ICT for Sustainable Water Resources Management & Campaign

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ABSTRACT

The global water crisis, caused by ever-increasing population growth, climate change and growing urbanization, requires a sustainable use of water resources worldwide. Sustainability is a crucial and at the same time vital approach for satisfying future generations' rights on natural resources. In this scenario global policies, supported by international organizations such as UNESCO and its international science programs, foster sustainable development as principal concept for the management of various thematic areas including the environment. ICTs, therefore, are increasingly becoming a key enabling tool for data acquisition, early evaluation, communication or automated management in the water sector. ICTs are booming, and their use in development is growing exponentially in the field of agricultural services together with the recognition of their potential role to increase transparency and accountability. ICTs can play in managing the water resources and services efficiently also. Improving water resource management is a critical issue and is becoming increasingly relevant due to the increase in population and ageing of infrastructures. Water losses in the water distribution system are a big issue especially for those countries that do not have an efficient water distribution networks, but also in those countries that suffer from the scarcity of water itself. In the water sector and especially in the integrated water resources management ICTs can provide solutions for its implementation. ICTs have a potential to contribute towards improvements in water resource management techniques; strengthen the voice of the most vulnerable within water governance processes; create greater accountability; provide access to locally relevant information needed to reduce risk and vulnerability; and improve networking and knowledge sharing to disseminate good practices and foster multi-stakeholder partnerships, among others. Concepts, such as the Internet of Things (including smart phones and tablets, social media, fast broadband and real-time instrumentation) make a powerful tool that enables managers to collect and exploit all data from the environment and deliver smart cities. ICT, through social media and gaming, can influence human behaviour, alter social patterns and inform a wide audience about the significance of water in the cities of the future, thus, helping citizens and stakeholders to develop sustainable habits regarding urban water use. This chapter deals with how social innovation and IoT platforms can be very beneficial for the urban water sector. The discussion is focuses how ICT applications are fruitful for used Billing System, Meter Reading System, Financial Management system, Procurement system and Distribution Monitoring System in water management.

Keywords : ICT for water use, IoT for water monitoring, Social media for water campaign, Water economics, Sustainable Water Resources Management

1. Introduction

The importance of water in human civilization can be seen from the fact that earliest civilizations grew around the rivers like Nile and Indus. The rivers are truly called the lifeline of any country. The domestic, agriculture and industrial activities depend upon the water availability. The world's population, now at 7.5 billion, is projected to add 2.3 billion more people by 2050 ***(Mirkin, 2010; WPP, 2019).*** The increase in population together with improving and changing lifestyles has exacerbated the water problem due to increased demand of water-intensive products like meat and energy from fossil fuels. Rapid urbanisation and unplanned growth in the last few decades have put continuous and unrelenting stress on the waterbodies.

The demand for water has increased manifold and it has put lot of pressure on the sources of water. Water covers more than two-thirds of the earth's surface. About 332 million cubic miles of water found in the oceans is salty and undrinkable. The freshwater resources are only 3% (***World Atlas, 2018)*** of the water available on earth but only 1% ***(Dinka, 2018)*** of it is accessible. It implies that 7 Billion population has to share about 0.4% of total water for drinking and other uses ***(World Atlas, 2018).*** The water in its natural form exists in different forms and locations. Water exists in the air as water vapor. The other sites are rivers, lakes, icecaps and glaciers, the ground as soil moisture, in aquifers etc. the distribution of water on the earth is given below:

Table : Water distribution(in percent)

oceans	97.2	groundwater	0.62
Icecaps and glaciers	2	Freshwater lakes	0.009
Inland seas and salt lakes	0.008	atmosphere	0.001
rivers	0.0001		

The atmosphere of Earth contains approximately 13,000 km^3 of water. This represents 10 percent of the world's freshwater resources not found in groundwater, icecaps or permafrost. This is approximately equivalent to the volumes found in soil moisture and wetlands. However, the fact is that this vapour cycles in the atmosphere in a 'global dynamic envelope', which has a substantive annually recurring volume, estimated to be from 113,500 to 120,000 km^3 ***(Al-Weshah, 2002).*** Precipitation occurs as rain, snow, sleet, hail, frost or dew. These large volumes illustrate precipitation's key role in renewing our natural water resources, particularly those used to supply natural ecosystems and rainfed crops. Approximate 40% of the precipitation that falls on land comes from ocean-derived vapour. The remaining 60% comes from land-based sources ***(Deshpande, 2010).*** It is particularly pertinent to recognize that snowfall can contribute a large percentage of a region's total precipitation in temperate and cold climate regions.

Water, equally important as air, is connected to every form of life for their day to day activities on earth and is a basic human need. A healthy and dignified living needs access to clean and safe water in adequate quantities for drinking, cooking, personal hygiene and sanitation. Access to safe and dependable (clean and fresh) water is rightly considered the fundamental/basic right of humans.

1.1 Meeting Water Requirement

The daily water consumption in India is around 398 billion gallons. The major requirement is met by surface water (321 billion gallons) due to its easier reach. 77 billion gallons of water is consumed using ground water ***(National Water Mission, 2008)***. As a criterion, the water must meet the required quality standards (chemical, biological and physical) at the point of supply to the users. Drinking (potable) water in adequate quantity made available to users must be clean and safe for drinking, food preparation, and personal hygiene. Water for other applications like washing should be safe. Safe water is not necessarily pure, it may contain some impurities like salts of magnesium, calcium, carbonates, bicarbonates and others.

2. Water crisis: The Role of humans

The Earth's hydrological cycle is the global mechanism that transfers water from the oceans and other surface to the environment by evaporation and replenishes it by rain and other precipitation methods. The principal natural components in the processes of the hydrological cycle are: precipitation, infiltration, runoff, evaporation and transpiration. Human activities (settlements, industry, and agricultural developments) can disturb the components of the natural cycle through land use diversions and discharge of wastes into the natural surface water and groundwater pathways. The human interventions cause a disbalance in the nature. Human must learn to live with nature.

2.1 Water crisis: World and Indian scenario

Water scarcity is lack of fresh water resources to meet water demand. It affects every continent and was listed in 2019 by the World Economic Forum as one of the largest global risks in terms of potential impact over the next decade ***(Global Risks Report, 2019)***. Water is one of the most precious treasures on our green planet but unfortunately most neglected in its utilization. The indiscriminate and non sensitive use of water manifests itself in water crisis which is indicated by partial or no satisfaction of expressed demand, economic competition for water quantity or quality, disputes between users, irreversible depletion of groundwater, and negative impacts on the environment ***(CWS, 2017).*** Two-thirds of the global population (4 billion people) live under conditions of severe water scarcity at least 1 month of the year. Half a billion people in the world face severe water scarcity all year round. Half of the world's largest cities experience water scarcity. NITI Aayog has cautioned that 21 Indian cities including caital New Delhi and IT City Bengaluru will run out of groundwater by next year. The report points out the severity of condition when it mentions that two hundred thousand Indians already die every year because they don't have a safe water supply. A shocking 600 million people face "high to extreme" water stress. The water crisis is getting to alarming levels in big metro ***cities (Standing Committee on Urban Development, 2019)***. One of India's largest cities, Chennai, is a case study dealing with a crippling crisis. The four lakes that supply water dried up in the middle of hot summer. Residents don't have enough water to drink, bathe or wash clothes. People are working from home; malls have closed their bathrooms; and restaurants have shut their doors.

Water is more abused than used. The growing scarcity of usable water for either domestic, industrial, agricultural or any other applications is giving rise to many disputes at all the levels- individual level, community level, state level and also international level. There are many examples of individuals quarrelling for water, states like kerla, karnatka and Tamilnadu having disputes over Cauveri river water sharing and countries like Pakistan unnecessarily meddling in Indian water projects. Water, central to our lives, has never been the central focus in our planning activities. Our cities and towns have subsequently grown without planning for water need vs water availability. Per capita water availability has gone down from 5177 m^3 in 1951 to 1545 m^3 in 2011 ***(Water Resources Division, TERI)***. The water scarcity is mostly man made due to excess population growth and mismanagement of water resources.

2.2 Management of water – The issues and possible solutions

The Central Water Commission estimates the country's annual need of water for all requirements at 3,000 billion cubic meters of water. The country alone receives 4,000 billion cubic meters of rain annually. Thus a pragmatic rain water harvesting alone is sufficient to mitigate water crisis faced by 130 million population ***(Standing Committee on Urban Development, 2019).*** But too much water is wasted, thanks to inefficiency and misuse. The solutions lie in the problem itself. A judicious use of water can solve many problems

3. Urbanisation

India is rapidly transforming itself into an urban society. In urban India, the number of waterbodies is declining rapidly. In the 1960s Bangalore had 262 lakes. Now, only 10 hold water. Similarly, approximate 137 lakes were listed in Ahmedabad in 2001. However, by 2012, sity five were already destroyed and built upon. Hyderabad is another example. In the last 12 years, it has lost 3,245 hectares of its wetlands ***(Centre for Science and Environment, 2012)***. The decline in both the quality and quantity of these waterbodies is to the extent that their potential to render various economic and environmental services has reduced drastically.

Increased concretization due to urban development has choked ground water resources. Water recharge and water storages are not given due consideration and much more the entry of sewage and industrial waste into water bodies is severely shrinking the availability of potable water. The growing urbanization and rising population has raised the demand for domestic supply of water. It is a matter of concern that people become apathetic while using drinking water in their construction works also. The drinking water is also used in car washing and other gardening applications although people are not squarely to be blamed for it due to absence of alternate water supply system/easy availability of alternate water supplies.

3.1 Some of the possible solutions can be

- Laying down alternate water pipelines supplying recycled water for non drinking/cooking applications
- Making available apparently clean water for construction and minor garages for car washing etc.
- City development should be based on a comprehensive plan which must have a focus on avoiding concretization of open areas. A negative list of areas must be clearly marked in the masterplan of city development without any ambiguity in the laws to avoid any nexus between politicians, administrators and land mafias. The discretionary powers of land use decisions must be done away from the hands of revenue officers.
- Traditional water bodies are ignored by rapid construction that has also acted as ground water recharging mechanism. We need to urgently revive traditional aquifers while implementing new ones.

3.2 Agriculture

India has been traditionally agricultural economy and the trend exists even today. Due to vast agricultural fields, huge amount of water is needed in irrigation. In 2011, 245 billion cubic meters of water were withdrawn for irrigation ***(Dhawan, 2017)***. It is a quarter of the total groundwater depletion globally that year. In distant past, water availability has never been a concern and hence flood irrigation gained popularity and it became a deeprooted habit of the farmers. Traditional techniques of irrigation cause maximum water loss due to evaporation, drainage, percolation, water conveyance, and excess use of groundwater Even after realizing water crisis reality and spreading awareness on water effective irrigation methods, adoption among farmers is low and much still needs to be done in this regard by identifying the bottlenecks in the way of farmers.

Some of the effective water application methods can be

- Using better seeds requiring less water
- Advanced methods of irrigation like drip irrigation, sprinkler irrigations can be applied
- Using proper mulching methods to conserve soil moisture/prevent soil moisture loss
- Developing water storage structure in the fields- ponds etc
- A new approach to farming based on water use-recharge balance should be resorted to and dependence on Northwestern states for water-intensive crops should be reduced. The food requirement of the country for water demanding crops should be searched in those areas that receive plentiful rainfalls and adopting suitable water harvesting techniques. However discouraging kharif cultivation in northwestern vis a vis other potential regions may be politically sensitive. The heavy subsidies in power and irrigation should be rationalized in such areas. This will help in conserving ground water.

3.3 Industrialization

India is poised for rapid industrial growth. The industries require water in huge quantities in their operations. The used water (effluent) is generally discharged in streams and rivers without treatment. Waterbodies are being polluted by untreated effluents and sewage that are continuously being dumped into them. Across the country, 86 waterbodies are critically polluted, having a chemical oxygen demand or COD concentration of more than 250 mg/l, which is the discharge standard for a polluting source such as sewage treatment plants and industrial effluent treatment plants ***(State of Indian Agriculture, 2015-16).*** The Ganga river water, most admired religiously, has been declared unfit not only for drinking but even for bathing. Yamuna has the same fate. The Namami Gange project is having a multidimensional approach to clean Ganga but it is too early to comment on the success and it all depends on the honesty of people associated in executing the programme.

3.4 The environmental issues- climate change

Climate change is warming the planet, making the world's hottest geographies even more scorching. Climate change activists have long argued that water will be the political flashpoint of the 21st century. Water-stressed India will likely be one of the first places to test that theory. Social and political tensions have developed on account of water shortages. As the world warms, the rains on which India depends have become erratic: They frequently fail to arrive on time, and they fall in a more disparate and unpredictable pattern. The country can no longer afford to waste its dwindling resources. A rapidly urbanizing and developing India needs to drought-proof its cities and rationalize its farming. Water-harvesting must be a priority, alongside mechanisms for groundwater replenishment. As it is, every summer is hotter and less bearable. If Indians run short of water as well, one of the world’s most populous nations could well become unlivable.

Paradoxically, climate change has caused an impact on the clouds formation and it is seen that clouds are moving away from the equator toward the poles. Precipitation pattern is changing and people who live near rivers and streams have the most to lose. Currently, at least 21 million people worldwide are at risk of river flooding each year. That number could increase to 54 million by 2030 ***(Urban Floods Community of Practice, 2017)***. All countries with the greatest exposure to river floods are least developed or developing countries – which makes them even more vulnerable to climate change and natural disasters.

3.5 Water wisdom: some examples

Struggle for existence is the law of nature. People in difficult and water shortage regions learnt the importance of water and developed novel methods of its conservation, storage and applications and offer a lesson to other people who have so far neglected sensitivity towards water use.

3.6 Irrigation methods

Kuhls (water channels), commonly found in West Himalayan cold deserts, are built along the hill gradient for maintaining proper flow for irrigation. The technique seems to have originated in Babylonian times and is still one of the commonest ways of bringing water to the crops. If the river has a steep gradient, water is diverted into a canal some distance upstream and led along a contour so that it can flow to fields by gravity. In dry temperate zone, kuhls (wooden water channels) are generally made by making notches at the natural water sources and the water is diverted to the fields for irrigation to different terraces, using the natural flow of water. Since the topography of the area consists of very high slopes and rocky terrain's, wooden water channels are used at many places as water passes from one place to another. The water channels are built and managed by the villagers with no government assistance. In the lower areas of Himachal Pradesh bamboo pipes are commonly used as irrigation channels on depressions/small nala. Another method is the collection of spring water in small reservoirs scattered at intervals on the high uplands and then drawing water from these ponds when required. It is a common practice in cold deserts and temperate wet Himalayas. Water from these ponds is used for irrigating crops and also for drinking purposes.

Country	Agricultural Water Withdrawals (billion m^3)	Total Water Withdrawals (billion m^3)	Share of Agricultural Water Withdrawal in Total Water Withdrawal (%)	Area Equipped For Irrigation (m ha)
India	688	761	90	67
China	358	554	65	69
United States	175	486	40	26
Pakistan	172	184	94	20
Indonesia	93	113	82	7

3.7 Field preparation

In plains and in valleys occurrence of dew and "pale" is very common after the receding of monsoon. After monsoon the humidity remains quite high (85%) in the atmosphere. During night time, temperature falls down sharply resulting in the formation of more water molecules from vaporous. As they are heavier, they fall on soil surface and make the layer moist and wet. In the hills, there is traditional practice to plough the fields early in the morning before dew or fog water is evaporated. By ploughing, moisture is mixed with soil particles in the plough layer i.e. 9"-12". This moisture is well retained by soil. If soil is clayey in nature, retention of water remains for a longer time and becomes a source of soil moisture. It is quite useful for land preparation in October-November and for the sowing of rabi crops like wheat, barley and pulses. During rainy season the rains are torrential, which causes splash erosion resulting in the sorting of particles and the formation of false compact layer on the surface. It results in water ponding and subsequently water logging. Crops such as maize, capsicum, tomato which are grown during this season are very sensitive to water logging. In our traditional agriculture there is a common practice that slope of a field is kept inside which is provided with a channel to take excess water from that field to a safer place, from where it is disposed to stream or nalla through grassed water ways. The grassed water ways are kept permanently and help in the drainage. These channels and grassed water ways are positioned in such a way that they do not hinder any agricultural activity such as ploughing, hoeing and harvesting.

3.8 Water storage

In the hills, rains are erratic and torrential. Relatively high percentage of rain water goes as run-off and stream flow. It carries fertile soil and plant nutrients which makes the soil degraded and barren. Roof water and surface water during rains is collected in dugout structures known as "diggi" in Kangra district and "'Khati" in Hamirpur and Bilaspur districts. These structures are dug in hard rocks. In some areas, excess water is stored directly in the farm ponds and depressions. The stream flow is diverted to safer points where it is stored. The stored water is used for irrigational purposes, as a life saver or for supplementary irrigation during lean periods. It also serves drinking water needs of humans, livestock and other domestic purposes

Harvesting of water is also done by constructing water ponds and water is collected in these ponds from melting snow. The ponds with time are sealed, with silt and clay particles thus infiltration/percolation losses are reduced and ponding time and volume of water is increased. Some vegetations are specially useful in reducing percolation losses. In Ladakh a popular practice is to use Pang grass is as the inner lining of zings (water ponds) and kuhls for checking percolation losses. The non-permeability properties are found similar and even claimed better by some farmers to that of polythene sheet or cement lining. In Kinnaur, covering the surface of soil with chilgoza tree needles and grass from the Kandas (hill tops) is a common mulching practice. Mulching conserves soil moisture in the fields. It also helps in the moderation of soil temperature. In this way hydro-thermal regime of soil is improved. However, the continuous use of chilgoza tree needles is seen to increases the acidity of the soil.

4. Meeting Water Crisis: The Path Ahead

Larger parts of India have already become water stressed. Rapid growth in demand for water due to population growth, urbanization and changing lifestyle pose serious challenges to water security. A holistic and inter-disciplinary management approach to water related problems had to be adopted. The water management in India must include following measures:

- Groundwater, a community resource, is perceived as an individual property and is exploited inequitably and without any consideration to its sustainability leading to its over-exploitation in several areas. Social and legal frameworks can be adopted to change the use consciousness among people.
- There is wide variation in availability of water, which may increase substantially due to climate changes, causing more water crisis and incidences of water related disasters, i.e., floods, increased erosion and increased frequency of droughts, etc. A pragmatic planning is needed to avoid the damages yhat may be caused to life and property.
- Climate change may also increase the sea levels. This may lead to salinity intrusion in ground water aquifers / surface waters and increased coastal inundation in coastal regions. Ecofriendly programmers and practices are the need of the hour.
- Access to safe drinking water still continues to be a problem in some areas. Skewed availability of water between different regions and different people in the same regions is has the potential of causing social unrest. Water distributions schemes need to be framed with objective of drinking water for all.
- Inter-State, inter-regional disputes in sharing of water hamper the optimum utilization of water through scientific planning.
- The existing water resources infrastructure is not being maintained properly resulting in under-utilization of available resources. Upkeep and maintenance is essential.
- Growing pollution of water sources is affecting the availability of safe water besides causing environmental and health hazards. The pollution sources need to be scientifically managed.

5. Water Resources Management & Internet of Things

The digital space technology has witnessed major transformations in the last couple of years and as per industry experts would continue to evolve itself. The latest entrant to the digital space technology is the Internet of Things (IoT). IoT can also be defined as interplay for software, telecom and electronic hardware industry and promises to offer tremendous opportunities for many industries. The Internet of Things (IoT) is driving new consumer and business behavior that will demand increasingly intelligent industry solutions, which, in turn, will drive trillions of dollars in opportunity for IT industry and even more for the companies that take advantage of the IoT. The number of Internet-connected devices (12.5 billion) surpassed the number of human beings (7 billion) on the planet in 2011, and by 2020, Internet-connected devices are expected to number between 26 billion and 50 billion globally. The Indian Government's plan of developing 100 smart cities in the country, for which Rs. 7,060 crores has been allocated in the current budget could lead to a massive and quick expansion of IoT in the country ***(Draft Policy on Internet of Things-DeitY, 2015)***. Also, the launch of the Digital India Program of the Government, which aims at 'transforming India into digital empowered society and knowledge economy' will provide the required impetus for development of the IoT industry in the country. IoT offers avenues for telecom operators & system integrators to significantly boost their revenues and this has resulted in their taking lead in adoption of IoT applications and services being offered by the technology. Apart from direct IoT applications, the IT industry also has an opportunity to provide services, analytics and applications related to IoT. Internet of Things involves three distinct stages:

- the sensors which collect data (including identification and addressing the sensor/device)
- an application which collects and analyzes this data for further consolidation and
- Decision making and the transmission of data to the decision-making server. Analytical engines and Big data may be used for the decision making process.

The key stakeholders in the Internet of things initiatives would be the citizens, the government and the industry. Participation and collaboration of each of the stakeholder at an appropriate stage is essential. At this juncture, we require policies for promotion of IoT and selection of e essential domains and then emphasize on building answers for 'what Data will Service the Citizens'. Internet of Things should clearly strategize with a simple goal of 'Value Up' and 'Cost Down' models. With industry collaboration, experiences from global forums, learning's from other countries who are leaders in IoT, active participation of global partners will help us induce more innovation driven approach. Key to success of Internet of Things would be in building open platforms for ease of use and low cost, building scalable models and using citizens as sensors. Data needs to be openly collected and shared between cross functions to bring out maximum benefits. Participation of start-ups at this stage will help us devise some innovative methods/ concepts which could be cornerstones for the upcoming overall 'smart concept'.

Fortunately, internet technology and AI have stepped in to revolutionize the commercial water purification space. Users in water sensitive segments such as food services, hotels, schools, offices and hospitals now have a fool proof way to ascertain the quality of water being purified in real time, and ensure the safety and wellbeing of their customers. The biggest advantage of AI for water is complete transparency over purity of water. Internet water users can also be relieved from ongoing expenses of consumables and spare parts. This is where AI for water makes a difference. We can develop also a ICT (IoT & AI) based commercial water purification (RO+UV) services to the rural and urban India that give us a continuous flow of pure water 24x7 and report performance and purity to us in real-time. The ICT (IoT with AI) purification plant with sensors continuously may monitor vital water quality parameters and plant performance 24x7 and sends this data to the internet based engine. The engine will send this data further to an AI system which receives this data and analyses it, using deep learning proprietary algorithms to ensure that the water is absolutely pure. The IoT and AI based systems even may detect minor abnormalities which signify potential problems in the making. Performance alerts detected by the AI system are automatically routed to the nearest field support engineering team based on the GPS location via the AI based engine. Faults or even potential faults may be resolved before they lead to a breakdown in the system. As the world is getting interconnected, Internet technology with AI can surely enable smart water management for water usage by sectors and give absolute clarity on water. AI for water presents an opportunity for water purification sector to optimize their current systems ensuring that every drop of water is absolutely pure. In return, complete transparency and assured purity are available 24x7 to the user for bringing both certainty and peace of mind to the user.

Summary

In order to address India's water problems, it is important to understand that the roots of the current water crisis do not lie in a deficient or delayed monsoon as is being made out by the Indian media. In fact, it is years of government neglect, wrong incentives and outright misuse of the country's water resources which has led to the current crisis. Moreover, it is important to understand that climate change would exacerbate India's current water scarcity in the coming decades. According to a report by the World Bank, a global mean warming of 2°C above pre-industrial levels, the mismatch between water demand and supply will increase dramatically and will have serious implications on India's food security. Although, the country has witnessed a dramatic increase in water demand for all uses: agricultural, industrial, and domestic, agricultural irrigation accounts for 90% of India's freshwater withdrawals. Therefore, any serious effort towards water management in the country should focus on the management of agricultural irrigation in India. India's annual agricultural water withdrawal is the highest in the world followed by China and the United States. Over the years, India has witnessed a major shift in the sources of irrigation. The share of canal irrigation in net irrigated area has declined rapidly and groundwater irrigation now covers more than half of the total irrigated area. It is this overexploitation of groundwater resources, more so, in the north-western part of the country which is one of the main reasons for India's water crisis. Moreover, groundwater is used to cultivate some of the most water intensive crops like paddy and sugar cane in states like Punjab, Uttar Pradesh, and Maharashtra. Rice, which is India's main food crop consumes about 3,500 litres of water for a kilogram of grain produced.

The most important crops of India like rice, wheat and sugarcane, are the most water consuming crops. Rice which is a major export crop, consumes about 3,500 litres of water for a kilogram of grain produced. Punjab, which is the third largest producer of rice, is completely dependent on groundwater for the production of rice. Although, the state fares well in terms of land productivity, it is way behind the eastern states in terms of water productivity. Punjab requires 2-3 times as much water as Bihar and West Bengal to produce a kilogram of rice. State procurement policy and subsidised electricity makes it profitable for farmers to produce rice whereas farmers in states like Bihar, West Bengal, Assam, and Tripura which are better endowed in terms of rainfall lack these incentives. Unfortunately, India has emerged as a major exporter of rice which means a water scarce country like India is actually exporting millions of litres of water annually. Same is the story of sugar cane, another water guzzling crop in Maharashtra. Farmers in Maharashtra cultivate sugar cane using groundwater because they are assured of marketing by the sugar mills whereas Bihar which is more suitable for the production of sugarcane only produces 4% of the country's total sugar cane output. Therefore, state governments should encourage cultivation of less water intensive crops like pulses, millets and oilseeds in water stressed regions and water guzzler crops, particularly rice should be grown only in water rich areas. In addition to the faulty cropping pattern, water use efficiency in agriculture is also very low. Flood irrigation is the most common form of irrigation in India which leads to a lot of water loss.

In order to avoid the doomsday when we actually run out of food and water, the country needs to introduce a slew of measures immediately. Firstly, as explained above, the northwestern and central part of the country which is severely water stressed should stop producing water-intensive crops like rice and sugar cane. Farmers should be given adequate incentives to switch to shift to crops like millets which require much less water and are climate resilient. Secondly, the spread of drip and sprinkler irrigation systems should be increased rapidly with state support. Thirdly, new agronomic practices like sub-surface irrigation, raised bead planting ridge-furrow method of sowing, and precision farming etc which have the potential to reduce water-use in agriculture should also be adopted.

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