive political resistance), in Maharashtra, by marching to a public tank protesting against this prejudice. Recent conflicts show how centuries of caste-based prejudice, deeply rooted in cultures and traditions, have not been eradicated. However, long before Ambedkar protested over water issues, Christian missionaries had attempted to address the issue by providing equal access to water for all and especially to the outcaste people. This missionary initiative, among others, demonstrated how Christians put into practice biblical principles of dignity, respect, and justice for all people.

- **Equitable access to drinking water**

Equitable access to water has become a demand in contexts where water rights are contested. For instance, in South Maharashtra state, drought-affected farmers have been organizing protests aimed at restructuring some irrigation projects in the area on more equitable lines. Some Christian organizations have already started responding to the water crisis in central India by assisting drought-stricken people to have access to clean drinking water. Bore wells are being dug, villagers are being educated in how to conserve and utilize water, and community committees are being organized so that the water is equally accessed by all. India needs more such initiatives.

- **Dams and displacement of people**

The Sardar Sarovar Project in the Narmada Valley has, for some years now, become a rallying point for protests against large dams. Most countries in South Asia receive the majority of their rainfall during the monsoons. Hence dams are necessary for storage and use during the rest of the year. However, these projects have caused endless political and communal conflicts over issues of unequal sharing and of displaced people. Most Christian NGOs and churches are yet to become seriously involved with those displaced by building of huge dams.

- **Privatization of water**

Water privatization will become a potent conflict area in most South Asian countries, especially India. Privatization involves the transfer of ownership of water resources from the public sector to the private sector. The first National Water Policy drafted in 1987 by the Government of India stated, 'Private sector participation should be encouraged in planning, development and management of water resources projects for diverse uses, wherever feasible.' This applied to hydropower, industrial and domestic water supply, and even irrigation. Within a decade, more than 300 private sector participation projects were commissioned. However, they resulted in an increase in water tariffs, undermining of water quality, non-accountability to customers, reduced local control and public rights, loss of jobs, and impacts on the poor. In the wake of globalization, many multinational companies are competing for access to major water resources, causing depletion of water levels in many parts of India. Christians in India needs to consciously address and speak out against unjust access and usage of water by the powerful and to stand for equal rights to water.

- **Trans-boundary conflicts**

Trans-boundary water conflicts occur when disagreements escalate with regard to sharing water from rivers that flow across national or state boundaries. India has had trans-boundary river water conflicts with neighbouring countries such as Pakistan, Bangladesh, and Nepal. The Indo-Bangladesh conflict over the Ganges is a case in point. Various diplomatic efforts are being undertaken to resolve these trans-national issues on water sharing. Within India, each state enjoys considerable freedom in deciding issues related to water, and most of the inter-state rivers have become an area of conflict in recent decades. The Cauvery water between Tamil Nadu and Karnataka and the Baglihar Hydropower Project in Jammu and Kashmir are two examples of inter-state water conflicts.¹⁴ There is ample scope for the Indian Christians to use their influence and to be a catalyst to resolve such trans-boundary water conflicts.

9. EFFECTS OF WATER SCARCITY

The effects of water scarcity can be grouped in these 6 broad areas—Lacks of access to drinking water, Hunger, Diseases, Sanitation issues, Poverty and Education.

● **Lack of Access to Drinking Water**

The biggest problem that happens when people are not able to get fresh, clean drinking water. In many developing countries, people are forced to drink low quality water from flowing streams, many of which are contaminated. There are many water-borne diseases that people die off. Less water also means sewage does not flow, and mosquitoes are other infections. Lack of water or quality water causes huge sanitation issues. Clinics, local restaurants, public places of convenience and many other places are forced to use very little water for cleaning. This compromises the health of the staff and people who use the facilities.

● **Hunger**

Water scarcity causes starvation to occurrence masse for both people and animals that are located in the area. It takes a lot of water to grow food and care for animal. Experts say that globally we use 70 percent of water sources for agriculture and irrigation and only 10 percent on domestic issues. Less water means farming and other crops that need water to grow have lower yield. It means farm animals will die and others will not do well without water. The result is constant hunger and thirst and low quality of life.

● **Diseases**

If you don't have clean water access, then you will be more likely to get diseases from the water that you do have. Whether you are drinking the water or using it for bathing, those diseases will get into the body and, in a number of cases, the people carrying those diseases will pass away to others.

● **Sanitation Issues**

Without access to clean water, there is no way to proper sanitation. It also causes health issues, including depression and anxiety. Freely-flowing water from the Oshiwara River in Mumbai, India may appear to be a positive sign that the city has not yet been hard hit by the country's staggering water crisis which has been driven by drastic escalation in urban population and has caused unprecedented demand on water. In fact, by 2050, India's population is expected to overtake China's current census numbers. Add climate change and increased agriculture to the mix, and India's water crisis may soon lead to epidemic health concerns.¹²

Unfortunately, water scarcity is not just a water availability problem but also one related to water quality. In order for water to be safe for human consumption or use, water must be potable. Potable water, or water that is free of impurities, pollution and bacteria, seldom exists naturally, such as in glacial waters.

In fact, in July 2003, a So Clean study found that a significant portion of water in Mumbai was contaminated by fecal cloriiform ("fc") or bacteria from human waste. Contamination was significant at 1600 fecal cloriiform per 100 ml of water. Safety norms in India have set a limit of 10 fc per 100 ml (although the World Health Organizations say that no fc should exist in potable water), obviously making this a significant public health concern in the city.¹³ That is, even though Mumbai had a good water supply, it was deemed unfit for use. It may be also be surprising to note that a major portion of the contaminated water was found in middle-class dwelling sites, demonstrating that sanitation issues are not just a symptom of poverty.

While over a billion people lack access to water, the WHO reports that over 2.6 billion people lack proper sanitation, which can lead to a host of diseases and illnesses, such as hepatitis and cholera, and this problem is alarmingly wide-scale. For example, approximately 50% of Sub-Sahara Africa lacks adequate sanitation, approximately 25% of Latin American countries fall short of proper sanitation, and even the U.S. has various sanitation concerns, particularly in urban areas. Across the board, sanitation issues range from (a) basic sanitation or the management of human waste from households, (b) on-site sanitation or disposal of sanitation at sites, (c) food sanitation or ensuring safe food handling before distribution, (d) environmental sanitation or effective planning for wastewater or contaminants and (e) ecological sanitation or natural recycling.

International governments, NGOs and communities are making some effort to address sanitation issues but not fast enough. It's an expensive task and consistently changing. Globalization, population, climate change, migration,

challenges in agriculture, water privatization and other water scarcity factors are all taxing existing sanitation. Regions such as Northeast Brazil and urban Thailand simply can't "set up shop" fast enough. Too many people, too much waste, no place to put it, and large-scale solutions take time, money and site evaluation, and once facilities are in place, it takes more time and money to maintain them, and there are many examples. "Our latrines at a (refugee camp in Ghana,)" said Elizabeth Murdock, a volunteer for WISE, "had to be closed for some time because the (UNHCR) didn't have a plan for sanitation and anyone who used the bathrooms got sick." There were simply too many people and no initial plans for adequate waste disposal.¹⁴

The WHO, which named 2008 the Year of Sanitation, suggests that sanitation solutions can be simple, and efforts are being made to provide public health education to both urban and rural areas worldwide to teach families about pit toilets, composting, hand washing, wastewater management and water purification.

So, it may surprise you that more than 1 in 3 people worldwide lack adequate sanitation, a problem that spans demographic variables of race, income-level and geographic areas, and by 2015 continued increases in urban populations will mean that tens of millions of people will die simply because they have no place to put their waste. Therefore, global outreach for water availability must go hand-in-hand with plans for adequate sanitation and public health education. For more information regarding some of these efforts, please see the U.N.'s site on sanitation development.

● **Poverty**

All in all, people who are dealing with water scarcity are often stuck in poverty as well. Access to quality water is key to economic prosperity and better living standard. Businesses and schools thrive when people come to work on time and not have to spend all morning looking for water. Restaurants, hotels and shopping places need to keep clean to attract tourists and foreign investment. Manufacturing activities, commercial farms, and mining processes all need a lot of water to thrive. Lack of water means no economic activities will happen and the people will be in constant poverty.

● **Education**

It is a bit hard to see how water and education is related. For many people in other parts of the world children (and teen girl) have to be up at dawn to collect water for the family. They have to walk for several miles to get water. The children get tired and some have to miss school as a result. Doing for this many years take away school times and the cycle continues. In other places, girls and women are not allowed to go to school at all so that they can serve the family by getting water and taking care of other family needs.

10. WATER SCARCITY IN INDIA

Several parts of the country are facing under a severe drought and a water crisis. Data also shows that the situation is getting worse day by day. The per capita water availability in India has come down 70% from 1951 to 2011, in a span of 60 years. While growth of population is one of the chief reasons for this, the over exploitation of ground water coupled with lack of harvesting is making matters worse. The per capita availability of water as per 1951 census was 5177 cubic meters. This goes down to 1545 cubic meters as per 2011 census. As per the 2001 census, it was 1816 cubic meters. It has continuously decreased owing to the increase in population. India will become one of the top 6 water scarce countries by the year 2025. Annual per capita availability of water will reduce to 950 cubic meters and the total demand is expected to increase to 1,050 billion cubic meters by 2025. Demand for water in industrial sector is also increasing by 8 per cent per annum and will reach to 191 billion cubic meters by 2025. India is the largest exploiter of ground water in the world. It is withdrawing 251 cubic kilo meter of water every year which is more than the US and China put together. Amongst major countries, ground water levels in India are going down faster than anywhere else.¹⁵ The reduced availability of fresh water and increasing ground water withdrawal is a matter of great concern. In parts of Gujarat, Rajasthan and Tamil Nadu, the annual per capita availability of water is less than 500 cubic meters, which is a critical level. The water reserves are depleting so fast and no systemic efforts are being made to address the situation. Water quality is also deteriorating rapidly. Fluoride, iron, arsenic, nitrate and salinity are afflicting ground water in various parts of the country. Increasing water pollution

from agriculture and industrial activity is also a matter of great concern. New contaminants like pesticides, pharmaceutical products and chemicals are coming to the fore. Water pollution comes from many sources including fertilizers that wash away from farms, untreated human waste water, and industrial waste. Even ground water is not safe from pollution, as many pollutants can leach into underground aquifers. Some effects are immediate, as when harmful bacteria from human waste infect water and make it unfit to drink or swim in.¹⁶

Further, water supply in India has two principal sources namely water from rivers and groundwater. However, the rivers are shrinking because of industrialization and pollution, which pushing us towards an enormous water deficit. Official figures show that each day, approximately 500 million liters of waste water from industrial sources is dumped into the Ganga. The Yamuna similarly receives 850 million gallons of sewage every day from Delhi alone. For those who are dependent on groundwater sources, the presence of arsenic in the eastern belt in the Ganga-Brahmaputra region poses equally dangerous threats. The Asian Development Bank has forecast that by 2030, India will have a water deficit of 50 per cent.¹⁷ The Union Ministry of Water Resources has estimated the country's current water requirements to be around 1100 billion cubic meters per year which is estimated to be around 1200 billion cubic meters for the year 2025 and 1447 billion cubic meters for the year 2050. Therefore, rampant pollution, dumping of sewage waste and abuse of the rivers has led to large sections of important rivers like Ganga and Yamuna becoming unfit for use. Take for instance, the Ganga, which flows through 11 states of India and provides water to more than 500 million people.

11. OVER EXPLOITATION OF GROUND WATER

India is the largest user of groundwater in the world. We have approximately 30 million wells, including the new bore wells and the old open wells, drawing 250 cubic kilo meter of water. Groundwater now contributes to about 85 per cent of India's drinking water security, 60 per cent of its agricultural requirements and 50 per cent of urban water needs. The big irony is that despite this reality, much of India's public investments have gone into surface water like dams and canals for irrigation, huge pipelines for drinking water, and increasingly for diversion to industry-especially to the energy sector. Essentially, groundwater extraction is a private enterprise in India. Most Indian wells and bore wells are privately owned and operated. Water is a state subject in India. Administration at the Centre as well as in the states has tried but failed to fully resolve the questions of who really owns the groundwater, how it should be mapped, extracted and replenished.

Ground water is the water that seeps through rocks and soil and is stored below the ground. The rocks in which ground water is stored are called aquifers. Aquifers are typically made up of gravel, sand sandstone or limestone. Water moves through these rocks because they have large connected spaces that make them permeable. The area where water fills the aquifer is called the saturated zone. The depth from the surface at which ground water is found is called the water table. The water table can be as shallow as a foot below the ground or it can be a few hundred meters deep. Heavy rains can cause the water table to rise and conversely, continued extraction of ground water can cause the level to fall. The underground setting of ground water defines the potential of this resource and its vulnerability to irreversible degradation. Experts believe that India is fast moving towards a crisis of ground water overuse and contamination. Ground water overuse or overexploitation is defined as a situation in which, over a period of time, average extraction rate from aquifers is greater than the average recharge rate. However, owing to the decentralized availability of groundwater which means that the owner of a piece of land has the right to the water under it by the Indian Easement Act of 1882. Therefore, it is easily accessible and forms the largest share of India's agriculture and drinking water supply. 89 per cent of ground water extracted is used in the irrigation sector, making it the highest category user in the country.¹⁸ This is followed by ground water for domestic use which is 9 per cent of the extracted groundwater. Industrials use of ground water is 2 per cent. 50 per cent of urban water requirements and 85 per cent of rural domestic water requirements are also fulfilled by ground water. The largest component of ground water use is the water extracted for irrigation. The chief means of irrigation in the country are canals, tanks and wells, including tube-wells. Of all these sources, ground water constitutes the largest share. Wells, including dug wells, shallow tube-wells and deep tube wells provide about 61.6 percent of water for irrigation, followed by canals with 24.5 percent.¹⁹ Therefore, India's use of groundwater is much in excess of the actual recharge being carried out. Free or cheap electricity also meant that farmers turned to tube wells electric pumps as preferred instruments for lifting water from underground. Since water is not economically priced, it is used

inefficiently through flood irrigation. For the same reason, water intensive crops are grown in areas where water is highly scarce, for example, rice in Punjab and sugarcane in Maharashtra, thereby contributing further to the decline in water tables. Marathwada in Maharashtra, the state's sugar belt, had declared a record production of sugarcane during 2014-15, despite a repeat drought after 2012 and 2014. Sugarcane is a water-guzzling crop, consuming over 70 percent of irrigation water. Rajendra Singh, a water activist, stated that the drought in Marathwada was not natural but manmade. He claimed that politicians of the state did not do anything for its people. He believed that sugarcane cultivation was responsible for drought and farmers often ignored the large amount of water being utilized, from wells and tube wells, for cultivation of sugarcane. He suggested to changing the crop pattern to overcome the water crisis and advised farmers to shift their focus from sugarcane to pulses which could survive even with moisture in air. The Maharashtra government is now pushing for crop patterns that would be suitable for growth in drought-hit Marathwada region. Punjab is also suffering from water scarcity due to its erroneous crop pattern. Punjab is among the highest rice producing states in India. Dr. R.S. Siddhu says, "Rice is not the traditional crop of Punjab. Paddy 1980s and currently, about 28 lakh hectares of land is under paddy cultivation. Water availability in Punjab shows that the state can afford only 16 lakh hectares of paddy cultivation, but farmers are not ready to change the crop pattern as there is abundance, guaranteed yield and an active system of minimum support price for paddy. Result is, about 110 blocks in a total of 145 are now declared dark zones.²⁰ Dark zones are those blocks where the level of ground water drops significantly because of uncontrolled lifting of ground water of agricultural use. The whole of central Punjab is suffering from acute water crisis as paddy farmers have drilled tube wells in large numbers. The free power policy for farmers has made the situation worse." Prof T. V. Ramachandra from the Centre of Energy and Wetlands Research Group argued that despite floods in Bengaluru in July 2016, the city is set to experience water crisis because of improper planning and ineffective implementation of the existing water policies. This apart, wastage due to leakages and indiscriminate use by people is also adding to the growing problem. The study also pointed out that Bengaluru generates 15 thousand million cubic feet (TMC ft) sewage water daily. Of the water used by people, 70% is wasted and joins sewage lines and the rest is lost by various means like evaporation, leakage and others. The Vidarbha region was termed "suicide capital of the country" after over 1,000 farmers committed suicide in 2015, the highest in about 14 years. The desert state of Rajasthan is in the grip of a water crisis, the government sending water trains to parched Bhilwara and tankers to other areas facing acute shortage.²¹ Nearly 17000 out of the total 44672 villages are facing water crisis and transportation of water through rail in Bhilwara and by tankers in other areas has already started by the state public health and engineering department. Water tankers are also being sent to the places facing water shortage. Ajmer, Banswara, Baran, Barmer, Bhilwara, Chittorgarh, Churu, Dungarpur, Hanumangarh, Jaipur, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur, Pali, Rajsamand, Udaipur and Pratapgarh are the districts which are severely affected.

12. EMERGING CHALLENGES

Scholars argue that 40 per cent of India's population may not have drinking water by 2030, if the water crisis in India is not met seriously. Jal Jan Jodo Abhiyan's national convener Sanjay Singh argues that the ground water is depleting, the small tributaries have dried up to 90 per cent and the flow of rivers has reduced by 60-65 per cent. This will lead to a severe situation in the coming years reducing water availability to a great extent. He also said that the per capita demand has increased whereas the availability is very less. The gap between the availability and demand is increasing at a greater pace. Cities like Bengaluru, Delhi, Mumbai and other metropolitan cities consume water in huge quantities due to changed in lifestyle of people. This must be looked into Himanshu Thakkar says ground water is the lifeline of the country which is depleting very fast. Water is part of ecological system as every living organism on earth needs water, if not dealt with properly water crisis may lead to more serious challenges like food crisis, livelihood crisis, and social conflicts. For instance, the people of Latur in Maharashtra are facing a real challenge because they have been receiving water from the supply only once in a month. The 4.5 lakh population is facing severe shortage of water because the dam has recently dried up. Unfortunately, Latur is not alone Hyderabad, Maharashtra, Rajasthan, NCR Delhi, Odisha and Kerala all reeling under a water scarcity. In Maharashtra, one of India's worst affected states, water is being transported by train to parched areas. In Rajasthan, 19 of 33 districts are drought affected. Though, the government is rushing water tankers across to parched Bhilwara and other areas, there are over 17,000 villages facing drought because of the receding ground water table. Moreover, in water rich Kerala, the water scarcity is mainly due to poor water conservation and faulty planning.

Kerala has also mismanaged its natural resources and failed to check deforestation, sand mining and pollution in almost all its rivers. Water used to be a free, basic resource. Now people have to pay for water tankers and private companies to secure something as essential as water.²² Now we will need to make changes to meet the escalating crisis through water conservation, drip irrigation techniques, reforestation, recycling of water through treatment plants, harvesting of rainwater and that multiple sources are tapped for water supply, rather than depending only on one resource until it is totally exhausted. India needs water to meet its current requirements and also for 2050 when its population is predicted to increase by another 450 million, nearly one-third more than at present. All these additional people will need food, energy, industrial and economic development, proper health, education facilities and a good environment to enjoy a good quality of life and meeting their needs will require increasingly more water. To satisfy these expectations, the present generation will require even more water in the future and from now onwards we need to adopt water management policies. Unlike oil, gas and all minerals, water is a renewable resource. Oil or coal once used cannot be used again. With good management, water can be used and waste water can be treated and reused. Indian cities generally lose 40 to 50 percent of water because of leakages and bad management practices.²³

13. SOLUTIONS FOR WATER SCARCITY

Sometimes the magnitude of a problem can make one feel that there is nothing that can be done. But there is a lot you can do for water. There is a high chance that people reading this do not live in water deprived areas, and may think it is not their problem. Here is what you can do to help. The World Wildlife Fund for Nature (WWF) reports that over 1 billion people lack access to safe and clean water. Over 2.7 billion people suffer from at least 1 month of water scarcity in a year.²⁴

These facts can be hard to grasp, especially since only 3 percent of the water in the world (which accounts for over 70 percent of the earth's surface) is freshwater deemed fit for human consumption. However, when we factor in the fact that 2/3 of the freshwater in the world is locked up in frozen glaciers, we can understand how much of a problem water scarcity really is. Perspectively, while over a billion people spend days searching for clean and safe drinking water, some of us with access to plenty of water often take it for granted.

Major factors of water scarcity include pollution and overuse of water, conflicts, travel distance to water sources, drought, and governmental control. With water Scarcity comes hunger, diseases and other health complications, poor sanitation, lack of education, and ultimately, poverty. The good news is that the problem of water scarcity can be solved, but it requires a collective effort with each and every one of us playing our own part to solve this global crisis. Here are some proposed solutions to the water scarcity crisis. In this article, we'll discuss the most viable water scarcity solutions for the 21st century.

- **Improved Infrastructure**

Water infrastructure is a very important element of water management and control. It includes all the infrastructure used to build, pump, transport, divert, store, treat, and deliver safe drinking water, as well the tools and equipment used to build them. These structures include groundwater wells, dams, storage tanks, surface-water intakes, pipes, drinking- water facilities, and aqueducts. With poor water infrastructure inevitably comes water scarcity. This is why it is important for us to improve the quality of our water infrastructure be it natural or artificial.

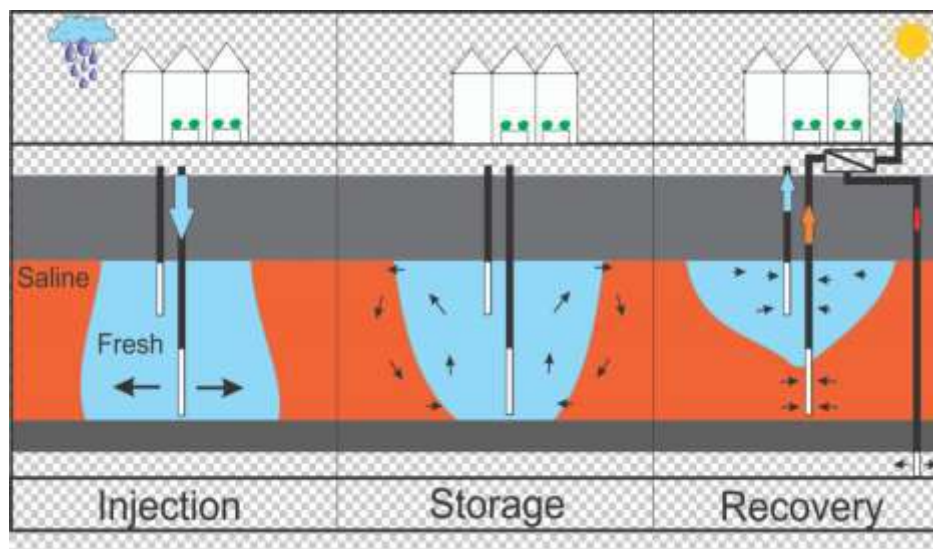
Infrastructure also encompasses natural infrastructure which makes use of landscape management techniques such as conservation, restoration, and sustainable management. These techniques provide basic water services such as flood control, aquifer storage and recharge, and providing a clean and abundant supply of water. Improved infrastructure will not only reduce the amount of clean water being wasted but will also help reduce the number of persons constantly searching for clean water on a daily basis.

- **Ground Water Recharge/Aquifer Storage and Recovery**

Another solution to the water scarcity crisis is to improve our attempt to recharge our groundwater. Artificial groundwater recharging has been in existence for decades and has proven to be one of the most successful methods of solving water scarcity in many areas. The process of recharge can either be a human-induced process or a natural

process as part of the hydrological cycle. Groundwater recharge can be done directly via injection wells or spreading basins or as a result of human activities including waste disposal and irrigation. Reclaimed wastewater and human-induced recharge are gaining grounds in many regions, gradually making it a key component of the hydrological cycle.

Aquifer recovery and storage is another water scarcity solution. Here, recharge is done via surface infiltration into unconfined, shallow aquifers. In recent years, this process has evolved to accommodate direct injection into deeper aquifer systems, including those containing poor quality groundwater, making freshwater storage available in areas where none formerly existed. A major constraint to recharging by injection and infiltration is the clogging of pores from particulates, chemical precipitation, and biofilm formation. This can have adverse effects on the quality of groundwater such as the formation of dissolved sulfides and iron solubilization. That notwithstanding, if done and controlled properly, these two methods can greatly reduce the level of water scarcity in some areas stricken by this phenomenon.²⁵



- **Pollution and Contamination Control**

Pollution is a major contributor to water scarcity in the world today. Water pollution, which is the dumping of harmful substances into clean water systems, is playing a major part in reducing the amount of water available for consumption. Individuals, as well as industries, keep polluting the water supply with chemicals and other forms of waste. With pollution comes a lot of adverse effects, especially health-related effects and eventually high mortality rates.

Pollution also plays a major role in global warming which is one of the major threats to our planet today. It is true that global warming leads to the melting of our frozen freshwater, but this water seeps into the ocean and causes the ocean levels to rise, leading to floods and other disasters which in turn reduce the amount of water in shortage. Air pollution leads to the contamination of rainwater which is a major source of water to many. It is up to us to reduce the insurmountable level of pollution plaguing our planet.

- **Water Conservation/Drought Mitigation**

Water conservation is another solution to the current water crisis plaguing the globe. As was mentioned for water, some of us have it in abundance but waste it, either intentionally or unintentionally. Here are some ways through which we can conserve water: (1.) Filling a sink basin with water when washing dishes instead letting the water run; (2.) Using a bucket to catch the water while waiting for the shower to warm up; (3.) Avoid letting the water run when brushing teeth or applying soap on our skins when taking a bath; (4.) Installing water-saving fixtures and appliances; (5.) Replacing your high-flowing showerhead with low-flowing ones; (6.) Use a broom to clean sidewalks instead of water hoses; (7.) Eliminating leakages in bathtubs, faucets, and toilets; (8.) Flush your toilets only when necessary. In the fight against water scarcity, every drop of water counts.²⁶

Drought mitigation is yet another technique to curtail the level of water scarcity in the world. Drought is a slow and gradual process which can be mitigated with proper preparation and with the right techniques. Drought mitigation techniques such as soil and water conservation and efficient irrigation can greatly reduce the effects of power scarcity. As the poem by Julia Abigail Fletcher Carnet goes, *"Little drips of water, Little grains of sands, Make the mighty ocean, And the pleasant land."*

- **Rainwater Harvesting/Water Catchment**

Rainwater harvesting is one of the main sources of water for a lot of people, especially in Africa. This is generally done via the use of a water catchment and collection basin. Water collected using a water catchment can be used to water our vegetable gardens, livestock, perform daily chores, cook, and even for drinking. Water collected directly from the atmosphere can be used for drinking, even without boiling. In many parts of Africa, water catchment and rainwater harvesting have proven to be a very important source of water to many. People build different catchment system from roofs and gutters. Websites exist which help people with designs and different means of building great water catchment systems for harvesting rainwater.

A major advantage of this method is that it allows for the conservation of safe drinking water while the harvested rainwater is used to take care of daily chores. This method is also useful in areas where the natural landscape acts as a natural water catchment and favours the collection of rainwater. This makes it possible for rainwater to be harvested in large quantities. This harvested water can then be treated and supplied to the population such as in the case of the greater Sydney area Australia.

- **Water Credit/Water Equity**

Mostly practiced in developing countries, this method of credit entails the provision of loans to households and small enterprises in an effort to increase access to a safe and improved water source as well as sanitation. Most water credit invests are financed by governments and other public-sector organizations, but due to the fact that their current investment levels aren't enough to reach everyone, private organizations and micro credit institutions have come in to complement the effort. Micro credits usually target the poor and less fortunate and help them to gain access to clean and improved water sources, safe water, and sanitation.

In the water sector, three major types of water credit schemes exist. These are water credit schemes aimed at improving household access to water supply, schemes aimed at improving water access to small and medium-sized enterprises, and schemes aimed at upgrading water service in urban and shared facilities. Regardless, the aim of water credit is to help improve access to clean and safe water, and to reduce the number of people suffering from water scarcity by financing household water and connections, toilets, latrines, bathrooms, pit latrines, rainwater harvesting tanks, and other systems.²⁷

- **Research and Technology**

Recent breakthroughs in research and technology have come up with techniques that have made it possible for water considered unfit for consumption, to be made clean and safe for consumption. Some of the most frequently used techniques include Reverse Osmosis, Electro dialysis Reversal (EDR), Desalinization, Nanofiltration, and Solar and UV Filtration.

- Reverse osmosis uses semi-permeable membranes to remove molecules, ions and other larger particles from water, making it consumable. This method can be used to remove all types of suspended or dissolved species from water, including bacteria, thereby purifying water and making it potable. It has also been adapted and used in making household filters and other filtration devices.
- Unlike Reverse Osmosis which uses pressure, Electro-Dialysis Reversal (EDR) uses direct current. During the process, ions flow to electrodes of opposite charge through ion selective membranes. The polarity of electrodes used in EDR systems is periodically reserved. This method is used principally used when purifying waters with low total suspending solids (TSS) or high silica.
- Desalination is a process of water purification used to make salty water pure and clean by separating dissolved salts and other minerals. Desalination can also be used to purify brackish water, water from wells, and other

forms of running water such as water from rivers and streams. This process which can be used to produce enough water capable of supporting large coastal populations is continually under evolving and under research to improve efficiency.

- Another method of water purification is nanofiltration which seeks to remove two-valued ions, as well as other mono-valued ions such as heavy metals from water to make it pure and safe for consumption. This method is mainly used for softening water and removing specific heavy metals from water as well as in the reduction of salt contents in slightly brackish water. Because the method uses less fine membranes when compared to other techniques, its fouling rate and feed pressure are usually lower when compared to reverse osmosis systems.
- Solar and UV Filtration is a purification technique that uses a blend of solar energy and solar ultra-violet (UV) light to make water contaminated by biological organisms such as viruses, bacteria, worms, and protozoa, safe to drink.

Using these techniques can help us fight water scarcity and make sure that more people have access to clean and safe water. There has been a lot of work in the world of water conservation, but there is also a lot that needs to be done in order to ensure that the rest of the world is able to conserve water. Putting money and effort into conservation could be life saving.

- **Support Clean Water Initiatives**

Another very important solution to water scarcity is supporting and donating to organization and initiatives that seek to provide clean water to those in need. Most of these organizations fund water projects using donations. Donations come from donors all over the worlds, they act as a middleman between those who do not have access to clean water and those who are willing to help.²⁸ Some of these organizations include NGO's like Charity Water, Water.org, Life water International, Water Lake, Save The Water and World Water Council. There are organizations located all over the world that are looking to bring clean water to areas that do not have it. Consider donating to these organizations, either with your time, your skills, or your finances.

- **Increase Awareness and Education**

Another very important and simple solution to the problem of water scarcity is to increase awareness and education on water scarcity and its efforts. There are a lot of people who are unaware of the reality of water scarcity as well as its negative efforts and the number of people suffering from it. We must educate people on how to conserve water, on how to support water organizations and NGO's, and on the importance of water. Raising awareness and educating people on the reality of water scarcity, its effects and the importance of conserving water is an important step in the fight against water scarcity.²⁹

People can learn more about the world around them. By educating those who are not dealing with water scarcity, they can be in a position to help. Those who are dealing with it can get educated on how they can prevent the problem from becoming even worse in the future. Learn about water crisis, just like you are doing. If you understand a problem, you are in a better position to have a solution. Talk about it with family and friends. Look out for news and facts on water shortages and crisis areas.

- **Recycle water**

There are a number of technologies the allow you to recycle rainwater and other water that you may be using in your home. Not only does it help to prevent scarcity but it can save some money as well.

- **Improve Practices Related to Farming**

Farming and irrigation are often a huge culprit when it comes to water scarcity. Because of that, we need to improve practices so that we can reduce as much water as those who are using it.

- **Improve Sewage System**

Clean drinking water starts with a good sewages system. By improving the sewage systems, we can prevent water scarcity from becoming any worse. The recent issue has highlighted some facts about urban sanitation in India.³⁰

Drainage and sewerage system in urban areas is an important priority in Indian setting because of rapid urbanization, industrialization, and population growth, along with increase in slum population and migration. A recent study showed that sewerage systems typically reduce diarrhoea incidence by about 30% or perhaps as much as 60% when starting sanitation conditions are very poor. But in many contexts, sewerage might be less cost effective and less sustainable than onsite alternatives.³¹ Another study also showed that urban sanitation can have an impact on diarrhoeal disease, even without measures to promote hygiene behaviour. In this regard, the presence of efficient drainage and sewerage system is a major factor in the prevention of spread of waterborne diseases in major cities. As per the census 2011, at country level, there is no drainage facility in 48.9% households, while 33% households have only open drainage system. National Family health Survey-3 (2005-2006) reported that 52.8% of the households in urban areas have 'improved sanitation' which means that their flush or pour toilet latrine connected to piped sewer or septic or other systems, while 41% of the households still have no latrine within household premises, with 24.2% of them depending on public latrine and other 16.8% practising open defecation. Besides, more than 28% of the urban population lives in slum areas. In Bangalore, Karnataka, only half of 52 towns were served by a sewerage system, while in Hyderabad, Andhra Pradesh, 86 of 124 towns had neither sewerage systems nor running water. The bulk of sewage treatment capacity exists in the metropolitan cities, with 40% of wastewater generation. The cities of Delhi and Mumbai generate some 17% of all the sewage in the country.³²

Treatment of wastewater is one of the important steps to prevent contamination of urban underground water. Because of unpredictable growth and regional shortage of water, urban areas may be monitored with semi-centralized supply and treatment system of wastewater. The change from centralized to semi-centralized supply and treatment systems will minimize the grave discrepancy between the rapid urban growth and the provision of supply and treatment infrastructure.³³ A case study from India showed that converting the existing open wastewater collection drains on the roadsides, as decentralized networks of covered drains, and converting the large open drains on the outskirts of suburban areas that carry wastewater to agricultural fields is 70% cheaper compared to conventional collection and treatment systems.

National Urban Health Mission is a welcome step and recent development which will be launched with focus on slum areas and other urban poor.³⁴ At the state level, there would be a State Urban Health Programme Committee, at the district level, a District Urban Health Committee, and at the city level, a Health and Sanitation Planning Committee. At the ward slum level, there will be a Slum Cluster Health and Water and Sanitation Committee. Involvement of local community in planning, implementation, and monitoring of sanitation activities, development of cost-effective and efficient methods and its delivery system to improve the sanitation for rapidly growing urban population, involvement of NGOs, local leaders, and other stakeholders, adequate financing, and political commitment are the requisite areas to be considered to improve the sanitation status in urban areas.

- **Climate change mitigation**

Climate change and water scarcity go hand-in-hand to cause some of the biggest contemporary challenges to the human race. These issues have a reciprocal relationship, identified by the International Panel on Climate Change (IPCC), in which, 'water management policies and measures can have an influence on greenhouse gas (GHG) emissions.' As renewable energy options are pursued, the water consumption of these mitigation tactics must be considered in producing alternative ranging from bio-energy crops to hydropower and solar power plants. The global environmental crisis affects India along with the entire world. Prof V. Ramanathan, in a lecture back in 2009, warned about Himalayan glaciers being the 'most threatened by global warming.'³⁵ The Himalayan glaciers, that span about 1,200 miles crossing eight countries, are the source of drinking water, irrigation, and hydroelectric power for about 1.5 billion people. These glaciers are depleting at alarming rates and will reduce water levels in major Indian rivers such as the Ganges and Brahmaputra.

- **Population growth control**

Because of the accelerating growth in global population, parts of the world could see a supply-demand gap of up to 65 percent in water resources by 2030. Currently, more than one billion people don't have access to clean water. And with 70 percent of the world's freshwater used for agriculture, water's critical role in food production must be considered as climate and resource conditions change.

- **Water projects in developing countries/transfer of technology**

Climate change and water scarcity are producing the most dramatic consequences in developing regions, such as northwest India and sub-Saharan Africa. One proposed solution is to transfer water conservation technologies to these dry areas. Doing so is tricky because economies are weak and there are gaps in skills that often compel government and business authorities to impose these changes on local cities.

- **Holistically manage ecosystems**

Simply put, holistic management applies to a practical, commonsense approach to overseeing natural resources that takes into account economic, culture, and ecological goals. In essence, the whole is greater than the sum of its parts, and each facet is related to and influences the others. Good examples of holistic management are communities that operate sewage treatment plants while pursuing partnership with clean energy producers to use wastewater to fertilize algae and other bio fuel crops. The crops, in turn, soak up nutrients and purify wastewater, significantly reducing pumping and treatment costs.

14. KEY MESSAGE FROM THIS PAPER

- **New indices are needed to measure available water resources**

The calculations of per capita water availability do not include disparity in water allocation and access. This disparity is identified as a major determining factor for water access and use. The per capita water availability does not take into account the temporal and spatial variability in a vast country like India that has varied socio-ecology. These data are the starting points of policy initiatives in the country and therefore any ambiguity in identifying the magnitude of the problem will only hamper workable solutions to it. The validity of the per capita water availability index needs to be rethought in the light of social and economic disparities in water usage that exist in India. On the same ground, putting forward the argument that increase in population leads to water scarcity needs rigorous debate.³⁶ A former's need of water for basic livelihood support often gets mingled with wasteful water uses of high-end consumers. Therefore, as a point of departure from this orthodox concept, some new indices should be developed and uses which are able to capture the underlying differences in water access.

- **Water demand is for exceeding supply and leading to inter-sectoral conflicts**

Myopic approaches in attaining food security are risking agricultural sustainability by encouraging increased use of water. The water demand from agriculture is set to increase tremendously and will have to be met to ensure food security in a high consumption scenario. The concept of inter-state virtual water transfer also needs emphasis. The states with lower availability of water resources end up being the net exporters of virtual water to the water surplus states. With the current rate of industrial expansion in the country, the water demand from this sector will also escalate in future. Present experiences also suggest increasing inter-sectoral conflicts in the country. It is imperative to initiate efforts for designing an appropriate industrial water use policy which could provide a framework for sustainable water use by this sector. Multiple uses of water and the traditional water allocation priorities and quantities also need to be revisited. The concept of scarcity and surpluses of water must look beyond state boundaries, as with a more disaggregate assessment, these comparisons will surely change.

- **The time bomb of increasing water pollution is ticking**

Water quality issues in India have reached an alarming proportion. Augmenting water supply to achieve the MDG targets will not suffice until its quality is ensured. There is no model in India that shows best ways to tackle the waste water generated through the industrial and domestic sectors. The economic implications of poor sanitation in urban Indian and its impact on water quality are profound. The agencies responsible for checking industrial pollution have failed. Pollution has reached an alarming level and contributes to water scarcity by polluting freshwater resources. This situation needs to be addressed soon.

- **To achieve any headway in gender-sensitive policies, data disaggregation is urgently required**

An analysis of the water sector is incomplete without an understanding of the inter-relations between gender and water. In India, gender interests with class and caste and products with class and caste and produces layered social

hierarchies that impinge on one's access to, and control over, a precious resource, water. Gender and water issues remain at the level of rhetoric for the want of a broad based and shared understanding, without any support from the ground data on charging gender and social relations. The issue of gender disaggregated data needs to be taken up as priority by the state for any progress to be made in mainstreaming gender in water resources management. Apart from the mainstreaming gender in water-related projects, another major issue is about how to tackle gender mainstreaming at the organisational level. The bureaucratic set-up that manages water also suffers from serious inadequacies with respect to gender mainstreaming. Without addressing these issues, well-meaning gender inclusion efforts will not lead to logical and intended inclusion efforts will not lead to logical and indeed outcomes. These will have to addressing at the earliest.

➤ **Reorientation and capacity building required for technocrats for a new vision for water management**

Education technocrats working in various water and environmental-related departments with integration skills is the need of the hour. Present day engineers with their backgrounds in engineering education are incapable of resolving certain issues, for example, of everyday water supply. Once hired, these engineering have limited access to resources to refresh their existing knowledge and/or to acquire new knowledge for water management. In addition to the issue of the changing paradigm for water education in India, there appears to be lack of coordinated and concerted effort in training in service engineers on the new vision of water management. Most of the engineers have received training from government-funded institutes that lack participatory methodology in imparting key messages and encouraging participants to understand the need for training and capacity building.

The Way Ahead

As it has been discussed earlier that India is going through severe water shortage in several states. The water scarcity is mainly due to the dry season, but it has been exacerbated by our inability to manage water resources and ignorance. The water shortage is being perceived as drought. Drought is a man-made condition. The present water scarcity is due to less than average rains for two consecutive years. However, the adversity has increased several folds due to human factors like water mismanagement, policy failures, improper water distribution and inadequate management of water sources. The problem can be tackled through efficient utilization of water through new, advanced and efficient utilization of water through new, advanced and efficient methods, including sprinkler and drip irrigation. Additionally cropping patterns should be changed. For instance, in major parts of Punjab and Haryana, crops like paddy, wheat and sugarcane are dominant and use more water compared to other competitive crops like maize, rapeseed-mustard seed and vegetables. Further, rain-water harvesting and groundwater is necessary.³⁷ In many areas, the groundwater table is falling due to over-exploitation. Capturing, collecting and storing available rainwater or surface run offs during wet season can prove to be a significant tool to turn around the situation. In traditional practices, collected rainwater was used resourcefully but these practices were neglected with the development of modern facilities like canals and groundwater extraction. Some other traditional methods in India include underground tanks called Kinds in desert areas. Apart from these, several new scientific methods such as check dams, roof-water harvesting, recharge pits, recharge wells, vertical recharge shafts and lateral trenches with bore wells help.

From past experience, water professionals have been insisting on river linking projects to enable inter-basin water transfers, from surplus to deficit basins, to even out the variations of water availability and allow for optimal utilization. It is high time that the river-linking project be taken up on a war footing instead of permitting it to crawl and slip into the shadows of history. Transfer of water by train, is a short-term solution but the long-term solution lies in having a network of rivers and canals in the country to address the impact of climate change and provide help to the millions who suffer from the ravages of floods and droughts stalking the country every year. Moreover, educating the multitude of farmers, awareness campaigns, sustainable development and good governance is what the government needs to do. Each drop of rainwater counts and must be saved and harvested. Sustenance in future depends on careful management in the present. Tens of thousands of tanks, irrigation canals, watersheds, reservoirs, and ponds needs to be constructed in water starved areas like Latur to harvest the rainwater and save it, which, in the longer run, would increase the ground water in the area. History shows that humans have the amazing ability to conquer difficulties.³⁸ So, it is time to improve water conservation management and technologies. An

important source of fresh water, the rain, is not harvested. India should revive the ancient rainwater harvesting systems giving them a modern touch. Furthermore, it is imperative to inform farmers with relevant questions on as how much water is needed, how much is being wasted, and to acclimatize and equip with water-efficient technology, practices as establishing farm ponds which collect wasted water, tanks and wells should be kept in mind to collect rain water etc.³⁹ The debate on putting a price on water usage is to ensure balanced usage of water; usage which comes with responsibility and a penalty if water is wasted etc. It is imperative to place industries under scrutiny and estimate their water footprints. The usage of water if exceeds the limits, adequate penalties should be enforced to deter any future negligence over the issue. It is also important to check if the industries do not dump their wastes into the natural resources without proper process of decontamination. Thus, it will be a definite solution to water scarcity if people take it upon themselves to avoid wastage of water and sensitizing others on the dangers of water crisis.⁴⁰ Leaking taps, wasting water on washing vehicles daily, excessive irrigation of home gardens, overflowing tanks, and many more areas should be checked for an effective water management in the home, community or colony. We as an individual and responsible citizen can tackle water deficit right in our backyard; the mentality needs to be revisited and rectified. Along with, the people should break the myth of water in abundance and sensitize the masses. Cut your own water footprint and become an example for your neighbours, relatives and the country to follow.

15. CONCLUSION

Mahatma Gandhi rightly said, *"There is enough on Earth for everybody's need, but not enough for everybody's greed"*. The over exploitation of ground water has been a major source of serious emerging challenges of water scarcity in India. We are the solely responsible for this acute problem, and now, from this moment onwards, we have to take this responsibility to resolve the problem of water scarcity. Government of India cannot resolve this problem alone, each and every citizen of India has to play a positive and active role in the field of water management. We have to understand the value of water, that is priceless and without water there will be not life on earth. If we want to save our life or our future generation, we have to save water, because water is not at risk, our life is at risk. We have to develop an attitude towards saving water and each and every action of our daily life which is related to water must be based upon the saving water or use sensibly. We have to educate ourselves as well as other selves regarding the nature's precious gift in the form of water. We have to encourage people to adopt traditional methods of water management. Today, we are in a position to handle this problem, but if we wait for tomorrow, it will be out of reached. Therefore, it is better late than never. The Government of India must also take long term policies and actions in the field of water management. Short term policies can only handle emerging water related challenges for the time being. Further, there is need to research and develop new technologies in the field of desalinization.

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