ISSN 0976-0628

Chetana's

Institute of Management & Research

Volume XII , Issue I

March 2020

Journal of Management Research

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Editorial.....

Dear Readers
Greetings from CIMR

It gives me great pleasure in presenting to you the March 2020 issue of CIMR's Journal of Management Research. This Issue (No. I) is a compendium of various articles that were presented in our International Conference on the theme of "A Water Secure World" held on 18th January 2020.

Water conservation is vital for reducing the global burden of disease and improving the health, education, and economic productivity of the population. Water scarcity affects more than 40 percent of the global population. One thousand children die every day across the world due to preventable water and sanitation-related diseases.

Some 829,000 people are estimated to die each year from diarrhea because of unsafe drinking water, sanitation, and hand hygiene. Yet diarrhoea is largely preventable, and the deaths of 297,000 children aged under 5 years could be avoided each year if these risk factors were addressed.

Women and children have to trek miles every day to retrieve water. This hard manual labour takes time that they might otherwise spend pursuing education or earning additional income.

Integrated demand and supply-side management, the creation of local infrastructure for rainwater harvesting, groundwater recharge, and household wastewater management are the prime focus areas for water security. Tremendous efforts need to be made to ensure that the taps in the country do not run dry and that the water is safe to drink.

In this issue, some papers focus on the methods to create awareness about the water problem in different groups and then provide some solutions that may help in the effective usage of water, more so in day-to-day activities, and reduce the water-related problems.

Water cannot be easily created and it cannot be substituted as far as human needs are concerned. It is believed that the water crisis could even lead to a war-like situation if we do not take the problem seriously. Therefore, we need to look at ways and means for optimum utilization of water. The paper presents the problem and the various means and measures that can be taken to overcome the water crisis.

There are other papers on varied topics like treatment and reuse of wastewater in a decentralized system & Quality-monitoring mechanisms.

It is indeed a great pleasure being an editor for the March issue of the journal. We attempt to bring forward articles of significance and academic rigor to enrich the reading experience.

Dr. Rajiv Gatne

March 31st 2020

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ISSN – 0976-0628

ISSN: 0976-0628

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Institute of Management & Research

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A Conceptual Analysis of Water Security Challenges and Sustainable Practices in the Indian Context

* Dr. Indira Singh

Abstract

The present article delves upon challenges and stress faced by India in water resources management. The analysis is based on an exhaustive review of literary contributions in the domain. Analysis of several issues pertaining to water security have acquired importance recently, as the usage of water has been increasing worldwide by about 1percent per year since the 1980s, this increase is driven by a combination of population growth, socio-economic development and changing consumption patterns. The demand for water is expected to continue increasing globally at a similar rate until 2050, accounting for an increase of 20 to 30 percent above the current level of water use. This is mainly due to the rising demand for water in the industrial and domestic sectors. Over 2 billion people living in countries such as India, experience high water stress. It is reported that about 4 billion people experience severe water scarcity for at least one month of the year (UN, 2019). Stress levels will continue to increase as demand for water grows and the effects of climate change intensifies. The paper contends that there is potential for India's water security challenges to aggravate further, thereby impacting the quality of life and contribute to various regional issues. An attempt is made to understand the stated concept and the factors that are contributing towards criticality of the resource.

It is concluded that if the current trends continue, more than 100 million Indians will soon face a desperate water shortage, in various human areas such as domestic, agricultural and industrial. This will contribute to serious implications for longer-term food security, livelihoods and subsequent economic growth.

The article gives a clarion call to people and government to jointly initiate good practices with partnership and attempt to capture and implement a unique range of demonstrated, cost effective and sustainable community-led solutions to adequately meet the challenges of water security. These practices cover multiple dimensions of community empowerment, water management systems, water entrepreneurship, management of indigenous knowledge, and development of safe water and sanitation models (UNDPR 2018). The intention of the present article is to stimulate debate and action

Keywords: *Water Security, Concept of Water Security, Water Security Challenges, Sustainable Practices*

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INTRODUCTION

Water is the toughest challenge and water security is posited as the most prominent challenge in the 21st century (Ghosh, Kansal, & Aghi, 2019). The challenge runs across multiple dimensions and cuts across societal divide. The problem is arising in various areas like that of drinking water, food production, climate risk and the overall quality of life on the planet. Securing water, therefore resulting in water security, is a central policy concern for successive governments because of the essential role that water plays in varied areas of human existence and endeavour. Since the water cycle is global phenomenon, the availability of water uses and resultant water security, cuts across local and regional boundaries. Water security across the globe is under severe pressure because of population explosion, shifts of people from rural to urban areas for livelihoods, impact of dietary changes, pollution of existing water resources, the general dependency on groundwater compounded by environmental issues created by climatic changes.

Also, it cannot be denied that water is life, since flora and fauna cannot exist without water and sustain biodiversity. Water provides nourishment to life and life forms. Despite the fact that India is a water rich nation, this resource is turning into a rare entity because of the pressure from increasing population and misuse of this critical asset. This is a cause of critical concern throughout the world. India is almost powerless on account of unchecked water wastage.

Scholarly focussed attention on this resource is definitely needed. The objective of such attention should be to generate empathetic enquiry towards understanding water needs of the people from diverse areas of human existence. It is reported in literature that more than 70 per cent of the world is covered with sea water. Fresh water is only 3 per cent. This is divided into two-thirds in the form of icecaps and glaciers. Lastly, 1 per cent is found as ground water (Thapliyal, 2011). As a result, almost less than 1 per cent of fresh water is available in rivers and lakes for human usage (Ohlsson, 1998). Hence, because of population growing at a compound rate and the emergent consumption pattern witnessed in agriculture and industrialisation, it is seen that the demand on water is on the increase.

This calls for prompt action by the government at the policy level and other partners to utilize the available resources of water in order to guarantee better quality of life to the people and livelihood opportunities for the people of India.

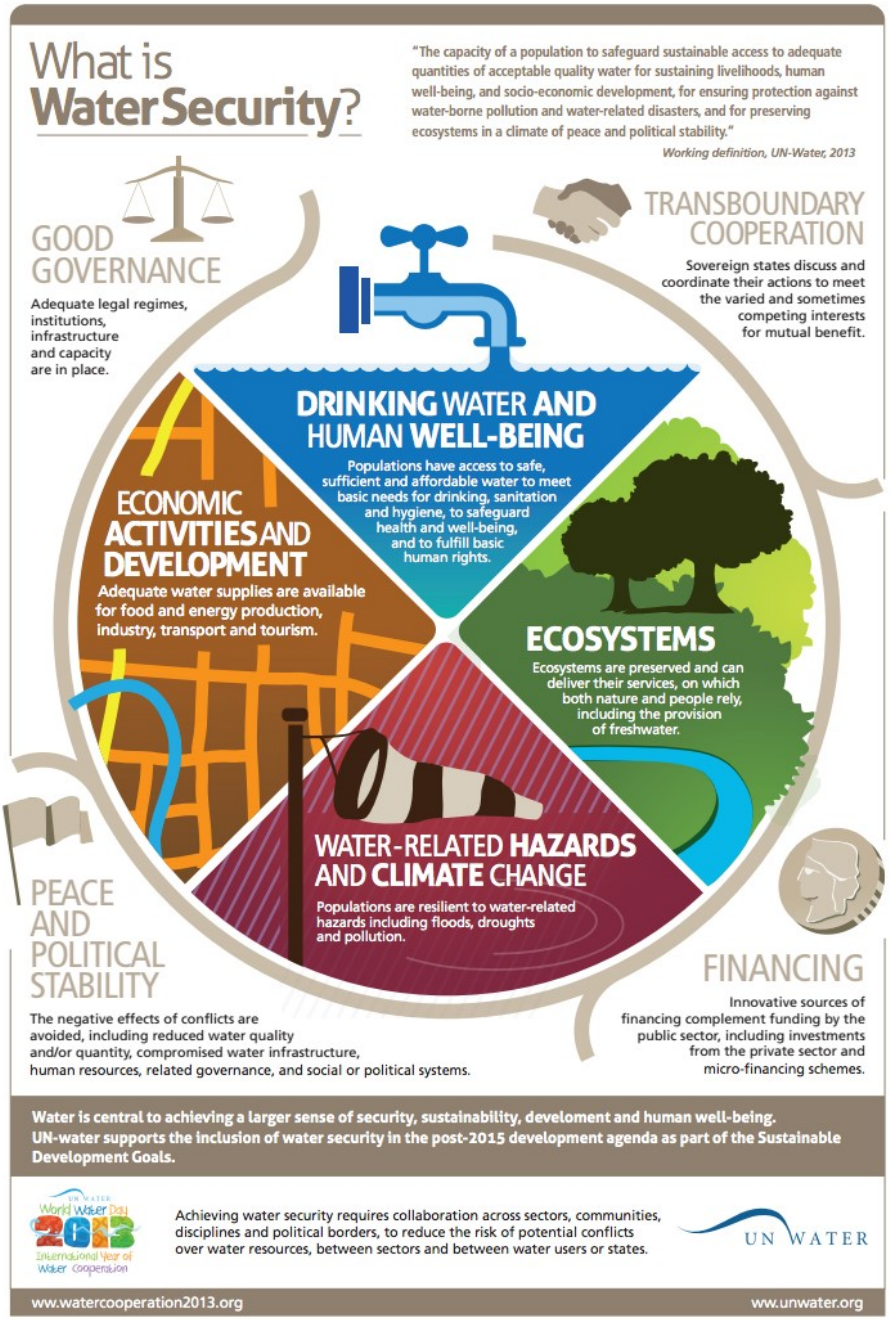
THE CONCEPT OF WATER SECURITY

From an academic point of view, water security implies affordable access to clean water for agricultural, industrial and household usage. It is therefore an important component of human existence and security of life. It is a part of the new security agenda of nations along with food and energy. It is also the basis of long-term planning in countries across the globe cutting across regional boundaries.

A quick review of literature revealed that the concept of water security is operationalised by different authors and interpretations varied according to the geographic regions which they studied, and the aims & objectives of their research studies commensurate with specific research questions. This diversity in definitions means that various stakeholders are using this concept in widely different ways as potential benchmarks for reducing water insecurity. In most cases, users of the concept have modified the conceptualization to fit their own particular context of study and visualization (Gerlak, et al., 2018).

The concept of water security in the present study has been defined as *"The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability."* (Working definition, (UN, 2013)

Illustration 1: Conceptual Framework Depicting Water Security



SOURCE: UN Water 2013

The above definition was proposed by UN (2013) Water report. The same has been adopted in the present paper to serve as a starting point for further conceptual deliberation of the concept. To move towards a water secure world, it is a demand that economic, social and further environmental sustainability is provided rather guaranteed to the people. At the same time the varied risks and threats related to the issue of water should be brought to the forefront and discussed for solutions.

With respect to India, water security implies effective responses in terms of initiatives to the water conditions that are always in a state of flux, and in turn, uneven distribution of the precious and scarce resource is available for usage to humankind. The issue of water security has become a matter of serious concern as the water levels going down because of rampant usage of groundwater, and deterioration in its quality, by the day. There is major dependency on ground water in the country for various kinds of usage, both domestic and industrial. It is observed that the quality of groundwater is falling due to various geogenic and anthropogenic sources. This is also hastened by a few other contributing factors such as waterlogging, salinization of water and soil, and degradation in the composition of surface water and ground water.

CRITICAL ISSUES PERTAINING TO WATER SECURITY

1. Depletion of Water Levels Across the Country

The country is witnessing the phenomenon of depletion in ground water levels all across, due to rampant misuse of water for industrial, agricultural and domestic purposes. The report published by Fifth Minor Irrigation Census Study corroborated this and stated that the groundwater level in India has declined to the extent of 61 percent between the years 2007 and 2017. This has had a direct impact as the reduction of water levels in the country poses a grave threat for sustainable management of water supply and ensuing water security. Reason being that the available water supply would still reduce with decreasing ground water levels. Also, environmental research has established that the quality of groundwater deteriorates as water levels and water table decline. Thus, if levels of ground water continue to decline, both quantity and quality of water, will also bear the brunt, and thus have a major impact on overall water security. Therefore, the two most important attributes impacting water security, which are quality and quantity of ground water should also be examined and protected.

2. The Issue of Waterlogging and Increasing Soil Salinization

The rising water levels because of climate change and salinization of water are also contributing and emerging as a serious threat to water security. As a result, safe drinking water supply to the public is impacted. To tackle the issue, a holistic approach needs to be adopted by the government for lining of canals, streamlining surface and subsurface drainage channels and amalgamated usage of surface and groundwater (Singh, Srivastav, Kumar, & Chakrapani, 2014).

3. The Issue of Declining of Potable/Arable Water Quality

The phenomenon of worsening quality of groundwater mainly due to documented causes is a prominent matter of concern and a serious issue pertaining to robust water security. The impact of the poor quality of groundwater on human health is being faced by the state of Punjab prominently because of the evidence of toxic elements like uranium, arsenic, sulphates and fluorides in groundwater majorly in deeper aquifers from where drinking water supply is sourced (Sharma 2015)

According to the report (Charting Our Water Future, 2009) released by International Water Resource Group (IWRG), it is posited that in India the low agricultural water productivity and efficiency when combined with very old supply infrastructure, would make severe supply-demand gaps likely in many basins with currently planned crop choices for the farming community in general. The report also projected that aggregate water demand is expected to double from the current level of about 700 billion cubic metres to 1498 billion cubic metres by the year 2030. With the estimated available supply of about 744 billion cubic metres by then, the water gap is projected to be about 50 per cent. This gap would further widen with a rapid increase in the ever-increasing requirement of water supply for agricultural activities, along with a limited water supply and storage infrastructure support available then.

A REVIEW OF SUSTAINABLE WATER MANAGEMENT PRACTICES LEADING TO WATER SECURITY

It is well established that water security is essential to humankind as it supports various areas of human existence, environment, public health, reduced disaster risk and overall political stability. In this section some well documented measures leading to robust water security are delineated.

1. Government Plans to Increase water storage capacity

For increasing storage capacity, it is suggested that farm ponds construction, percolation tanks, building water reservoirs and construction of small and medium size dams on rivers should be initiated. These measures can retain more surface water, while increasing the ground water recharge in the designated area. Also, work on constructing a series of contour bunds particularly in undulating areas will contribute towards facilitating percolation of water in the soil. This will also contain and hasten the subsequent rise in the ground water table, while reducing soil erosion at the same time. According to National Water Policy 2019 document, method of gully plugging along with construction of several small dams in series on rivulets will aid in storage of water in reservoirs resultantly recharging ground water in the process.

2. The Government Initiative on Interlinking of Rivers

According to (Ministry of Jalshakti, 2019) document, interlinking of rivers traversing the country will assist in preventing repetitive floods also improving distribution of water across the country. This method would control the water run, floods, and will also help prevent erosion of soil. Presently, billions of tons of fertile soil along with valuable nutrients are washed out of our fertile agricultural lands and forests because of the resulting soil erosion. The data available in the report states that the amount of nutrients that are lost due to soil erosion is almost comparable to the production of chemical fertilisers in the country.

3. Encouraging Efficient Irrigation Practices

Efficiency in irrigation practices adopted by the farmers is most essential, if the country wants to adequately tackle the challenge of securing water. In India as most of the crops are irrigated through the flood irrigation system, almost over 70 percent of the water used for irrigation is thus wasted. Also, since the water supplied to farmers is not measured in quantitative terms, farmers have developed a tendency to flood the field with excessive water as they do not have to bear additional cost of water. Such inefficient irrigation practices contribute to creating a negative impact on water security. This is because of increased cost of leached nutrients, ground water pollution, soil salinity increase, and increase in incidence of pests and diseases. It is high time that India forces the farmers to adopt

micro-irrigation systems. Such systems will not only reduce the water requirement by farmers but also bring down the cost of farm production, while increasing the overall area under irrigation.

4. Towards Development of Watershed Areas

Watershed Development Programme is an important programme launched by the government to harness the rainwater for agricultural purposes, while at the same time contributing to improving conservation of soil and enriching the existing biodiversity. This has resulted in certainty in water supply to farmers in rain fed areas. As part of this programme, the catchment area of a basin is considered as a unit. Efforts are made to bind rainwater by treating the portion of land between the ridges to the valley. It is estimated through a government survey that over 63 percent of the cultivated lands in the rain fed areas need to be brought under watershed development programme to conserve soil and water, which in turn would improve the crop yields as well as ground water table. Watershed development programme, introduced almost about three decades ago by the government, has covered over 51 million by the end of the Tenth Five Year Plan as per report (Ministry of Jalshakti, 2019).

5. Initiatives to Control water pollution

This is another measure to reduce the excessive use of water for agriculture, industries and domestic uses which is contributing to water pollution, as excess water is getting transformed into saline water, sewage or effluent. Thus, necessary rewards and punishments should be introduced for persuading and compelling people to make optimum use of this precious resource. Discharge of sewage and effluent into water bodies and rivers must be banned, and recycling of waste water must be pursued and enforced through policy. This will contribute to keeping the water sources clean and containing the future demand for water thereby contributing to water security. Treated sewage and effluents can be directed and used for agriculture and industrial production.

6. Desalination of Sea Water Project:

Since over 70 percent of the global water resources are reportedly saline, economic desalination of sea water is an excellent option to meet the future shortage of sweet water particularly to meet the human consumption. Presently, the process of desalination of sea water is rather expensive and not a very popular method of choice. However, with the usage of solar power, the process of desalination can be a viable alternative to meet the water needs of people in coastal and adjacent areas.

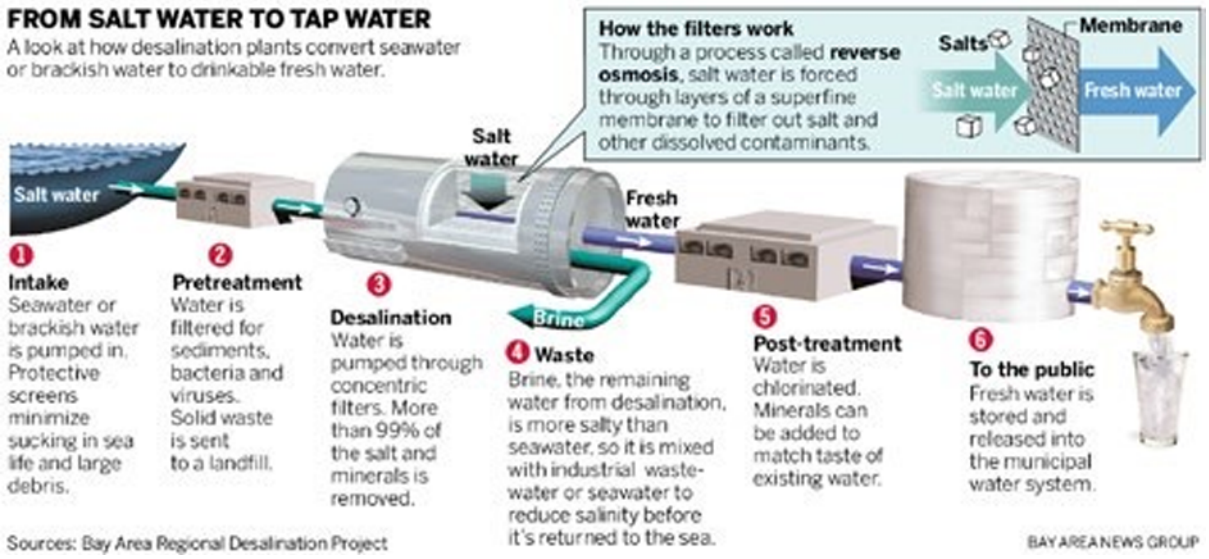
7. Investment in Research and development initiatives

There is a need for investing in research, related to ground water monitoring, weather forecasting, breeding and developing water efficient and drought resistant crop varieties that can cope up with the changing climatic conditions, arising due to global warming.

8. Making Tree-based Farming Practices Popular

Tree-based farming as a workable solution offers great potential in the areas covered under the watershed development and wastelands development programme. The reason for the same is that trees require less water and can withstand water stress for more and longer periods of time. There are many methods available to select based on desired tree species, soil productivity, moisture availability data and the specific local needs of the area. It is but obvious that shallow drylands can be covered with shrubs and grasses. Also, deep, fertile lands can be used for growing fruit crops for generating more economic value. This programme has become very successful in rehabilitation of over two lakh tribal families across the country as per

ILLUSTRATION 2: DESALINISATION PROCESS



available BAIF data.

9. Development of Wastelands across the Country

This pertains to reclamation of sodic lands, and is yet another important programme that needs to be pursued, as over 9 million hectares of good quality fertile lands are lying idle because of presence of high salt content. Methods for efficient reclamation of these infertile lands will bring the area under multiple cropping patterns. This will make available surplus water to bring additional 8-10 million hectares under irrigation. This practice can enhance food production to the extent of 50 million tons per year.

10. Livestock and Dairy Initiatives

This is yet another method to bring about water security. Animal Husbandry is a major sector requiring water for feeding livestock and also to produce fodder for them. However, as over 75 percent of these animals are of inferior quality and it is practice followed by farmers to let them loose in the field for free grazing. This leads to denudation of vegetation and contributes to substantial soil erosion. Research (BAIF Development research Foundation) has demonstrated a new approach of improving the productivity of these animals which will motivate the farmers to take up stall feeding for reducing the herd size of animals domesticated by them. Method of dairy husbandry is one of the most reliable sources of livelihood for small and marginal farmers. These farmer families maintain 2-3 good quality cows or buffaloes and therefore are generally able to come out of poverty.

11. Training Initiatives

United Nations University Institute for Water, Environment and Health (UNU-INWEH) has partnered with CATHALAC (UN, n.d.) to develop a knowledge based, online training course on water security. The Global Water Security course is being developed in response to the growing need to understand the complexities of water security issues outlined in (UN, 2013) UN-Water's Analytical Brief: Water Security & the Global Water Agenda. As water security becomes a mainstream and relevant concept it will become increasingly impor-

tant to educate water-related professionals and public servants with information and activities that can be used to achieve water security at the local level.

CONCLUSIONS

The quick review of related literature undertaken for the study has highlighted that apart from the increasing water scarcity and related issues, India is also facing the challenge of addressing growing disparity in populations' access to water resource bodies too. This is continuously compounding the problem of water scarcity and distribution. Water supply services for irrigation purposes for agriculture, and potable municipal water supply is impacted because of poor water quality that is available. It is observed that, the resource poor bear the brunt of the growing water scarcity and access to potable water. With regard to inequity in access, the resource institutional mechanism's lacuna, a key factor emerges. With respect to surface water from catchments areas governmental regulatory framework needs to be drawn and communicated. India needs to conserve its water resources and water bodies, rivers etc as a first step towards securing water.

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ISSN: 0976-0628

Chetana's
Institute of Management & Research

Vol XII Issue 1 : pp 9 - 16

Water Management – *An Empirical Study*

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Abstract

Water is a very precious natural resource and the very reason for our existence on this planet. With the steady growth in the global population, the overall requirement of water is also increasing. Providing safe and adequate water to every person has become a challenge for every governing body.

The per-capita water requirement also has grown due to various gadgets used by households and manufacturing units like cleaning machines, washing equipments, etc. Failure to pursue water conservation methods at individual, community and state levels makes the problem even more acute

Water cannot be easily created and it cannot be substituted as far as human needs are concerned. It is believed that the water crisis could even lead to a war-like situation if we do not take the problem seriously. So we need to look at ways and means for optimum utilization of water

This paper endeavours to study the problem and the various means and measures that can be taken to overcome the water crisis.

Keywords: *Natural Resource, Water Crisis, Water Conservation*

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INTRODUCTION

Nearly three-fourths of our planet earth surface comprises of water (71 percent) and this has remained nearly constant over the years. The total volume of water on Earth is estimated at 1.386 billion km³ Most of this water is contained by oceans around the world which is about 96.5 percent of the total water. This water is saline and as such the salt present in the water makes it unsuitable for direct use. Huge quantities of water are also present in Ice and snow, frozen in mountains, Antarctica, Greenland, Artics. This water is in pure form and potable. The access to this water is difficult. With the increase in global warming phenomena. It is believed that the melting of these ice is likely to raise the water level in the world's oceans to an alarming level, leading to submerging some of the coastal cities in the world. Water is also available as groundwater which is partly saline and partly fresh. The other sources are lakes, rivers, atmosphere and which is mostly freshwater suitable for human consumption.

Source	% of total water	Type	Accessibility
Oceans	96.5	Saline water	Easy access to coastal areas
Ice and Snow	1.76	Fresh water	Very Difficult
Groundwater	1.69	Both saline & Fresh	Comparatively easier
Lakes	0.013	Fresh	Easier
Rivers	0.00015	Relatively fresh	Easier
Atmosphere	0.00093	Fresh	Very easy

Source: *Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources (Oxford University Press, New York) and NASA Earth Observatory*

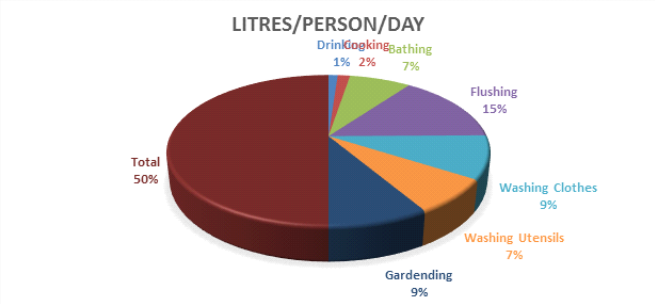
On the other hand, we receive abundant water in the form of rainfall, the world over and only a small proportion of this is utilized and rest is allowed to go waste. Estimates vary, but, on average, each **person** uses about 80-160 litres of **water per** day, for indoor home uses.

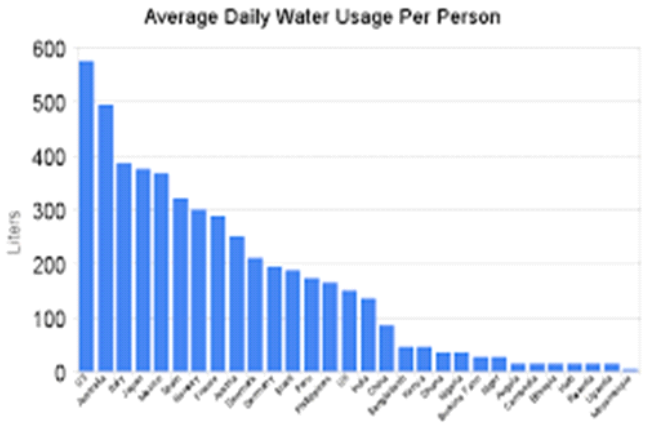
Purpose	Litres/person/day
Drinking	3
Cooking	4
Bathing	20
Flushing	40
Washing Clothes	25
Washing Utensils	20
Gardening	23
Total	**135**

Source: *Prescribed by the Central Public Health and Environmental Engineering Organisation (CPHEEO) Jun 4, 2008*

It is obvious from this that the problem we face is not dwindling water availability but the problem of water management. Because water is still available, at most places at a reasonably low rate we are not too concerned about economizing its use, the way we do for other utilities like electricity, gas that we use more conservatively because of a higher price per unit.

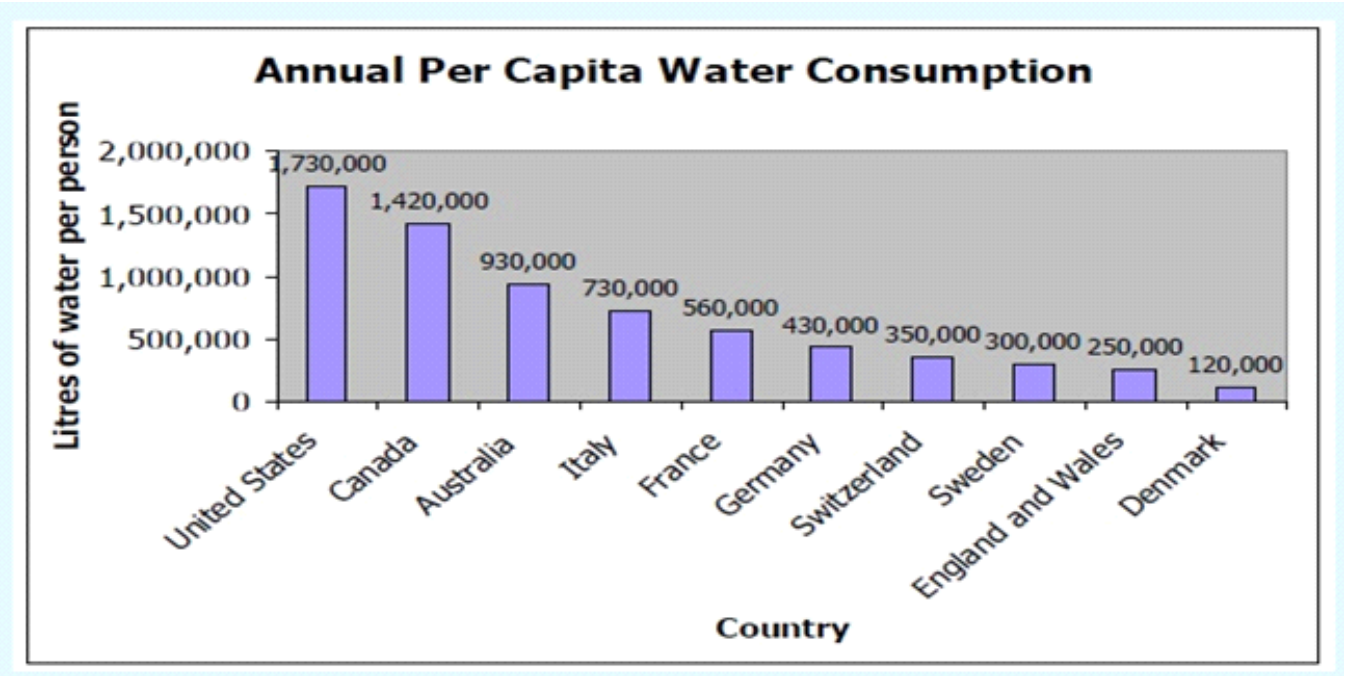
Apart from the lower cost per unit of water, the





major reason for its reckless use is the method used for billing of water to users. Unlike electricity, gas, phone, cable TV, etc wherein every user has to pay based on actual consumption or use of the utility. The billing of water is done at a flat rate to every household irrespective of the actual use. So if only one person is staying in a house or ten members the same amount is to be paid irrespective of the consumption of water. Thus there is no incentive to economize on the use of water or any penalty for excess consumption or wastage of water.

The water requirement of a typical household can be divided into two categories one is potable for drinking and cooking purpose and the second is for cleaning purposes. The potable water comprises about ten percent of needs and the second category required for cleaning which comprises the bulk of the water needs.



Source: *The statistics from the Organisation for Economic Co-operation and Development (OECD)*

OBJECTIVES OF THE STUDY

- To understand the fundamental problems associated with water management
- To suggest ways of improving the effectiveness of water usage
- To overcome the water crisis through optimization.

Methodology:
The study is based on observation, surveys and secondary data analysis

Overview:
The water we get in sourced from
- Lakes for places having access to such resource
- From rivers
- Bore Wells

The water from these sources is first purified by various treatments and then supplied to households and commercial users like factories, offices, hotels, malls, and other establishments. The water supplied to residential users is highly subsidized, whereas the water for commercial users is at a much higher rate ie nearly four times the domestic water charges The water contained in icebergs and frozen at the poles and Antarctica is mostly in pure form. The water received from rainfall is relatively pure. However, the water available from other sources needs to be treated and purified before we can make it usable or potable.

Water is abundantly available from the following sources

- **Ice-Bergs:**

Enormous quantities of frozen water are present in ice-bergs. The water is in pure form and quite suitable for human use without much treatment. However to access the water from the icebergs and economically transporting of this water vast distances is not possible presently.

- **Seawater:**

Plenty of sea water is also available and transporting of this water is also not a problem as many coastal cities have easy access to seawater. However, the water is having high salt content. To use this water, desalination plant has to be set up which is expensive. The corrosive nature of seawater because of its salt content makes it difficult to use for cleaning and for purposes other than drinking.

- **Rainwater:**

Most places on earth get a reasonable amount of rainfall. This water can be harvested and used later. Primarily this water can be used for cleaning purposes without any treatment. The government can also make artificial ponds for holding water or large water tanks capable of storing water which otherwise goes waste. Also when there is excess rainfall it causes flooding and inconvenience to people. Making water holding ponds or tanks can be very beneficial. The Karnataka State Council for Science and Technology (KSCST) has undertaken steps to promote, put into practice and create awareness on sustainable water harvesting and groundwater recharge concepts. 'Rainwater harvesting in rural Karnataka' funded by Rural Development and Panchayat Raj Department (RDPR), Government of Karna-taka is probably the largest rainwater harvesting project in the world.

- **Air:**

Water is present in the air in the form of water vapour. To extract water from air, machines have been developed. To make water from air Atmospheric water generators can be used. These are available in various capacities ranging from twenty-five litre/day machines to five thousand litres per day. But the limitations are, these can operate only if the water content in the atmosphere i.e. the humidity in the air is more than twenty percent.

However, the cost of the generators is very high. A twenty-five litre per day machine may cost as much as rupees forty-five thousand to seventy thousand. A thousand litre per day machine may cost up to rupees ten lakhs. Also, these machines need electricity to operate. Some of the machine manufacturers are a) Air-O-Water b) AKVO 55K c) Maithri Aquatech d) Bharat Electronics - Atmospheric Water Generator. The capacity of these units range from 1000, 2000, 5000 and 10000 litres per day.

FINDINGS AND RECOMMENDATIONS

To address the possible water crisis in the near future a concentrated all-out effort is needed by all, the government authorities at the centre and state level, district and city level and lastly the locality and individual household users. Some of the measures are as follows:-

i) Government:
Policies should be framed to make conservation of water and harvesting of rainwater mandatory, especially for new construction. Completion certificates to buildings should not be issued unless proper infrastructure for water harvesting is in place. Further regular check-ups should be made to ensure that these are always maintained and functional. Adequate penalties to be put for non-maintenance of these

ii) Treatment Plants:
Units need to be set up like seawater desalination plants, or plants where adequate fresh or good quality water is not available.

iii) Recycling Plants:
Recycling of water can help in reducing total consumption. So water discharged from saying utensil cleaning and clothes washing machines can be used for gardening or cleaning of floor or flushing tanks.

iv) Prevent Leakages:
Pipes transporting water from reservoirs to housing complexes or end-users lead to lots of wastages. Sometimes these leaks are made intentionally by slum dwellers who are residing nearby these pipes as they get easy access to free water near their residences. Plucking these wastages will help in the misuse of water. Leakages inside the residence in the form of leaking taps, overflowing water, or keeping taps running when other tasks are being done, lead to a lot of wastage.

v) Wasting water:
While washing utensils, etc, avoid using running water, preferably use water tubs. Taps should not be kept running while some other activity is being done, like brushing, shaving, applying soap, powdering utensils, For bathing shorter shower baths using low flow showerheads, should be preferred as it economizes the usage of water. Water tubs or swimming pools should be avoided to reduce consumption. Defrosting frozen items should also not be done under running water. Leakages should be immediately rectified. Flushing of toilets should be restricted and use dual flushing models for toilets. Watering plants excess usage of water to be avoided, sprinklers, drip watering system

vi) Redistribution of Water:
As water bodies are not uniformly distributed, arranging water availability based on the demand of particular areas or regions, the scarcity can be reduced. Making huge water tanks to store excess water, which can be used later to overcome shortage. Another option could be to construct canals to connect various water sources so that water can be moved from surplus areas to deficit regions.

We can also use the system to store rain water in the reservoirs and later use it for farming, industries and other regions where there is a need

vii) Rational Use of Groundwater:
Nearly one-fourth of the water requirement is sourced from **g**roundwater and rest by lakes, rivers. High usage of groundwater results in a corresponding decrease in the stock of groundwater. Re-infiltration of groundwater takes a very long time. Limiting the use of groundwater should be encouraged to maintain the levels of groundwater. In India, the groundwater is used largely for agriculture. We should discourage growing crops needing more water because of their commercial value thus depleting the groundwater stock further. A conscientious use of groundwater can help in water conservation. Crops needing lesser water should be preferred over crops requiring more water. Lesser water should be used by industries and for recharging ground-water, drainage area necessary should be made available.

viii) Population Control:
Population increase leads to more water requirement. Thus, it becomes pertinent to control the population growth rate.

ix) Renovation of Traditional Water Sources:
Presently the existing water storage units meet the demand for drinking water in many areas but they have been renovated frequently. Stored water from traditional sources has been used for, agriculture and for drinking. These methods had been employed in India based on the nature of rainfall in different regions; however, the increasing population needed an increased demand on agriculture, hence the decrease of these traditional sources. Conserving of traditional water source, instead of being limited to the water reservoirs, extends to the whole drainage system where rainwater is kept.

x) Use of Modern Irrigation Methods:
Globally, around sixty-nine percent of water is required for the agricultural. The water requirement for agriculture is sufficed by surface water and groundwater. Water used for agriculture is obtained through canals, storage tanks, wells and tube wells. Large quantity of water goes waste through existing methods of irrigation. Canal irrigation does not distribute water uniformly, thus creating prob-lems such as waterlogging. Large amount of water can be saved by adopting modern methods of irrigation. By using sprinklers and drip irrigation, we can conserve up to fifty percent of water. With drip irrigation method, spread over the land the crop directly receives water with very little wastage. There is also no loss because of evaporation and nearly 95 percent of water is effectively used. Therefore, water utilization by this method is optimum. Improved methods of irrigation therefore are useful for conservation of water.

xi) Increasing Forest Cover:
Water is received every year by rainfall in variable quantities scattered all over the surface of the earth. Ultimately this water flows into the seas. Some rainwater is stored in water reservoirs in the form of lakes and tanks, whereas some quantity of water infiltrates the land and takes the form of ground-water. Due to increase in deforestation over the decades, most of the rainwater flowed into the seas without infiltrating into the ground. The old system of tree plantation on the banks of rivers and tanks needs to be restored. Forest cover will have to be made on barren lands and hilly areas on a mass scale. Trees can bear drought conditions for a longer period as compared to crops, we can make use of this to reduce requirement of water and simultaneously recharge water sources.

xii) Change in Crop Pattern:
If crops are grown according to agro-climatic conditions less water is required. Changing crop patterns based on higher profits is the recent development. Such type of crops consume more quantity of water as compared to usual crops. In Rajasthan, crops consuming more water were grown without regards to the avail-ability of water and

focus was on cultivation over the past thirty years. This resulted in excess use of groundwater because of the inadequate surface water to fulfil the requirement of commercial crops needing more water. This resulted in an acute water crisis. So it is important that we adopt the practise of crop rotation based on agro-climatic conditions. Where water availability is less we should promote agroforestry and horticulture.

xiii) Flood Management:
A considerable amount of freshwater is lost due to floods in India. Large proportion of land area is flood affected out of a cumulative land area of 32.8 crore hectares, This affected land can be protected from flood with suitable measures like building canals, embankments and storage tanks, leading to minimum losses due to flood and at the same time conserving large land masses. An increase in forestation can also provide safety from floods. It will help in the absorbing water in the soil. Drainage areas of various rivers in India like Yamuna, Ganga and other rivers have been some of the rivers where flood management is set up to conserve large areas of land.

xiv) Use of Geothermal Water:
Water scarcity can be reduced to some extent by using such geothermal water. We receive water from hot waterfalls regularly at many places on earth.

xv) Conserving Water in Industries:
Nearly twenty three percent of total freshwater available on the earth is consumed by industries across the world. On one hand some industries use water to a large extent, whereas some industries add to pollution of water like the leather industry, dyeing industry.

Water can be protected from pollution as also reuse after processing. Water recycling should be developed as normally industrial units dispose of water after single usage. This also causes pollution of other water sources. With recycling of water we can control or restrict the demand for water

xvi) Reuse of Urban Waste:
increasing urbanization has caused increase in demand for water especially in cities. Very few places have wastewater treatment in India as compared to towns and cities of other countries. Thus instead of reusing, it leads to pollution of other water sources.

In many countries, urban water is used after treatment in nearby fields for growing vegetables and fruits and after the use of water, disposed water can be suitably treated and conserved so as to use it in agriculture in the neighbouring areas of the cities. Modern urban development must have such type of policies incorporated in town planning.

xvii) Water Conservation by Municipal Bodies:
Municipal bodies have the responsibility of managing demand and supply of water at the individual level as well as conservation of water. Laws should be made to make in mandatory to collect rainwater from rooftops and make use of it. Regular awareness drive is very important for water conservation.

CONCLUSION

We should develop an attitude of water conservation at every level and prevent even a drop of water from being wasted. We should conserve rainwater and make maximum use of it for various cleaning purposes, along with maintaining the quality of the water. We should ensure that the depth of traditional water sources and water bodies should be maintained and also kept clean.

As large proportion of the water is used the world over primarily for agriculture, so it is important

that water should be conserved in agriculture where ever possible. Proper cultivating of fields in off-season will help in retaining soil moisture. If cultivation is done up to a foot of depth then moisture can go up even 3 feet of the depth and because of capillary action the moisture is prevented from coming out of the soil.

The soil moisture can also be retained by before-time sowing, proper use of pesticides, fertilizers, and weedicides. Green manure and crop rotation should also be adopted. Environmental balancing is the primary objective of water conservation. Due to changes in the world environment there is a shortage in the quantity of fresh water. Over the past few decades it is observed that there is a rise in temperature of the world leading to freshwater in the form of snow melting and drifting towards saline oceans.

The change in climatic conditions also causes a change in nature and quantity of rainfall, thereby resulting in unevenness in the distribution of water. This makes it necessary to develop the mentality of World Environment Balancing at the individual stage and conservation has to be worked on at every level.

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ISSN: 0976-0628

Chetana's
Institute of Management & Research

Vol XII Issue 1 : pp 17 - 25

Awareness of Effective Usage of Water in Day-to-day Activities

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Abstract

This paper focuses on the methods to create awareness about the water problem in different groups. It analyses the situation of availability of water and the intensity of water related issues. Accordingly, certain methods, techniques and solutions are presented and discussed for this issue. The objective of writing this paper is to first ascertain the water related problems in India and then provide some solutions that may help in effective usage of water, more so in day to day activities and reduce water related problems. But because the paper talks about the day to day usage of water, it does not deal with the broader level issues related to water and the appropriate solutions for it.

Keywords: *Water, Conservation, Scarcity, Techniques, Shortage, Crisis, Urban, Rural, Domestic, Resources, Younger Generation, Groundwater, Water Recycling.*

INTRODUCTION

"When the well is dry, we know the worth of water." Benjamin Franklin, The way to wealth (1758)
Water is an extremely important resource not only for mankind but for the entire planet and the universe. As the responsible habitants of the planet and the ones who have thinking power, we should look at the efficient usage of this resource so that we are able to get the required amount of water in long term and also are able to give enough water to the future generations.

'The problem of studying water resources includes not only an assessment of their natural state, territorial distribution, and fluctuations in time, but also of changes due to human economic activities', says Peter H Gleick[8].

This paper tries to discuss water resources in the country, need for creating awareness about the effective usage of water and also provides some suggestions towards this goal.

RESEARCH METHODOLOGY

The methodology used in this paper is primarily secondary research, where various available litera-

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ture and research papers were consulted to analyse the situation. Accordingly, the suggestions for creating awareness about the effective usage of water were given.

LITERATURE REVIEW

In order to understand the given topic, we first need to understand the available water resources in the country. 'India receives annual precipitation of about 4000 km3 including snowfall….. India supports about 1/6th of world population, 1/50th of world's land and 1/25th of world's water resources", as Rakesh Kumar, R.D. Singh & K.D. Sharma say in their paper 'Water Resources in India'.

In the same paper they also mention that "The total utilizable water resource of the country are assessed as 11086 km". "Community Water supply is the most important requirement and it is about 5% of the total water usage. About 7 km3 of surface water and 18 km3 of ground water are being used for community water supply in urban and rural area." "It is estimated based on above figures, water requirement per year for domestic use will be 90 km3 for low demand scenario and 111 km3 for high demand scenario. It is expected about 70% of urban water requirement and 30% of rural water requirement will be met by surface water sources and remaining from ground water"

In his editorial article, 'Incoming Water Crisis in India: As Understood by others', Shibabrata Pattanayak,[10] says, "As per the 2011 census, India is having a population load of 1.2 billion, who are having only 1,000 cubic meters of water per person. India had between 3,000 and 4,000 cubic meters of water per person in 1951. A country is considered water-stressed if it has less than 1,700 cubic meters per person per year. On the other hand, United States has nearly 8,000 cubic meters per person today." "Large parts of India have already become water stressed" mentions National Water Policy 2012 and adds that "Access to safe water for drinking and other domestic needs still continues to be a problem in many areas". It also narrates that "Low consciousness about the overall scarcity and economic value of water results in its wastage and inefficient use."

In his editorial article, 'Incoming Water Crisis in India: As Understood by others', Shibabrata Pattanayak, explains the three main reasons for water shortage in India. "According to a report of the National Bureau of Asian Research, Wasington, USA, India's water crisis is mainly rooted in three causes. The first is the very rapid population growth, which leads to insufficient availability of water per person." He quotes the same report again for another cause "the second cause is poor water quality resulting from insufficient and delayed investment in urban water-treatment facilities. Water in most rivers in India is largely not fit for drinking, and in many stretches not even fit for bathing."

Finally, he talks about the third cause of water crisis in India "dwindling groundwater supplies due to over-extraction by farmers. This is because groundwater is an open-access resource and anyone can pump water from under his or her own land. India extracted 251 bcm (billion cubic meters) of groundwater in 2010, whereas the United States extracted only 112 bcm. Further, India's rate of extraction has been steadily growing from a base of 90 bcm in 1980, while this rate in the United States has remained at more or less the same level since 1980".

Shibabrata Pattanayak, quoting a World Bank report[11], says that, "Due to the amenities of typical urban life, such as flush toilets and washing machines, people living in cities tend to lead more water intensive lives. The urban population has doubled over the past 30 years, now representing

30% of India's total population". It is postulated in the report that the urban population in India is expected to reach 50% of the total population by 2025. Population growth is going to accelerate the water crisis in India, especially as more and more people move into the cities and become part of the middle class section. Because the water in rivers is too polluted to drink and the government is unable to consistently deliver freshwater to the cities, many urban dwellers are turning to groundwater, which is greatly contributing to the depletion of underground aquifers."

Thus, it is evident from most of these pieces that our country, as of now, is short of water resources and needs an effective usage of water in day to day as well as in other commercial consumption.

ANALYSIS & INTERPRETATION

The share of Indian population as a percentage of that of the world, is 18%, but the share of usable water available in India is only 4%. Data shows that 163 million people in India lack the access to safe drinking water. [6][7]

As we see from the literature review and the data given above, we are increasingly facing the scarcity of water and should be prepared at the earliest to handle this situation.

SOME CITIES AND WATER

There are certain cities which have run completely dry such as Cape town, and there are some which are facing acute water shortage situation such as Chennai etc.

Many cities in India are facing a shortage of water as was seen in case of Latur in 2019. Because of this not only the farming activities were affected but it led to food insecurity and high rate of unemployment.[5] Take the case of Delhi[4], which may run out of groundwater by 2020. One estimate says that the water needed in Delhi is approx. 1100 million gallons daily and the supply is limited to 900 million gallons daily. This crisis may be attributed to i) Water leakage, ii) Absence of a long-term water policy & iii) Absence of coordination in different departments.

Similarly, the water shortage in Bangalore and Hyderabad is primarily because of increasing population (including migration), fast development and industrial growth.

Per Capita per year availability and utilizable surface water in India[9]

Year	Population (in million)	Per-capita surface water availability (BCM)	Pre-capita utilizable surface water (BCM)
1951	361	5410	1911
2001	1027	1902	672
2011	1210	1614	570
2025	1459	1339	473
2050	1692	1154	408
2065	1718	1137	402

Thus, in order to manage the situation better in these cities and also to avoid any such situation in future, we need to create awareness about the same among the citizens.

Findings

We get to understand from this review and analysis, that India is water stressed and the situation may become worse in future.

The trend of water wastage is prevalent in Rural as well as Urban sector both.

This may lead to a situation where we may have difficulty in getting water for basic necessities also. Therefore, the activity of creating awareness about the effective usage of water is essential.

SUGGESTIONS

Urban and Rural Plan

The water conservation has to be done differently in Rural and Urban areas. The villagers have access to different and multiple sources of water. The usage of water in the rural sector is pretty different from that in the urban sector.

The domestic water requirement in future in Urban and Rural areas may be seen in the table given below:

Domestic water requirement for the years 2050 and 2065[9]

Item	Unit	Year 2025	Year 2050	Year 2065
Population	Million	1333	1692	1718
Percentage Urban		0.45	0.6	0.65
Percentage Rural		0.55	0.4	0.35
Norm – Urban area	lpcd	220	220	220
Norm – Rural area	lpcd	70	150	150
Demand – Urban	BCM	48.17	81.52	89.67
Demand – Rural	BCM	18.73	37.05	32.92
Total	BCM	66.90	118.58	122.59

Rural Sector

First and foremost, the relevant techniques to save water for rural and urban areas should be developed separately. By doing this, the effectiveness of these techniques may be increased.

Water is primarily used in villages for irrigation and for cattle care etc. Till date these are the main occupations of the majority in the villages.

The irrigation techniques, which use less water, such as drip irrigation should be talked about in the villages etc. Certain model farms or villages should be developed where these techniques should be used and the results should be shared. The awareness should also be created about the sources of procuring this technology which may not be easily accessible.

Public sector and private sector companies should develop the appropriate irrigation techniques and instruments to be used in farming, which may save water. There is a need to popularize the new innovations and make them accessible in our country.

Again, posters, wall paintings etc. could be used effectively in the villages to communicate about the latest technology etc. Posters are helpful in creating mass awareness in short period and is a cost-effective method. Wall paintings could be very effective for the people staying in that and nearby villages.

Many traditional sources of water exist in the villages, such as rivers, wells, ponds etc. In order to conserve water, the same should be protected

and utilized to the fullest. Ponds and lakes are the resources that can be effectively used by the residents for multiple activities. So, the messages given in the rural area should talk about the methods to keep these waterbodies neat, clean, potable and accessible.

Knowledge and awareness about the usage of these water bodies should be given to them through talks, videos, radio and TV programs. The best method among these is the live demonstration, which may help people understand these techniques better.

Practices such as washing clothes, throwing garbage in these water bodies should be avoided to the possible extent. The reason and the result of the same should be explained to the villagers. But the effort should not stop here and should be extended to giving them alternatives, so that these suggestions may be adopted easily by the villagers.

Another source of water in villages are wells. Some of these wells are now closed, but some are still usable. The Gram Panchayat and other local bodies should take the onus of looking after the dry wells. The dry wells can be used to recharge the ground water.

Information about how to clean these dry wells, how to direct the rain water etc. to these dry wells and how to maintain these wells should be done by the villagers. The usable wells also should be kept clean. The villagers should not only keep the surroundings of these wells clean but also should try to clean the water in these wells through adding the required cleaning substances from time to time.

Urban Sector

The water conservation techniques for the urban sector is very different. The accessibility and availability of water in big cities is limited because of the population being concentrated in one area. The objective here is to get more resources and recycle the available water in the urban set ups.

The main focus in cities should be to recycle the water being used there. First of all, the recycling plants should be developed, then the awareness about the recycling should be created among the public, so that they may start using it.

Rainwater Harvesting

Rainwater harvesting is a solution which may be useful both in rural as well as urban set ups. In cities, the construction should be done, keeping in mind, rainwater harvesting. Towards the same authorities and activists should educate the architects and designers etc. Since they are the ones who counsel the customers on making the house and mostly design the house, shops etc., if they are aware of the rainwater harvesting system, the architects may suggest the same to the customers and get it done at the appropriate time.

Ground water level

Residents in various regions try to get water for the daily need by drilling the ground and accessing the ground water, but the authorities should not allow it in the regions where the groundwater levels are already low. The citizens in that area should be made aware of the problems associated with depleting ground water levels.

New initiatives should be taken in form of competitions involving the locals, school children etc. to discuss and find ways and means to increase the ground water levels in the area.

Younger Generation

Keeping in mind the future generations, awareness campaigns should be designed and carried out for the children as well. There are total 492 million children under 18 years of age in India, which is approximately 39% of the total population[1]. Thus,

it is a must to pay attention to this audience. Awareness could be created in schools or colleges or in residential areas in order to disseminate Information and develop the right habits among children, which could go a long way to save water and the environment.

Relevant messages could be given through TV also, which is a very popular medium among the children. Special programs may be made to include the water saving messages, from which they should understand the importance and methods of saving water and the results of not following it. Since cartoon shows are very popular among children, the water saving messages should be imparted through cartoon programs.

'Get Water' is a mobile game developed by a start-up named Decode Global, which is based on the water scarcity in India and its impact on girls' education. In order to create more awareness among the children this company has also developed some lessons for the teachers of standard 4-6, that may be downloaded from the website of the game.

Schools should run the awareness campaigns from time to time, so that they develop the right habits and may retain them.

Reaching the End User

Among all the people who use water, a lot is being used for the domestic work. The number of domestic helps in India ranges from official data of 4.2 million to unofficial estimate of 50 million[2]. The kind of work that the house helps do in India are cleaning, cooking, washing etc., all of which require the usage of water. In order to stop the wastage of water, if we educate this segment, it will be a great idea.

Informative Sessions

Special sessions may be conducted for the domestic users in the zones where water wastage is very high. So, the experts may talk about the methods to save water in the domestic activities. Since the domestic helps are mostly uneducated, the messages and the training sessions for them need to be very simple. It should ideally be conducted in their local language.

The sessions should talk about the problem of water shortage, wastage and the impact of the same on mankind. They should be given the information about the impact of water shortage on their nation, on other nations and on the world in totality. Many of them probably would not be aware of the difficult situation and may start complying with the water saving drive, once they get to know of it. Additionally, one to one dialogue with them could also be helpful. Some facts that should be shared is the quantity of water present in that region. People should be told about the existing requirement and the amount of shortage etc.

The most important step in the session is to tell them about the various methods of saving the water. The methods should be devised, thought through, tried and then spread among various audience in order to create a mass awareness about the same. A clear demonstration and practiced during the training itself could go a long way in helping them adopt these techniques in life. They should be told that they have the ability to become the brand ambassadors of this drive. Since they work in multiple houses, they may create awareness about these techniques among the various people they get in touch with.

If good videos in easy languages and with clear demonstrations may be created, the message may reach an even bigger audience. These days many domestic help and drivers etc. possess mobile phones and may use social media actively. Thus, the relevant messages could be circulated using social media.

GENERAL AWARENESS CREATION METHODS

Traditional

Some old techniques such as displaying posters about water scarcity and ways to save water in the local language may pass on the message, educate them, and remind them to practise it. The posters are an effective medium of reaching out to the masses.

Audio Visual

Television and radio also could be gainfully used in making this campaign a success. Since this segment is primarily not educated much, this is one channel which may create ample awareness in the domestic help segment. The easy and relevant communication should be created, which should convey a long lasting and impactful message to the audience.

Online Presence

A workable method could be to create a website dedicated to water, where a page on each region with the kind of local water related problems and the data should be made. As and when, a new water saving method, tool or technique is found or discovered in the region the same should be updated on this website.

The website should have different pages containing information about the team, benefits, programs, locations etc. With relevant pictures the website may create the required impact on the audience and may be easily accessible.

Similarly, Twitter, Instagram, Facebook pages etc. should be created with the latest updates on the events, success stories etc. The social media should be carefully managed by the experts in order to reach out to the remotest locations and interested people in any place at any time.

If a proper record is maintained of the kind of questions asked regarding the topic, the awareness creation team could be in a better position to provide solutions to these problems. A helpline number should be created and shared with the masses, providing them access to the people who may have certain questions. The helpline may provide answers to the specific questions of public and may be useful.

Celebrity Endorsement

As was seen in the success story of the Polio eradication campaign, the involvement of the celebrities may make the drive successful. Similarly, some celebrities may be roped in to create awareness among the masses about the water saving movement. There are masses that follow a leader, film actor, a television artist, a social activist, a sports person, a musician etc. Thus, if they talk about the importance and utility of this kind of movement, the message may really have better impact on a large segment. If the message is impactful, the masses are likely to believe it much more.

Brand Ambassador

Another good idea could be to select a brand ambassador. In celebrity endorsement, the celebrity may appear in one message or advertisement only, but the brand ambassador is usually associated throughout the entire campaign. If this association is successful, the campaign will be able to generate a much better result.

Cases

Once introduced, soon the activists will come to know of the results of the campaign. So, if the success stories of the awareness campaign and its results are collected and shared with the people, the campaign may become more successful over time. People connect with the real stories much more than they do with advertisements.

While talking about the real stories, the people may get to see the real obstacles they face while following the water saving practices and could be better prepared to handle these issues and follow these practices more effectively.

BUDGET & EXPENDITURE

Some resources will be required for this campaign. It could be in form of financial resources, human resources, physical equipment or place etc.

To start with, the required budget for the campaign should be prepared according to the kind of awareness generation program needed. The same should be divided as per the city, state and country in order to get near accurate numbers. The budget could be divided in the heads of expenditure also.

For the awareness generation program, a team may be prepared depending on the requirement. Starting from planning specialist, executing specialist and trainers etc., all should be recruited to be part of the team. It is possible to outsource part of this work to outside vendors also. This helps in getting a more specialized work input, and sometimes save on money and time etc. Specialists belonging to the field of environment and marketing will definitely be of great help.

Certain equipment such as projector, screen etc. may be required for the demonstration, trainings etc. and should be procured during the campaign to generate the required impact.

Division of Time

The broad timelines as per the milestones should be assigned to the campaign. The same should be shared and then adhered to, as far as possible, while running the campaign.

Time also means the event around which the campaign should be introduced, developed or run e.g. the campaign should get more aggressive before summers to avoid any water scarce situation. The campaign should be more widely talked about in the regions where there is a shortage of water. By doing this the effect may be maximized and the result obtained could be significant.

The monitoring of the awareness program should also be done from time to time. An analysis of the result may indicate the best method or process to run the campaign.

CONCLUSION

Thus, by adopting some of these measures and suggestions, we may generate the required awareness among people about the water problem and may stop the water wastage and create enough resources for the future. We need to actively work towards creating awareness about the effective usage of water and saving this valuable resource.

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ISSN: 0976-0628

Chetana's
Institute of Management & Research

Vol XII Issue 1 : pp 26 - 32

An Overview of the Industry Initiatives to mitigate the Global Water Crisis

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Abstract

Water is an essential resource required for the existence of life. Water is used and consumed in every act of our existence. Industrial water use comprises around 6% of the total water use. The water crisis is real and has been documented by variety of agencies such as the United Nations and the World Economic Forum. The onus to demonstration accountability and reduce the water foot print is high on the businesses. The push towards sustainable development and responsible business has made many key players participate in addressing the water crisis. The efforts by the industry to mitigate the water crisis begins by adopting good governance practices and transparency. It is important to document and evaluate the water foot print. Strategies to monitor and reduce the water foot print needs to be evolved and implemented. Water used in the manufacturing process also needs to be reviewed. Use of technology and innovation has aided industries to check the use of water in the manufacturing process. A lot has been done around the product design to reduce the use of water. Without comprising on the usability and the functionality of the product, many companies have innovated the product design to make it environment friendly. The companies have engaged in social responsibility on their own or through various actors and stakeholders. Focusing on water conservation through water harvesting, preservation and addressing the use of fresh water in agriculture is changing the landscape. These initiatives have transformed many communities and are true torch bearers of sustainable development. Community participation and involvement has created a sense of ownership through these initiatives. It was also important to rope in the consumers in the process. The end user of the product is an equal stakeholder in the water consumption. Campaign and awareness programs around water conservation have been initiated to ensure consumer participation and bring about behaviour change.

Keywords: *Deionised Water, Global Water Mandate, Water Abstractions, Water Conservation.*

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An Overview of the Industry Initiatives to mitigate the Global Water Crisis

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INTRODUCTION

This paper is an attempt to review the efforts undertaken by the Industry to mitigate the Global Water Crisis. The paper refers to published information sources which are available in the public domain. It is an attempt to present best practices and understand responsible business behaviour. No primary research was carried out but the paper provides opportunities to conduct primary research on Strategic Business Decisions, Social Responsibility and Activism etc.

Water is essential for the sustenance of life on our planet. Not only forming a considerable volume of the human body (around 70%), it occupies a large part of the planet earth (around 71%). A very small quantity of this water on earth is for the human use. Unfortunately, we are at a stage when this essential part of our existence is at risk. Reports suggest that by 2030 we will be facing a 40% gap in our water requirement. Water crisis is real and the World Economic Forum has identified it as the number four global risk in relation to its impact on the global community. The United Nations (UN) also identifies the need to address the crisis in 'water and sanitation' along with 16 other issues in the Sustainable Development Goals (SDGs) 2030. Water is used for drinking, personal use, agricultural use, for generating energy, industrial use etc. In India, according to Ministry of Water Resources, Government of India (GoI), about 40 billion cbm (cbm = cubic meter, 1 cubic meter = 1000 liters) water is used by the industries. It is estimated that the Industry uses around 6% of available water. The usage is projected to grow to 8.5% by 2025 and more than 10% by the year 2050. The pharmaceutical and the electronics industry use deionised water. Softened water is used for broiler feed applications. The industry accounts for around 40% of total water abstractions.

The efforts by the industry to mitigate the water crisis can be broadly listed as; good governance practices, efforts to reduce the water use in the manufacturing process, by changing the product design, through social responsibility and sustainability efforts and efforts to create awareness among the consumers.

GOVERNANCE AND TRANSPARENCY

Awareness about the issue and the willingness to participate to bring about the change is the primary step in the process. Many business leaders have understood the importance of sustainable and responsible development. Being an important stakeholder, the industry has started developing and engaging in sustainability accounting standards and tools. It was a felt need to document the water foot print and to engage in strategies that would help to reduce the same in order to attain sustainability. Third party engagement to help evaluate the industry's performance on various sustainability standards is a welcome step. Organizations like the Sustainability Accounting Standard Boards (SABS), Water Stewardship Programme, World Business Council for Sustainable Development (WBCSD), Water Footprint Network (WFN), Global Sustainability Reporting Standards (GRI Standards), etc. are helping the industry achieve this. Efforts by companies like Unilever Ltd., who have developed their own guidelines, i.e. 'Unilever Sustainable Living Plan' (USLP) are worthy of a mention.

Identifying water crisis as a global risk which could impact the future of business, the WBCSD developed the Global Water Tool and the India Water Tool. It helps the business to identify the water risk, to understand its impact on the business and helps to develop water stewardship strategies. The organization has launched the version three of the India Water Tool (IWT) in 2019, which collates water data from the government and other sources

and makes it available for public use. It is a technology driven initiative for the users to get a real time satellite data of surface water availability. Such data helps the users in the decision-making process to develop responses. The WBCSD has eight major Indian headquartered corporations as members. They work with 60-member companies globally. They also engage with the Government of India at the national and state level on projects to advance sustainable businesses.

According to the KPMG survey on corporate responsibility reporting - 2017; almost 230 out of top 250 corporate in the world report on their sustainability performance. Organizations like GRI provide a platform to these corporate to present an integrated report of their financial and non-financial performance. The non-financials include the triple bottom line (John Elkington, 1994) reporting, corporate social responsibility (CSR) reporting etc.

MANUFACTURING PROCESS AND WATER CONSERVATION

The manufacturing process in terms of the use of water comprises of activities such as washing, cooling, fabricating, processing, diluting and transporting, while making the products. Industries have come out with innovative ways which are driven by technology to minimize the use of water in the manufacturing process.

Arvind Ltd. established in 1938, is one of the leading textile company in India. Aware of the fact that the textile industry ranks amongst top ten consumers of water in manufacturing process, the company initiated its sustainability plans, reducing the use of water from 75 litres to 15 litres in production of one pair of jeans by using foam dyeing and different finishing technology. The company is aiming to move towards a waterless denim dyeing process in the future. The company has units like the one at Santej are equipped with waste water treatment plan which recycles almost 98% of the effluent. In the Bangalore unit 100% of the water used is treated waste water. The company has also introduced the E-soft Nano-bubble technology. This technology helps the company saves almost 98% of water, 80% chemical and 79% energy. The efforts did not stop at their own plants. The company felt the need to share its success with other industry players. In 2011, they established Arvind Envisol, a business that helps other business to deal in water treatment, industrial waste water treatment, sewage management and zero liquid discharge. Today Arvind Ltd. & Arvind Envisol have acquired 30 global patents for its environmental solutions and have established a lead in water saving technology.

Pharmaceutical companies like Pfizer have aligned their water sustainability program with the UN Global Water Mandate. They have committed to understand the water related risk to their business and work around strategies and responses to it. The focus will be to implement improved practices in water recycling and reuse. Some basic efforts carried out by the company such as leak detection and repairs in fresh water distribution lines, re-loading well water supply by rain water collection and using waste water for landscape irrigation. In the manufacturing process the company reuse of treated waste water in cooling towers, uses techniques like condensate recapture, optimize broiler operations and maintenance. Another pharma company, Cipla Ltd. follows the five 'R' policy; reduce, recover, reuse, recycle and rethink. They have been able to recycle and reuse 70% of their waste water generated in the manufacturing process. The company reuses the recovered steam condensation for boiler feed water. The cooling water from its jacketed production vessels is reused for cooling towers. The company is actively involved in rain water harvesting. Cipla also carries out recirculation of the compression machine vacuum pump water.

The company cites have displays on water conservation and creates awareness amongst the work force. They also conduct water training for them. Cipla API (Active Pharmaceutical Ingredient) manufacturing sites have zero liquid discharge.

SUBSTITUTE TO FRESH WATER

The industry is dependent on fresh water for its consumption. But companies like Chennai Petroleum Corporation Ltd. (Chennai) and Madras Fertilizer Ltd. (Chennai) have invested in desalination plants. They have started using the sea water in manufacturing process after desalinating it. Chennai Petroleum Corporation Ltd. and the Rashtriya Chemical and Fertilizers (Mumbai) have set up plants to recover water from Municipal sewage and use the same for the cooling applications in their plants. Companies are investing in recycling and reusing of water for the manufacturing process. Industrial water and wastewater are by-products of industrial or commercial activities. Companies are ensuring that water treatment is carried out to reduce water pollution from industrial waste.

Companies like Asian Paints are having a conscious approach to water management within their premises. Under the larger umbrella of the resource conservation policy the company has introduced automated water management systems (WMS) and reverse osmosis (RO) systems. The company has also ensured 100% reuse of rain water in its utilities. They have installed sensor-based taps and waterless urinals in their premises.

Water conservation through water treatment has become an industry in itself. At an embryonic stage and much fragmented this market is expected to grow at a compound annual growth rate (CAGR) of more than 12%, between 2016 and 21. The water treatment industry is growing, some of key players include; VA Tech Wabag, Thermax India, GE Water, Siemens India Water Technologies, Aqua Innovative Solutions, Ion Exchange India, Hindustan Dorr-Oliver Ltd., Voltas Water Solutions Pvt. Ltd, Hindustan Water Engineering Company and Wipro Water.

SOCIAL RESPONSIBILITY

Companies have taken water conservation beyond their premises. Many businesses are spending funds under Corporate Social Responsibility (CSR) on water conservation. India is the first country in the world to make corporate social responsibility mandatory, following an amendment to the Companies Act. (Section 135 of Companies Act, 2014). The Dharampal Satyapal Group (DS Group) established in 1929, is headquartered in Noida. The group is a known Food and Beverages manufacturer. They also have diversified in Hospitality and Agribusiness sectors. The company has taken up water conservation as their focus area under CSR. Under their initiatives the company has constructed check dams in Rajasthan. These dams harvest and hold more than 4 lakh cubic meter water. The group has also initiated development work in Uttar Pradesh. With a focus on making farming sustainable and not dependent on rainwater, they have constructed water bodies or farm ponds. To provide safe drinking water, the company has constructed 2500 plants. They have installed about 1900 water vending machines (WVM) across 12 states in India.

YES Bank addresses water security through their CSR intervention called 'Livelihood and Water'. They are implementing a joint initiative with the Indian Railways and are providing clean and safe drinking water at 1000 railway stations. They have engaged Livinguard (a social enterprise) that uses patented membrane-based water purification technology. The technology uses no electricity and no chemicals for water purification and also ensures no water wastage.

Cement giant, Ambjua Cement has undertaken unique initiative in the state of Rajasthan. They

have pushed for the development of community based infrastructure to address the water crisis in Thar Desert. Community engagement in rain water harvesting and use of traditional water conservation methods has been promoted. The company is also educating the rural communities on water conservation. They have created roof rain water harvesting structures and check dams have been built to harvest water. Farm land has been cultivated through the micro irrigation systems. Community mobilization, participation and ownership is ensured through the formation of *Pani Samitis* or Water Committees (Groups).

Another initiative by Dhanuka Agritech, an agrochemical company in Rajasthan has been using campaigns to create awareness amongst the communities for conserving water. They have used campaigns like *'khet ka paani khet mein, aur gaon ka paani gaon mein'* (field water in the field and village water in the village) for educating the community. The famous Bollywood superstar, Mr. Amitabh Bacchan has been roped in for a 60 second documentary which is themed around a social message; *'Humans cannot make water, but can definitely save water'*. Apart from this the company has constructed check dams in various villages benefitting more than 10000 households.

INNOVATION AND CHANGE IN PRODUCT DESIGN

A ground-breaking process to reduce the use of water in the toilets and urinals has gained a lot of attention and praise. On an average a single urinal uses more than 100 thousand litre of water every year. Loowatt is a UK based company that manufactures waterless flush toilets and provides the users various sanitation solutions. The toilets designed by the company do need water to flush. The waste is captured in a safe biodegradable polymer sheet. This forms an airlock thus blocking the odour, stops contamination and spread of disease. This sewage is transferred to an anaerobic digester which converts it into biogas, fertilizer and produces electricity. Diversey is an American company that develops innovative cleaning and hygiene solutions. They have developed the 'Flush-Me-Not' waterless urinal systems. The urinals do not require water and thus reduces the water usage, but also controls the odour. In India, the Mumbai Chatrapati Shivaji Maharaj International Airport has installed nearly 15000 urinals. The company has also installed the urinals in the restroom around Vaishno Devi temple and across Mac Donald's branches. The company has also developed a smart laundry dispenser that tracks energy, water and chemical consumption on a real time basis. Another company, A.G. Aqua Solutions Pvt. Ltd. Has launched the 'Kupple Waterless Urinals' in India. They have many corporate clients such as Bharat Heavy Electricals Ltd. (BHEL), Oberai Mall Mumbai, Vedanta Group, Infosys, L & T, Trident Hotel, AMUL, Apollo Hospitals, Godrej Industries, Torrent Pharma. Reliance Industries etc.

CREATING AWARENESS AMONG CONSUMERS

Companies like Colgate who are a lead brand in manufacturing oral hygiene products are aware of the consumption of water while using their product. A campaign on water conservation with an action: pledge to save water, '#every drop counts' has seen overwhelming response from the consumers. More than 3 lakh people have pledged to save 4 crore cups of water everyday while brushing their teeth.

CONCLUSION

Water conservation is not just the responsibility of the people, it's an institutional responsibility. The paper provides opportunities to conduct further research on Strategic Business Decisions, Ethical

Business Practices, Social Responsibility, Sustainable Business Practices and Conscious Consumerism etc. Industry and business are one of the important stakeholders in the consumption of water and pollution of water. They have also shown leadership in the process of conservation of water. There is a need to scale up the initiatives at a larger level. The water crisis is acute and efforts need to be intensified. There is also a need to bring the industry on a single platform to create synergy and convergence around the efforts. A platform to share the best practices and contemplation on making the water conservation models scalable. Some of the steps the industries can take for conservation of water.

1. The first step is acknowledging the need to conserve water and other natural resources. This should be part of the governance agenda of any industry.

2. Followed by standard operating procedures and policies that trickle down in from of implementation guidelines and protocols.

3. Monitoring the efforts is another aspect of ensuring the practices are being followed. Setting Sustainable, Measurable, Achievable, Realistic & Timebound (SMART) goals and targets that involve all stakeholders is another crucial aspect.

4. Processes where steps for water conservation can be actively implemented needs to be identified, be it manufacturing processes, product design or the use of water by the consumer while using the product.

5. Another aspect of industry as mandated by the law is social responsibility. Industries must work towards engaging local communities and stakeholders in the development process and ensure the measures for conservation are rolled out.

6. 'Awareness to action', a 360-degree approach is the key to sustainable development.

7. Policy makers can ensure the push for better governance and transparency in regards to conservation of natural resources such as 'water' get a priority in the overall scheme of things by the industries. These can be set as pre-requisite for issuing licenses and permissions.

8. Learning from the best practices implemented by industries and organizations globally can help not only in the scaling up of efforts but also help in further developing local prototypes and models of sustainable and responsible businesses.

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ISSN: 0976-0628

Chetana's
Institute of Management & Research

Vol XII Issue 1 : pp 33 - 42

Quality Monitoring Mechanisms

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Abstract

Water is one of the main constituents for all the living beings on this planet for survival. Without water, no living organisms can survive for more than seven days. Even the quality of the water plays an important role for survival. So, we have conducted a research that will help to monitor the quality of water which is supplied for the purpose of drinking. Here, we found that there are many problems related to the quality of water. A proper analysis of the data was done by us, based on which, we have introduced a mechanism that will surely help in improving the water quality. In our methodology, we have done a ground level research and interviewed people from different localities, which led us to know that water quality is a major issue that is getting ignored from time to time. Our research paper also contains some responses which are taken from people belonging to different districts on what type of water they consume. As our research aims at providing the same quality of water to all human beings whether rich or poor, there should not be any differences in the same.

Keywords: *MCGM Water Quality, Types of Pollutants, Bandra and Kurla Water Quality, Break Point Technology, Chlorination*

INTRODUCTION

Water is an essential need for human survival and therefore, there must be mechanisms put in place to rigorously test the quality of water that is made available for drinking in towns and cities, articulated supplies, as well as the rivers, creeks, and shorelines that surround our towns and cities. Water is one of the most important substances on Earth as all plants and animals require water to survive, in the absence of which, there would be no life on Earth. Drinking water in urban areas comes from the rural areas which have lakes, rivers, and reservoirs which are the sources to attain consumable water (Denchak, n.d.). In Mumbai, the water supply plan was developed and implemented by the British

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government in the nineteenth century, where the foundation of various pipelines was done (MCGM, 2019). Since the pipelines are old and rusted, rust particles dissolve into the water. Hence, even though the water which comes to our places is purified by certain measures from the Government, there is a possibility that the water you consume may be impure due to improper storage management. The role of the Government is to deliver the water to the societies, buildings, and other commercials. Further care should be taken by the respective bodies regarding maintaining the quality of received water while storing it. As water is uniquely vulnerable to the pollution it can dissolve more substances than any liquid on Earth. We need to prioritize and monitor the quality of water, for which we have planned some monitoring mechanisms in this paper, where one can get pure water for domestic purposes. This research paper consists of various monitoring mechanisms that are used to preserve the quality of the water. We have considered a 360-degree approach in terms of water quality mechanisms. Since this paper falls under operations and supply chain management, we have certain techniques or methods, in sync with the new era of systems. With the help of industry 4.0 tools, we could maintain good quality mechanisms in terms of water. We have also taken various case studies from different locations where various water mechanisms have been installed by the Government regulatory bodies. Water from different places and sources has different characteristics. After proper analysis of the type of water characteristics water purification techniques can be applied to it.

OBJECTIVES

Our main objective is to monitor the quality of the water which is supplied to us for our domestic purposes. The reason behind this is that, as the pipelines through which water is provided to us has the possibility of getting rusted, its particles get dissolve into water. We do not doubt the government solutions which are done in the initial phases of every lake, but sometimes the water gets impure due to the rusted pipes or due to some unhygienic storage facilities. As water is vulnerable to pollution, due to its quality of dissolving of any particles, research was done by us in which the monitoring the quality of water was necessary. The water after a certain level of contamination from several environmental factors becomes difficult to drink, which in turn give rise to many diseases. So, in that case our objective is to check the quality of water from some parts of the urban areas in Mumbai.

LITREATURE REVIEW

According to international geological surveys, Kasun Thivanka has found out that about 71% of the Earth's surface is water covered by the oceans, containing 96.54 % of all the piles of Earth's water which is completely undrinkable due to the salinity. The rest of the 3.46% of Earth's water is located at places such as icebergs, groundwater, lakes, soil water, atmosphere, etc. and among them, only 1.42% is fresh water that could be used for the survival of the living beings. According to the researchers, it is found that only 1% of the total available water can be easily available to use as freshwater. The figure shows the basic block diagram. (Drinking-Water, 2019)

As per the reports of the Hydraulic Engineering Department of MCGM it was found that Mumbai has a water supply of 3800 MLD and has a total network of 6500 Kms. Mumbai receives raw water from seven impounded water resources viz. Vehar and Tulsi within Mumbai, Tansa, Modak Sagar, Upper Vaitarna, Bhatasa and Middle Vaitarna which is located at a distance of about 100 to 175 Kms from Mumbai. Raw water available from these sources is conveyed with transmission in main

system ranging from 2235 mm to 5500 mm diameter pipelines and tunnels. to state of the art water treatment facilities at Bhandup Complex (2810 MLD) and Panjrapor (1365 MLD). Water Treatment facilities for Tulsi (18 MLD) and Vehar (90 MLD) are located near these sources. At these treatment plants, water is treated with processes such as coagulation, flocculation, settling, rapid sand filtration, and post-chlorination. The quality of the effluent water is maintained in accordance with drinking water-specifications. The treated water is stored in the Master Balancing Reservoirs (MBR) located near the treatment plants at Bhandup Complex (within Mumbai) and Yewai (Outside Mumbai). It is further distributed to 27 service reservoirs located throughout Mumbai City with a complex water supply network through this conveyance system which remains charged for 24 hours and eliminates the chances of water quality deterioration because of intrusion of ground water/ sewage etc. (MCGM, 2019)

According to the Research paper of Microbial and Chemical Analysis of Potable Water in Public – Water Supply within Lagos University A. Ojo*, S.B. Bakare, and A.O. Babatunde Department of Microbiology, Lagos University, in which authors tried a few experiments, which were carried out at the laboratories of Lagos State Water Corporation (Iju Water Works) Lagos. The source of water was the four tap water sources in four strategic locations within Lagos State University, Ojo Campus. Aseptically, tap water was collected in the morning into a sterile 4-litre plastic container after the tap was allowed to run for 5 minutes. The 4- litre container was immediately covered tightly after the collection of water samples and transported to the laboratory for chemical and microbiological analysis. This process was done separately on each occasion for the four selected sampling points in the four faculties. Nutrient agar, Baird – Parker agar, McConkey agar, Plate count agar, Potato dextrose agar (PDA) and pseudomonas agar base, which was used from isolation of micro-organisms like Escherichia coli, general coliforms, total bacteria, pseudomonas aeruginosa, yeast, moulds and Staphylococcus aureus. They also did Chemical Analysis in Alkalinity, Acidity and hardness analysis which includes total hardness, calcium hardness, and magnesium hardness and spectrometric analysis of water samples. It was found that water supply can be improved if faculty water distribution networks are properly replaced and maintained to reduce health hazards. So, at this point, our research paper will help to overcome all these challenges. (Ojo, 2007)

RESEARCH METHODOLOGY

In this paper, we have adopted the root cause analysis in terms of quality management. Also, we have adopted the strategies for closing the gap in service quality.

As per our research, these types of pollutants contaminates the water which is presented in the following figure.

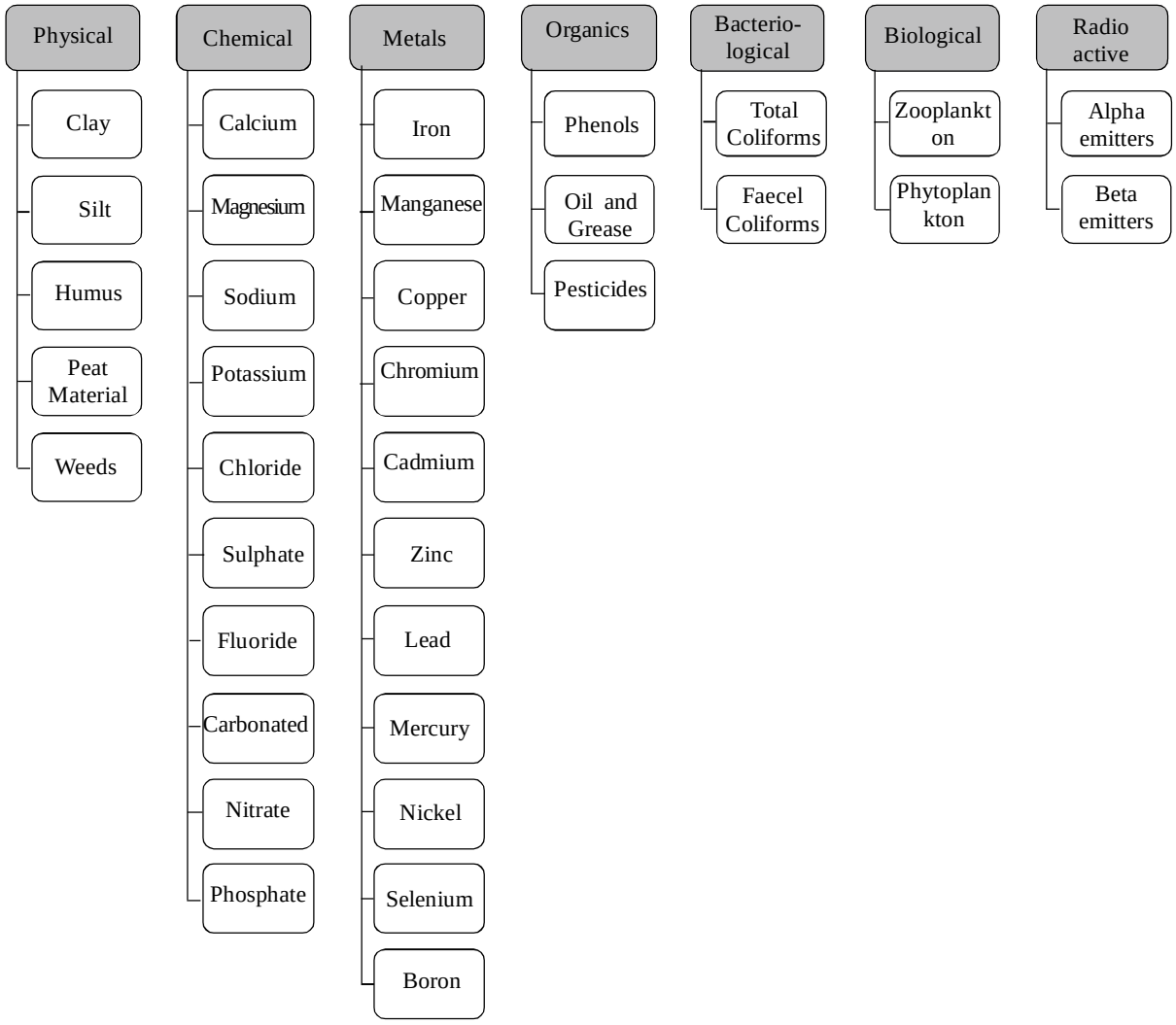

Figure: Types of Pollutants in water

Since we are all aware that the Government supplies filtered water to different localities, but still due to some above-mentioned unfavourable factors, the quality of water can be degraded.

Considering the fact that we respectively interviewed people from localities in Kurla and Bandra, slum areas in Bandra like Bharat Nagar & Maharashtra Nagar, the quality of water can degrade due to lack of hygiene in these areas. The sample size taken over here was 60, as 20 people from 3 different areas were interviewed. Water quality mechanisms can play an important role with the help of technology and operation methods. Also, there are societies in Bandra east that come under the Government regulatory bodies like MHADA where they receive water from the Municipal Corporation. They store water and supply it across buildings for regular domestic purposes. Although, this authority takes the responsibilities of maintaining the storage tanks which are not up to the mark in terms of quality. In that case, the people in

those areas should also take the initiative in maintaining the quality of water which should be cost-efficient. At the same point, big societies like MIG colony Pali Hill, etc, proper care should be taken because these societies stored water in big tanks. Techniques like the rainwater harvesting method which is the current technique and can be outdated, so new methods based on IoT and other sensing techniques could help in terms of quality of water as well as cost-efficiency.

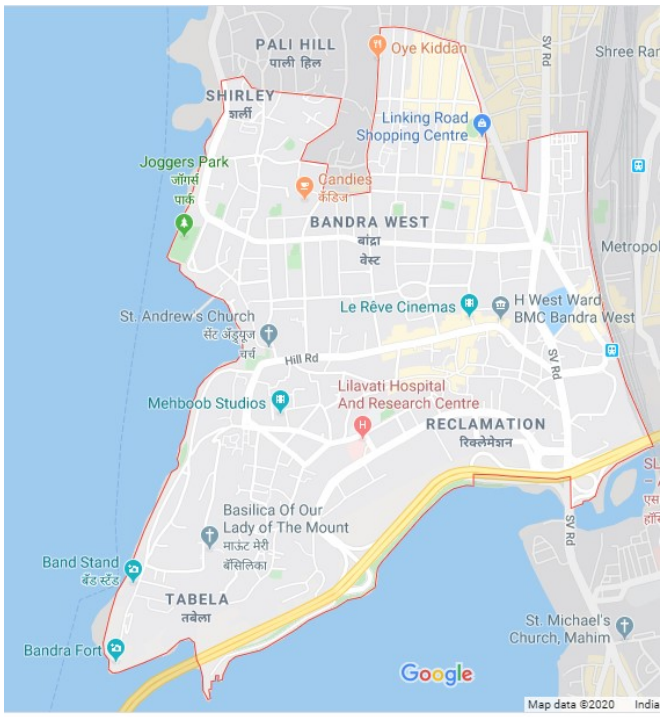

Figure 1: Map of Bandra West

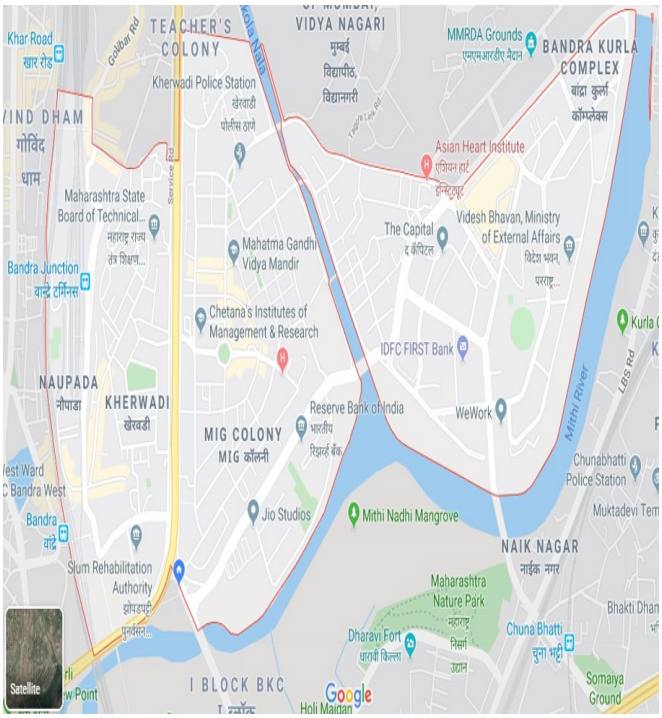

Figure 2: Map of Bandra East

According to the map view (Fig 1 and Fig 2) of Bandra which is divided into 2 parts i.e., Bandra East and Bandra West. Since the population of Bandra is more than 9,17,391 and the demand for water is also increasing, our research paper also suggests that this suburb is located to the immediate north of the Mithi River, which separates Bandra from Mumbai City. We can take the water from the river through a water tanker and create a small filtration plant for the collection, restoration, and filtering of data. Therefore, this water can be used for the betterment of Bandra and even for the people living in the city.

In Kurla, we interviewed Nehru-Nagar and other slum localities. Residents of several chawls near Kurla garden on LBS Road have been receiving contaminated water for the past 25 days. The situation got worse as dirt particles were also found in the water. We interviewed the local doctor in which he said for the past 12-15 days, people came with complaints of abdominal pain, diarrhoea, vomiting, and fever. We detected the pattern in the complaints and asked about the water they are consuming and got to know the situation. There has been a rise in cases of severe diseases as well. A few people visited the hospital as their condition was quite severe. Even a formal letter was written to the MLA where he took the review of the situation and then he instructed the authority to do

the needy as soon as possible. So here the operating mechanism was very poor as there was no proper maintenance. Also, due to education drawback, no one was capable to read or write to request help on this issue.

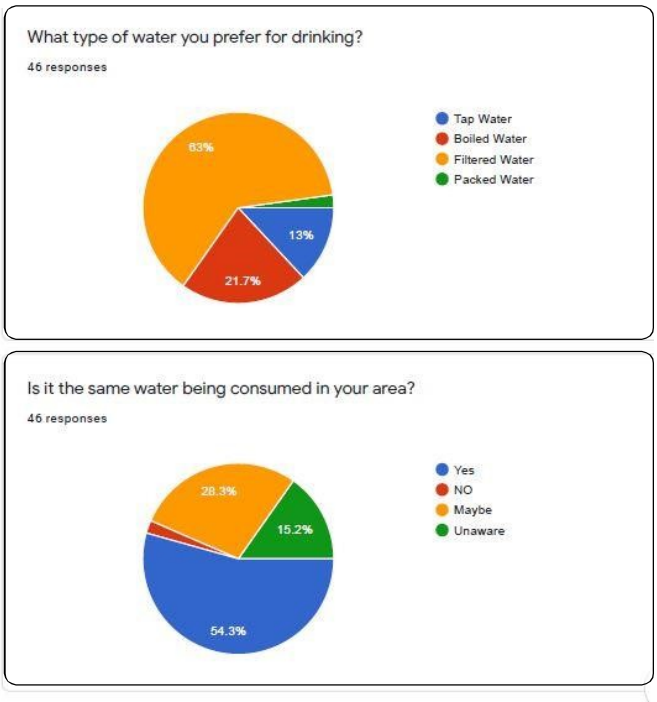

Figure 1:

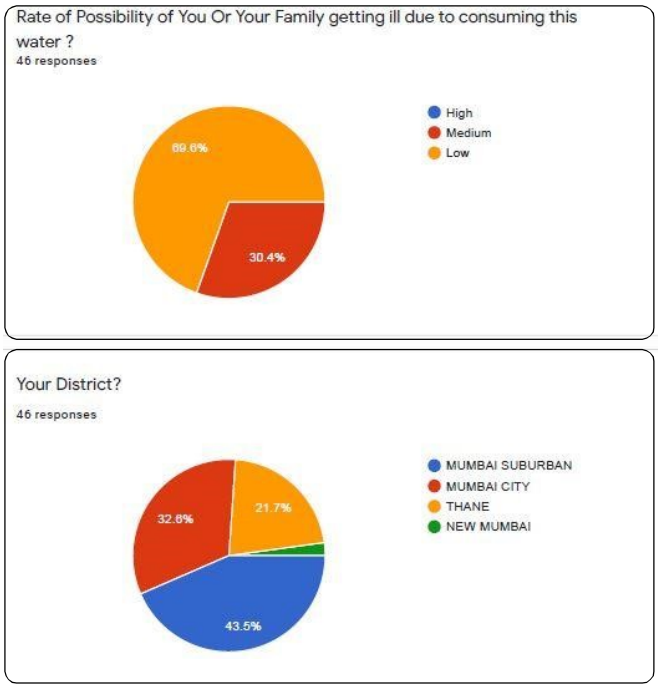

Figure 2:

Few responses were taken from different people of different districts on the type of water they use, the possibilities of getting ill and the type of water they consume daily. During our research we found that there was a gap between the pipes, and the water supplied to all the areas that had different levels of purity. So, we have come up with a mechanism to resolve this issue.

For e.g. considering two areas which have different pipes and which are maintained in a different time frame. Due to this, there might be a possibility that one of the pipes which is properly maintained may get pure water and the other pipe which may have not been maintained up to the mark may get impure water till it reaches the destination. In order to avoid such critical situations in the future, we are suggesting something that may add value to what our system is providing. This study does not doubt the quality of filtration that our Government is providing but exploring the other side of the coin. We are ensuring that water, which is the greatest gift to mankind and the main reason for each and every living organism on this planet to be distributed with the same quality and with zero pollutants, and so, we have found out a few methods that will help us to improve the quality of stored water.

The gap from where the distribution process of the Government will end, and the collection process of the society will start, in between, we are proposing a monitoring mechanism that will surely help to monitor the quality of water. We have named it **Water BreakPoint Analysis Technology** which is a cost-effective system.

This technology contains components like embedded systems, Water quality sensors, and software which can detect the quality. It will be a real-time application as it will give live updates to the user as well as a proper record will be maintained. The below figure shows the algorithm of Water BreakPoint Analysis Technology.

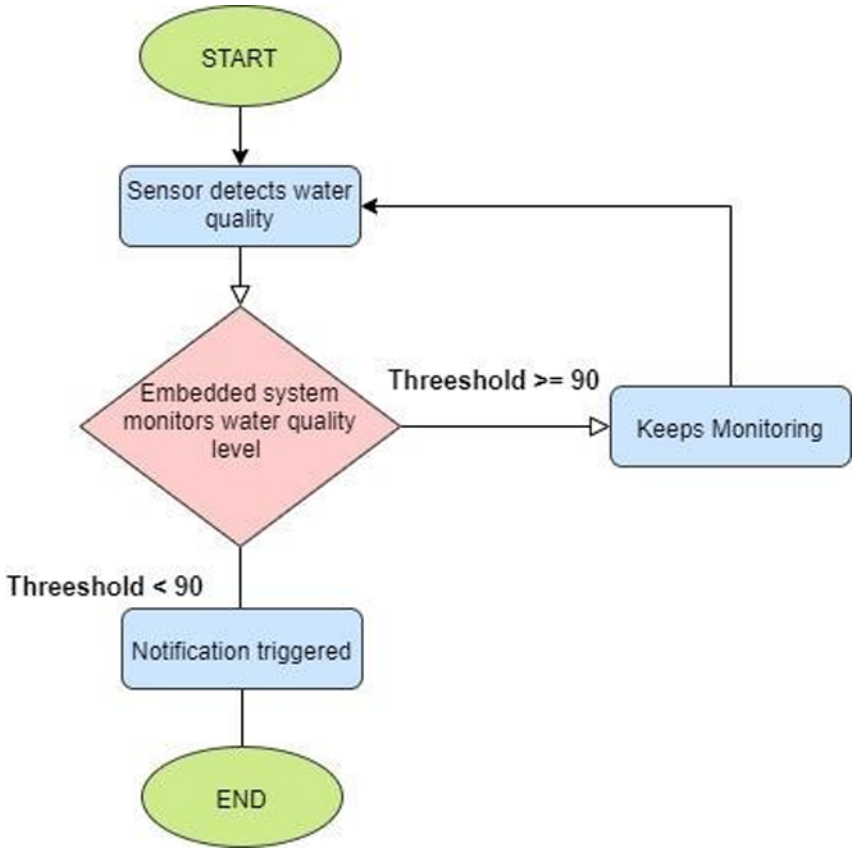

Figure:- Algorithm of Water BreakPoint Analysis Technology

These are the following steps:

- The water in the pipe will be detected by the sensors.
- Sensors will send the date to the embedded system in a machine language.
- The embedded system will convert the language which will be readable to the user.
- A particular threshold level will be assigned to the Embedded System. For e.g.: here we are considering a threshold level of 90%.
- After this level drops a particular alarm or a signal will be sent to the personnel of that particular area.
- Here we are planning to reduce the labour cost as maintenance of pipes has to be done at regular intervals which can be reduced, and this data will be sent on a daily basis, in a statistical form to the deputed person where further actions can be taken in the terms of quality.

Due to this mechanism, the concept of Kaizen can take place in order to improve the quality of the water which will be handed over to the respected authorities. This system works under the EMS (Environment Management System) Model. This model mechanism contains stages such as –

- Stage 1 - General Requirements (like Rainfall water in lakes etc.)
- Stage 2 - Environmental Policy
- Stage 3 - Planning (Environmental Aspects, Legal & other requirements such as Objectives, targets & Programs.)
- Stage 4 - Implementation & Operation (Resource, roles, responsibility & authority. Competence, training, awareness, Communication, Documentation. Control of documents, Operational Control, Emergency preparedness & response.)
- Stage 5 - Checking (Monitoring & measurement, Evaluation compliance, Nonconformity, corrective & preventive action, Control of records.)
- Stage 6 - Management Review

Following these stages in the repeat cycle, it will lead to continuous improvement

Following are the questionnaire which we considered throughout the research:

What type of water you prefer for drinking?

Tap Water

Boiled Water

Filtered Water

Packed Water

Is the same water being consumed in your area?

☐ Yes

☐ No

☐ Maybe

☐ Unaware

Rate of Possibility of You or Your Family getting ill due to consuming this water.

☐ High

☐ Medium

☐ Low

Your District?

☐ Mumbai Suburban

☐ Mumbai City

☐ Thane

☐ New Mumbai

Figure: Questgionnaires of Research

RESULTS & CONCLUSION

Water pollutants are majorly divided into solid form and bacteria form. Chlorination plays an important role in the quality of water. Since chlorine helps to remove the pollutants of the water. The residual chlorine is maintained at 2 ppm while water is conveyed from sources to water treatment plants (pre-chlorination), which also helps in reducing algae formation at treatment plants. Our system will provide a continuous monitor of the quality of water. It will check that chlorine is maintained at 2 ppm, and also checks other pollutants that were mentioned earlier in research methodology to ensure that the quality of water will not degrade. As our research roams around only in the city with only two localities taken into consideration. The problems were studied properly, and accordingly a mechanism was developed by us which will be effective in the future to monitor the quality of water. As the main aim of our research is to maintain the quality of water and make it consumable for all the people around the city. We want to say that it is the equal responsibility of the residents living in that particular area to maintain the sanitation of proper tanks in a particular time frame. The reason behind this entire research is that people shouldn't face any problem from drinking unhygienic water. As people are facing many disorders due to impure water, with our methodology we will try to reduce it to a greater extent. In the future, we just hope that everyone receives the same quality of water that may be used for consumption and for other domestic purposes. Our sensors also detect bacteria in the form of air and our quality model is cost-efficient in terms of pricing of water. It was found in our research that Mumbai Municipal Corporation charges for societies like a slum and another residential area around 4-5 rupees per kilolitre and for commercial and other industry it charges to 40-50 rupees per kilolitre, at the same countries like Singapore, their government charges for water up to 70 per kilolitre in terms of rupees. Our system will not affect any costs or price of water because our system is a one-time investment and it also does not require very much maintenance in terms of cost.

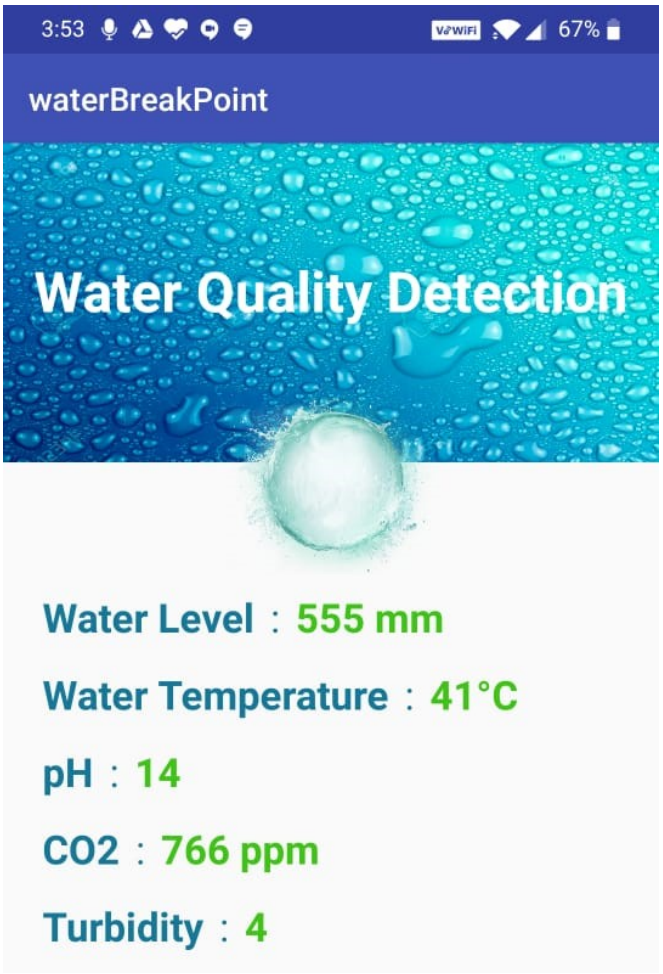

Figure: Android application home screen

RECOMMENDATIONS

We can recommend our Water Break Point Analysis Technology in certain industries as we still think that these places are the ones which require pure water.

- In hotels as the sanitation is an important factor this will be installed in their water tanks which

will detect the quality of water which can be used for cooking purpose or for sanitation purpose.

- We even recommend this technology in residential areas as it will be installed on all the water pipes which will help them to decide the usage of water for drinking purposes or for boring purposes as the same technique can be used in hospitals as well.
- Even all FMCG companies can use our technology for their projects.
- Most importantly if BMC starts using our technology it would be very helpful for them as well as to the people, as their labour costs would be reduced as they start digging their pipelines from wherever they want.
- This will be reduced as the negligence caused to the people would also be reduced and time will be saved

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ISSN: 0976-0628

Chetana's
Institute of Management & Research

Vol XII Issue 1 : pp 43 - 46

Treatment and Reuse of Wastewater in a Decentralized System

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Abstract

The water scarcity in cities is becoming severe year after year. Most of the cities bring their water from long distances. At the same time disposal of wastewater is becoming a costly affair. As untreated or partially treated sewage is disposed of in water bodies like rivers and sea, they are getting polluted. The centralized wastewater treatment plants require highly expensive and disruptive drainage network and also high investment in the treatment plant. Further, the treated water cannot be used even for non-potable uses being at the end of pipe. This paper describes the decentralized wastewater treatment technology as a viable option that helps in recovery of treated water for non-potable uses and also a rich manure that can be used in city gardens.

Keywords: *Wastewater, Decentralized, SWTS, DEWATS, CDD Society*

BACKGROUND OF WATER SUPPLY IN CITIES

Water is precious and availability of clean water suitable for human consumption is diminishing fast[1]. Big cities like Mumbai are dependent mainly on water from dams, which in turn receive it from rainfall. With ever rising population and erratic monsoons the uncertainty in water collection has reached unpredictable level. Only 2.5% of water on earth is freshwater, rest being salty ocean water 70% of the freshwater is in ice and snow cover, 29.7% ground water and only 0.3% freshwater is in lakes and rivers 70% of the usable freshwater is consumed in irrigation, 22% for industry and 8% for domestic use[2]. One third of World population suffers moderate to high water stress[3]. Most of our lakes, rivers have been polluted to an extreme level and are unusable as freshwater. Cities are mostly dependent on rain water collection system but have a poor level of rain water harvesting practice. In most of the large cities in India water is brought from long distances in pipes e.g. Mumbai – Bhatsa, Tansa, Vaitarana 70 – 100 km, Bangalore – Cauveri river > 100 km, Chennai – Veeranam lake 230 km and Delhi – Tehri dam 500 km. [4]Large sum of money have been spent in establishing and maintaining these projects[5]. Thus, the cost of

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supplying water in large cities is very high. The tariff recovered against the collection, transportation, purification and supply cost is small fraction[6].

WASTEWATER TREATMENT AND DISPOSAL

The situation regarding wastewater treatment and pollution of water bodies (rivers, lakes and sea) around our cities is precarious. Wastewater, also called sewage, in cities with independent houses as well as apartment buildings is collected but very few cities have reticulation networks to take it to a Sewage Treatment Plant (STP), and where it is present it covers only a small part of the core city areas. In others it is collected in septic tanks, which are nothing but percolation tanks where water seeps in the ground. In some cities where the sewage network is laid, the treatment plant capacity is limited. Moreover, these are end-of-the-pipe plants, the treated water from which cannot be economically used and is disposed of in the water bodies[7]. According to information presented to the National Green Tribunal in April 2019, total of 61,948 million litres per day (MLD) sewage is generated in cities and towns in India and only 23,277 MLD of this is treated, thus over 62.5% of untreated wastewater is disposed of in water bodies[8,9]!

REASONS AND POSSIBLE SOLUTION

The main reason for the pathetic state of wastewater treatment in India is highly capital-intensive infrastructure for laying sewage network and the treatment plants.[10] Also, it is highly cumbersome to lay the network in densely populated cities[11]. In view of these limitations, a best way could be to install small-scale water treatment plants closer to the generation of wastewater[12]. There are several advantages of these, especially in a water-constrained economy such as ours[13]. A comparison of centralized and decentralized systems is provided in table below:

Table: Comparison of central and decentralized wastewater treatment systems[14]

Centralized city-wide sewage treatment	Small wastewater treatment system
• Sewage treatment plant of larger capacity • Underground Sewer Pipeline network connecting houses, buildings to the treatment plant running long distance • Highly complicated infrastructure project • High Capital and O&M costs • Treated water is generally disposed of in water bodies (wasted) • Overall money spent in water treatment and transport is lost • End of the Pipe solution	• Smaller individual plants covering small localities but in large numbers • Minimal sewer pipelines • Easier to construct and manage • Comparable overall capital costs but much Lower O&M expenses • Treated water is usable for non-potable uses • Recovers Money in freshwater treatment & transport • Reduces burden on public infrastructure • In-line solution

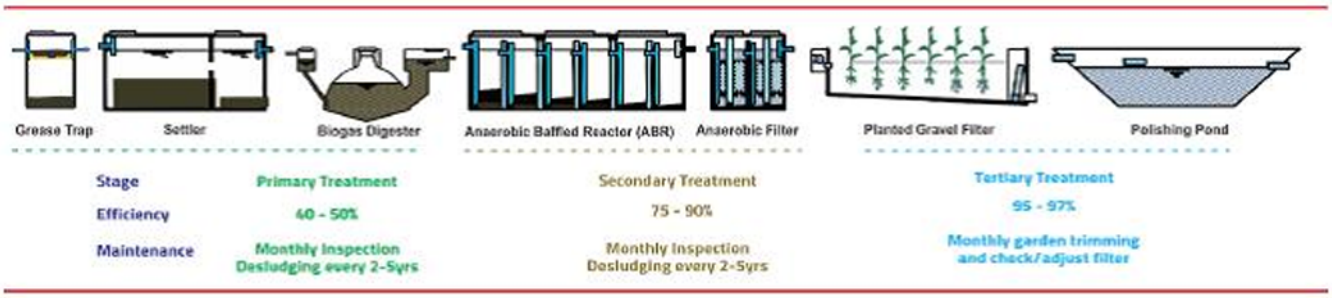
BRIEF DESCRIPTION OF TECHNOLOGY

The small wastewater treatment system (SWTS) is simple and inexpensive. It involves four main stages of treatment. They are: Settler, Anaerobic Baffled Reactor, Anaerobic Filter and Planted Gravel Filter. These may be followed by polishing pond or disinfection (with chlorination/ ozonisation) as desired. The

Sewage flows by gravity through these stages, hence the power requirement is very low and depends on the terrain of the site. The system involves mainly civil construction with minimal moving equipment; hence the maintenance is easy and inexpensive. The rough cost of construction of SWTS catering to a 28 flat residential building with about 140 inhabitants would be about [1] 10 - 20 lakhs. SWTS can be built in wide capacity range 1 KLPD to 1 MLD. This covers sewage up to 9260 persons or 1852 households. Also, now some manufacturers sell prefabricated SWTS for different sizes. By-product of SWTS is the sludge, which is rich in nutrients for plants and can be used as manure for gardens or mangroves.

CONCLUSION AND BOTTOM-LINE MESSAGE

It is high time we look differently at wastewater as an "invested resource" rather than a disposable item. Water is precious and it should be treated as such in the urban water cycle from its capture/generation to safe disposal.



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ISSN: 0976-0628

Chetana's
Institute of Management & Research

Vol XII Issue 1 : pp 47 - 53

Use of Technology in Water Management

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Abstract

Globally, there is a shortage of water because of misuse and improper handling. This paper gives a glimpse of the situation in India and the World. It then proceeds to state the importance of Artificial Intelligence in water management and its benefits compared to the manual water management methods used so far. The significance of technology in water management is highlighted with the help of two case studies wherein technological implementations are put to use for effectively managing water.

Keywords: *"Artificial Intelligence", "Technology", "Water Management", "Use of Technology in Water Management"*

WORLDWIDE STATE OF AFFAIRS

The water crisis is one of the most serious issues we have right now on the planet.The unrestrained utilization and outrageous climatic changes together have worsened the circumstance and within a blink of an eye, there will be scarcity, abnormalities in market interest, groundwater shrinkage, among other similar difficulties.

One of the most exceedingly awful Indian water emergencies is staring us at the face.We as a nation remain near the precarious edge of sicknesses, deaths, and devastation. The NITI Ayog report on Composite Water Management Index, states that around 70% of India's groundwater is polluted and in 2 years, major urban cities like Bangalore, Delhi, Hyderabad, and Chennai will face groundwater scarcity. Right now, near 600 million Indians face

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high-to-outrageous water stress, and around two lakh individuals lose their lives every year due to lack of access to safe drinking water. To help beat the water crisis, associations have begun utilizing smart technologies to fruitfully stop this wastage and be beneficial as compared to the hydrological models being used so far.

A REQUIREMENT FOR AI IN WATER MANAGEMENT

The issues related to movement, distribution & management of water result in various drastic effects, which require accessibility in terms of point-by-point and exact information of execution frameworks, normally inaccessible in the creating nations because of financial and foundation restrictions.

ANN (Artificial Neural Network) calculations support assembling an infra-structure that gives refreshed insights related to the present assets & helps in manufacturing models for up-and-coming circumstances. Programs created using coding languages equipped with artificial neural network systems formulate water activities powerfully.

It additionally helps in building up the available water assets. Scientists are attempting calculations and projects to fabricate water plants that not only give refreshed measurements about the momentum status of an asset but also help in building models for what's to come. Programming fuelled projects with sensors and neural systems strategize water-related tasks powerfully and insightfully. Forecast models for later utilization of water, automated sensors in water transfer plants, and block-chains for working the money-related exchange were made possible with the proper use of AI procedures.

Upgrading the momentum of water assets with AI as indicated by UN insights, about 1.2 billion individuals, or one-fifth of the population over the world, are living in water-scarce zones, while 500 million people are moving toward this situation. Another 1.6 billion individuals are encountering financial water deficiency situations where they come up short on the foundation to have perfect and consumable water.

With such measurements, the principal centre is around the choice of amplifying flow water assets. This enhancement and mechanization can be achieved with the basic leadership capacities of AI. Man-made intelligence-driven arrangement empowers government bodies and water offices to comprehend the constant water misfortune and abuse, structure and execute exhaustive appropriation systems that can help in improving the water frameworks over the world.

THE SITUATION IN INDIA

India possesses 4 percent of the world's inexhaustible water. However, eighteen percent of the world's total population lives in India. India generally gets yearly precipitation of 4-thousand billion cubic meters (BCM) which is the major wellspring of crisp water in the nation. Nonetheless, a wide variety of precipitation takes place over various districts of the nation.

The per capita yearly water accessibility saw a reduction from 1816 cubic meters in the year 2001 to 1544 cubic meters in the year 2011. The water usage level for domestic practices in India is set at 135 litres per capita per day (LPCD) as a normal standardized practice. This is done based on the prescription given by the 'Central Public Health and Environmental Engineering Organisation' (December 20, 2017).

With the nation previously encountering water shortage, there is a need for expansion of both-

water supply in areas receiving adequate water supply, but lacking an appropriate framework and oversee the request for water in districts experiencing scarcity. The resourceful underground water has a drastic impact on the Indian economy. It takes into account around 85 percent of provincial interest, 50 percent urban prerequisites, and over 60 percent of our water system needs. Extraction of groundwater which is unregulated has prompted abuse in numerous locations, making the groundwater table dive, drying springs, and Aquifers.

Different strategies and combinations of instruments adopted by states incorporated in state-level policies facilitate groundwater regulation in India (Narasimhan, 2008; Shah, 2014)

As per the CGWB Report (2011), the yearly groundwater draft is 245 BCM, accounting for a record sixty percent of the net water accessible. From all the resources available ninety-one percent was utilized for the systematic utilization of water. As the findings say, the consequences for the depletion of groundwater in various districts have been inconsistent. The circumstance is disturbing in areas where aquifers abuse surpasses renewal. States like Haryana, Punjab, and Rajasthan now draw more water than is yearly recharged. A few places in Rajasthan and Haryana have a high salt fixation in groundwater, which makes it unconsumable.

The amphibian assets of our country need to be preserved and taken care of. Their health, just like any other living being is directly dependent on the quality of water being consumed. To re-establish the healthiness of these assets, the Water Pollution Control Act aims at controlling and preventing contamination.

The Water Pollution Control Act commanded to keep up the quality of water and re-establish the healthiness of national amphibian assets by forestalling contamination. Then again, a report by CPCB (2017) demonstrated that natural contamination (organic oxygen request and Coli structure microbes) keeps on being overwhelming. Thereby polluting ingredients in waterways, lakes, water tanks, and underground water assets. Unformulated & unprocessed wastewater from urban areas and modern foundations are the principal explanations behind the contamination. In River Ganga, the release of numerous unprocessed wastes along the whole waterway stretch determines the fundamental driver for contamination notwithstanding the halfway subsidized ‘Namami Gange’ venture.

National Water Policy 2012 (NWP) formulated many proposals to conserve, develop & improve water resource management within the nation. National Water Policy emphasizes on lack of awareness towards the available quantity & insufficiency of potable water which leads to an ineffective use & wastage of the important source of life. The water revenue recovery in India is additionally poor.

On 11th June 2019, State Ministers in charge of Water Resources, Water Supply, and Sanitation held a meeting to review the steps taken on water conservation and implementation of action plans by various States. A water conservation campaign – Jal Shakti Abhiyan (JSA) was launched by the Government of India. It is being implemented in 256 water-stressed districts of the country.

Phase–I was executed from 1st July 2019 to 30th September 2019 across the country and Phase–II was executed from 1st October 2019 to 30th November 2019 in the southern states which receive retreating monsoon. Through this campaign, huge awareness has been generated and several stake-holders like government departments, agencies,

NGOs, officials, Panchayats, individuals, etc. have started taking steps for water conservation.

The diversified water resources across India need distinctive basin-by-basin analysis. Differing precipitation indicates that renewal is inconsistently dispositional over time. This culminates into ineffective water management and replenishment of storage facilities becoming fundamentally important rather than just mindful usage of water.

The agriculture sector consumes the biggest quantity (over eighty-five percent) of the nation's water. Water utilization would intensify more with pressure from industry and urbanization.

As per the experts, it has been predicted that by the year 2050, over half a million population which accounts for 800 million people will migrate from rural to urban locations.

Measures need to be taken to enhance the potency of water, cut back leakages, the acquisition of acceptable water tariff, refurbish and recharge native water bodies keeping into consideration several components of rural & concrete areas that suffer from water shortage for daily use (Lahiry, 2017) Under the Constitution of India – Part 1 'States and Union Territories, the topic "water" is on the state list. However, the Central government has the mandate to curb conflicts over the use of inter-state rivers. In India, water governance is fragmented that ends up contrary to the policy of water between the states and Unions.

The nation is docketing attention-grabbing developments within the space of crisis management. Two ANN models were formulated to search out the quality of water at the Gomati watercourse which originates from Gomat Taal (formally known as Fulhaar jheel) near Madho Tanda, Pilibhit, India. It extends 960 kilometers (600 mi) through Uttar Pradesh and meets the Ganges near Saidpur, Kaithi, 27 kilometers (17 mi) from the Varanasi district. In the next attention-grabbing progress, the ministry of water resources has teamed up with Google for developing an Artificial Intelligence model (AI model) to forecast floods. This program remains within the budding stage. The government of India and Google square measure operating for the most effective prognosticative analysis to handle natural disasters diligently. With government programs like 'Digital India', 'Create India', and 'Start-up India' gaining momentum and the IT sector moving towards analytics, rapid developments and adoption of AI-driven mechanisms are leading towards a hopefully better situation shortly. The paper has highlighted two organizations based in India which have provided solutions in water management utilizing smart technologies

CASE STUDIES

1. Fluid Robotics (AI)

Fluid AI came into existence in August 2016. It was the result of Asim Bhalerao's thought process based on his experiences in Mumbai after returning from the USA. Asim observed certain notice boards put up by residential societies and offices which stated water cut in those premises for a particular period during the day because of leakages and faulty pipelines. He realized that there was a lack of correct maps of the pipes from the government departments and the use of very old traditional methods to diagnose the pipeline issues as the two prominent reasons for inappropriate dissipation of water.

Asim was thus inspired to implement computer science stream influenced solutions to distinguish water & sewage network of pipelines to manage the flow and supply of water within metropolitan areas. Fluid AI asserts to be the primary company to use such a tech-enabled mechanism to resolve water problems. Multi-sensor robots were developed

to examine pipes as little as six inches in diameter and as massive as 5 by 5-meter tunnels.

AI capabilities are designed so that machines did fault detection rather than the workers, which enabled information acquisition and visualization and at a constant time forestalled information manipulation. The technique isolated the human element from the shabby and treacherous job of exploring deep pipelines and minimized human endeavors.

Fluid AI depended on the Robot-as-a-Service (RaaS) business model, developed in the line with the Software-as-a-Service (SaaS) model. Alternative services offered were topographical scrutiny, flow inspection, hydrological and hydraulic modeling.

Artificial intelligence was utilized to resolve stream and lake pollution issues through the company's work with the Municipal Corporation of the bigger cities (MCGM). The very first project of Fluid Robotics was the restoration of Powai Lake and the Mithi river. Asim was quoted saying that the project helped in treating four hundred million litres per day (MLD) of effluents that were polluting the water bodies. This has helped reduce huge amounts of human labor and about twenty million litres per day (MLD) of water leaks were identified and fixed. The company had taken the river and lake restoration model to various metropolitan regions in India which include cities like Bengaluru, Hyderabad, and Pune. It aimed to provide a perfect solution to urban water pollution problems. The work that needed groups to air the bottom around the clock, usually in area units that are wedged the foremost as a result of water contamination, was a challenge. Asim believes that the issues with water and waste material area units are interlinked and have to be solved if the country is to own water for 24 hours on all 7 days and with zero pollution levels.

2. Agua Water System

Water is progressively turning into a scarce resource across several regions in Asia and other parts of the world. The water insufficiency in India is imputed to natural and synthetic reasons. This is mainly due to poor management of resources. To deal with this problem and facilitate effective use of water, the co-founders of Agua Water Systems a Bengaluru-based start-up are validating a smart water management system to assist individuals to keep an account of the usage of water.

The smart system based on the plug and play model which is developed by Agua Water Systems utilized artificial intelligence to research the usage of water, track water level within the pump, and conjointly manage apportion of water. Agua Water Systems has developed an application to notify users about the usage of water. Individuals may manage their water pumps and sprinklers through this application, says Rohit, the founder of Agua Water Systems. A UN system-wide evaluation of global water resources graded India at 133rd position in a hundred and eighty countries for its poor water management pegged at 1,880 cubic meters per person annually. As water management is a major issue, everyone needs to utilize water with immense care. For this, Agua Water Systems came up with innovations like smart wireless devices like motor controllers, supersonic sensors, and flow sensors. The machine-controlled valve consolidated with flow sensors facilitated individuals to route their day-to-day usage of water. The wireless device was priced around Rupees Seventeen thousand and the wired device was priced Rupees Four thousand. The device is assimilated with varied tiny devices. As an example, it uses micro-controllers to control pumps, the supersonic device is employed to track water levels in tanks, and flow sensors area units accustomed to oversee and govern the flow of water.

For the project at Telangana- Kaleshwaram, Agua

Water Systems consisted of an automatic valve that helped the appropriate supply of water and controlled any type of wastage. Based on the information that is received by the device, the user comprehended if at all there is any potential outflow, concerning the water levels within the tank, or the user would be intimated if the water is gushing out. Users kept a check on the effective functioning of the motor. Agua Water Systems customized the devices as per the infrastructure design and construction style of the residential buildings.

This tech-based device can also aid the individuals employed in treating sewage at Sewage Treatment Plants (STPs). Agua's centralized gadget eased the management of the inflow and outflow of water within the STPs from a distance. Each drop was accountable for and with the rise in the number of apartment complexes in most metropolitan regions, residents were liable to pay a particular amount as maintenance bill, which also included the water bill. On one hand, when the electricity bill was paid as per the cost associated with the individual's usage, the water bill sometimes mounted, no matter the usage. "To deal with the dilemma and hold people accountable for excess water usage, Agua Water Systems has come up with a charging system, that consists of flow sensors to maintain the track of charges and managing the water flow," says Rohit.

A residential complex incurred three lakh eighty-nine thousand as their water bill. When Agua Water Systems deployed the sensors at the complex, the bill amount was reduced to one lakh fifty thousand which is lesser by fifty-five percent of the amount paid earlier. Water usage was better tracked upon and that resulted in a cost-effective mechanism for usage and handling of water resources.

Agua Water System's co-founder Siddharth, says "The water equipped by the government through underground pipes sees forty-five percent wastage of water. Nobody is ready to trace exactly where that forty-five percent water is gone." Agua Water Systems launched 'Master Metre', for this. It helped individuals in keeping track and investigating if at all, there is any loss of water.

Rohit started to develop water sensors together with the data available at his end and hosted on IoT and cloud computation mechanisms. During the same time, he started National Archives and Records Administration Technologies, which was responsible for developing wireless communication devices and universal sensors. Rohit had made water sensors in great numbers and if they didn't work the way they had to, a little scrubbing would do the needful. However, there came a realization to Rohit that some intelligent mechanism was needed to fix the improper functionality, if any, with the water sensors. Early 2016 was the time when he started working on the ideas that he had. Realizing that his daily routine wasn't taking him in plenty, Rohit who was just a college pass-out was determined to concentrate on making electronic devices. However, his interest still dwelled in the development of water sensors. Later, he additionally proceeded towards developing a mobile application for controlling the motor. It was around this time that Rohit happened to meet Siddharth at an occasion with a typical aim of avoiding wastage of water and together they consolidated every idea that they had.

Siddharth took care of creativity in terms of designs for the merchandise and the user interface whereas, Rohit worked on the mobile application and commercialism. Agua comprises of actively involved four members as a team who are collectively aiming to achieve the same target goal of solving the water crisis in Bengaluru. The team is choosing residential flats in particular alongside attempting to carry funding (Reddy, 2019).

CONCLUSION

The use of technology in the conservation of water is imperative for the country. The water crisis that looms huge over certain regions of the country must be addressed on priority. Guaranteeing that there is zero wastage of water and in turn maximization of these water resources is the need of the hour. The success stories of the Fluid Robotics (AI) and Agua water system unit are inspiring enough for individuals and corporates to invest their time, resources, and energy in an area that will be very important to the citizens and thus to the country.

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