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An Overview of Technology intervention for water purification: an Indian Context

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ABSTRACT
In the last decade increasing population and pollution rate have revealed the lapsing picture of drinking water resources in India. Indian Government proactively stepped in to support water technology research by Public and Private sectors and made significant contribution to provide S & T Interventions for water contamination removal and few of them are commercially available. Since for the policy makers it is the efficiency (effectiveness, cost, accessibility, maintenance) of the solutions, rather than their origin, is critical, an in-depth study of water purification technologies options is necessary. This research paper draws insight about the recent water contamination scenario in different States of India and Science and Technology interventions in India at National and International level has been identified.

I INTRODUCTION

Water is not as abundant and readily available as it appears. Various reports published by World Health Organization put forward alarming facts about water availability. 17-19 million people in the world lack access to clean water. 3.4 million People die every year from water scarcity, sanitation and hygiene related problems out of which 99% death occur in developing countries[1]. In South Africa alone 5.7 million people lack potable drinking water which adds to the hardship of their lives.

In India 1.2 billion people live with a very minimal per capita consumption of 1820 cubic meter which was 5177 cubic meter in 1951[2]. This decreasing trend of water availability hints to water crisis situations in coming future. It has been reported that only 68% of Indian population has access to safe drinking water. 21% of communicable diseases in India are from unsafe drinking water[3]. India is ranked at 124th position out of 174 countries in terms of Environmental Pollution Index. This is really an alarming situation and the need of efficient actions can't be overemphasized further. It is essential to have a long term vision for water conservation and management.

The global population expansion or specifically in Indian context has been rapid for the past few decades. This growing population increasingly demands heavy industrialization. In the next forty years half a billion growth in population is expected. Heavy urbanization shifts have been observed by people moving from rural section to urban parts of the country. Out of 1.2 billion 377.1 million people live in cities and it has been predicted that in next two decades 225 million people will be added to this urban population[4].

It's not just the population alone. Water is not scarce, but the efficient methods to make it available are. 85% of Indian population depends upon water withdrawn from ground water reserves[5]. In ecological conservation point of view a minimal level of water should be available for sustainable growth in the water ecosystem including rivers, lakes, ponds and ground water. Most of the aquifers suffer declining water levels. Most of them are affected by heavy salt intrusion, surface water contamination and inadequate replenishment.

Major mining and thermo-electricity generation industries withdraw major fraction of water available in natural resources. For USA, in 2000 water withdrawal by thermoelectricity industry was 3% which is expected to surge up rapidly to 28-49% in 2030[6] to cater the increasing energy demands. Such stresses on current water resources make it essential for us to reuse and recycle of waste water.

Besides this ,Indian municipal water infrastructure has been under criticism for a very long time. Every heavy rainfall or natural catastrophe like Tsunami (2004) exposes the weak links in age old water channelling systems. Water treatment technologies have to evolve one step ahead of the demands.

II WASTE WATER STATUS

Waste water quality has been degraded due to rapid industrialization in past 4-5 decades. Contaminated waste water can cause severe damage to ecology by eutrophication, GHG emission. The current treatment capacities are not sufficient enough, only 60% of Industrial waste water is treated while as low as just 26% of domestic waste water is treated[5]. The following table shows the difference between our waste water generation capacities and treatment infrastructure availability.

Table 1:
Waste water generation and treatment, Source: Jindal ITF 2011[7]

Period	Waste water generation (MLD)	Waste water treated (MLD)
2004-05	26254	7044
2005-06	29129	6190
2007-08	33000	7044
2008-09	38254	11787
2009-10	41131	13066
2010-11	51232	14484

As reported by the State departments dealing with rural drinking water supply into the on-line Integrated Management Information System (IMIS) of the Ministry, Government of India and Rajya Sabha Parliamentary Answer in 2015 by Ministry of Drinking Water & Sanitation, Govt of India the states[8,9,10,11,12,13] affected by water contamination has been shown:

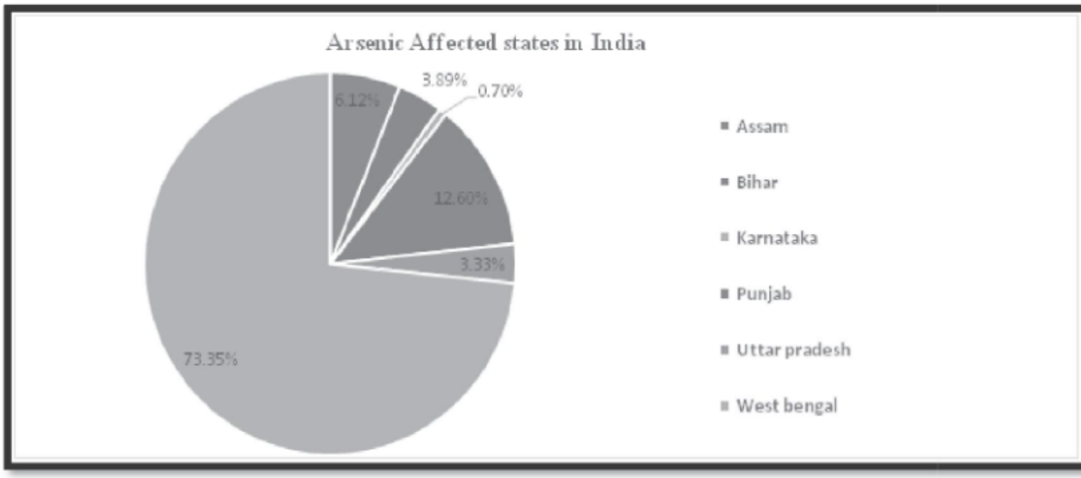

Fig 1 (a) Arsenic affected status

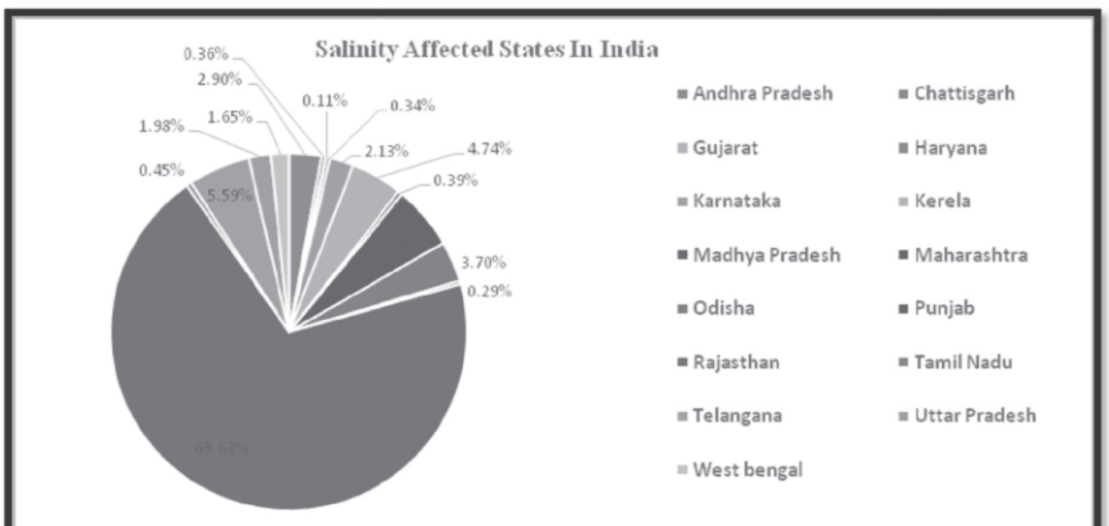

Fig 1 (b) Salinity affected status

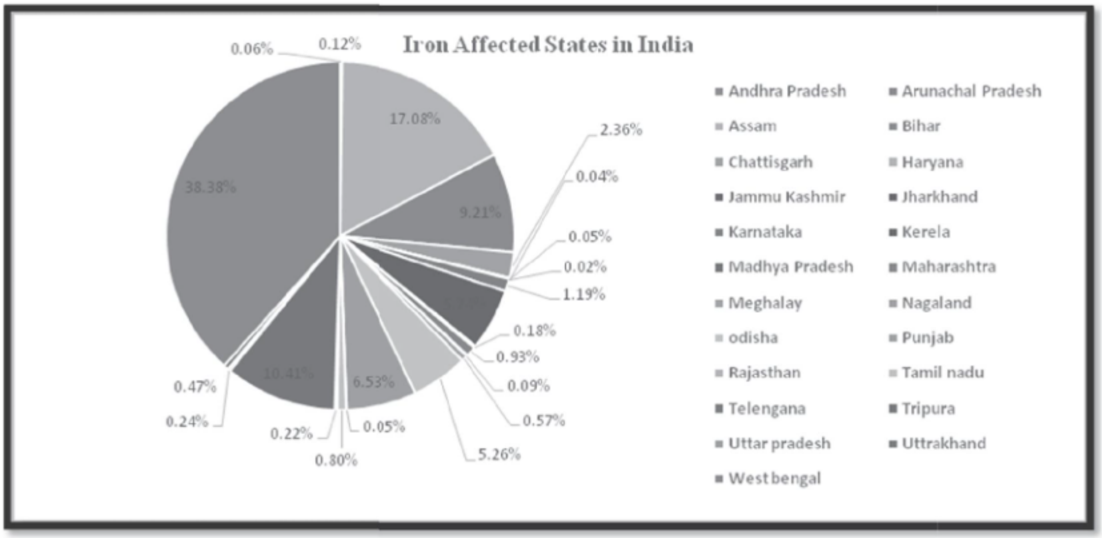

Fig (c) Iron affected status

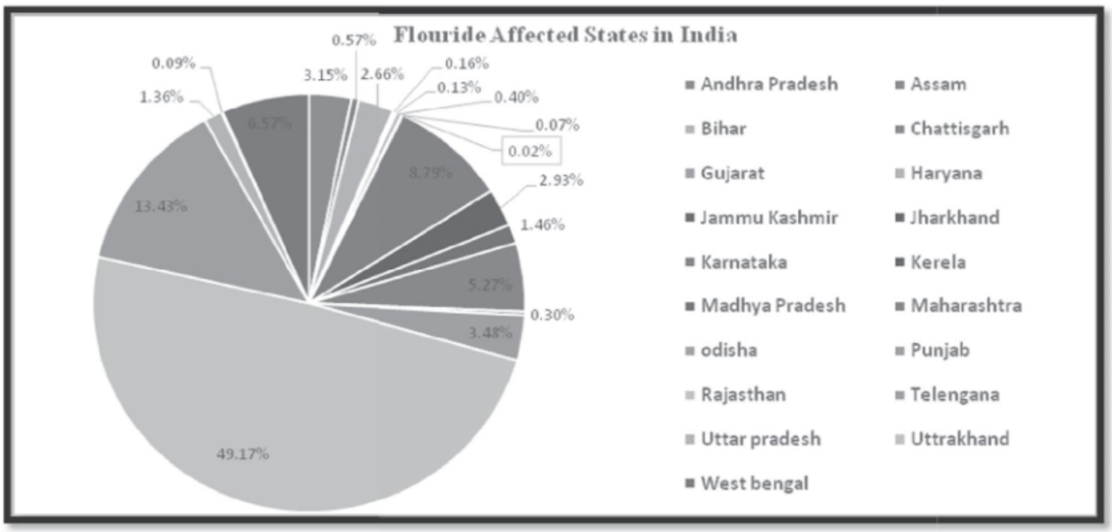

Fig 1 (d) Floride affected status

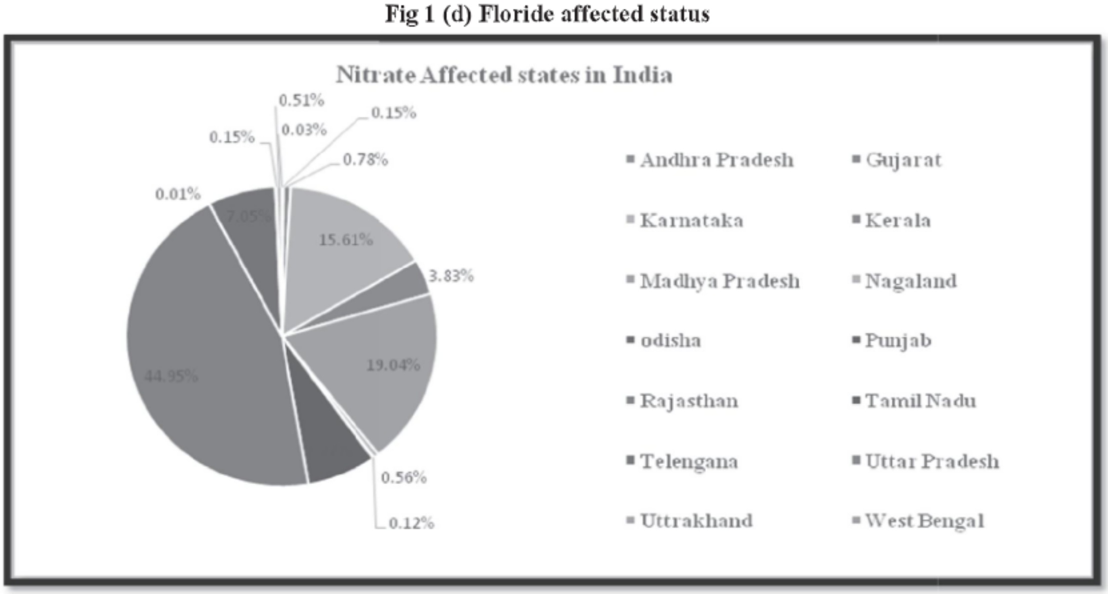

Fig 1 Nitrate affected states

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Using the data provided by Ministry Of Water Affairs percentage of contaminated sites in different states have been calculated and depending on that we analysed that in Andhra Pradesh and Mizoram more than 90 % tested sources are affected by bacteriological contamination[14,15] while other states like Kerala, Telangana, Maharashtra, West Bengal, Tripura, Haryana contaminated sample were found in the range 10-90% According to the Indian Standard drinking water-specification (Second Revision) Total Bacteria shall not be detectable in 100ml sample in all water intended for drinking.

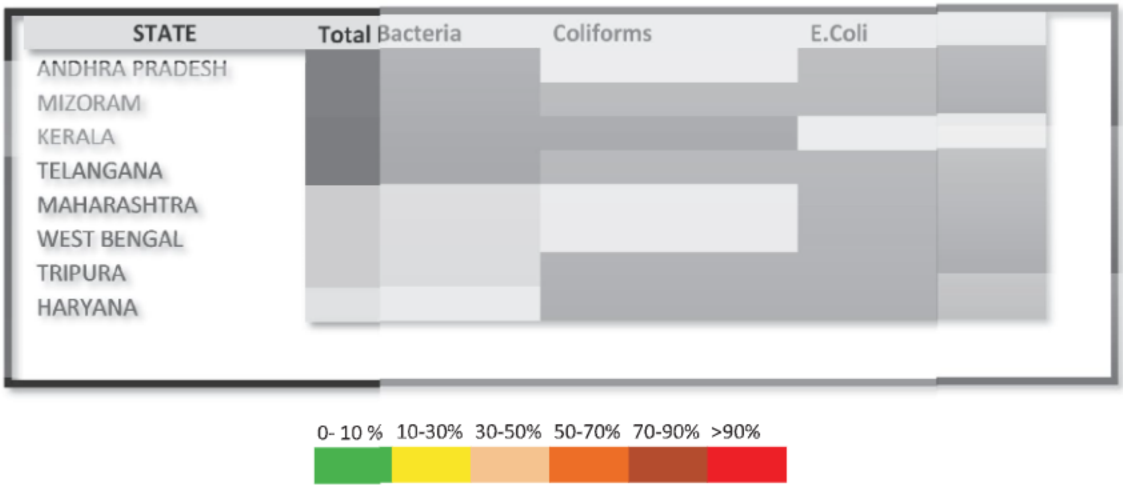

Fig.2 State wise Biological Contamination Level

This emergent perception of an imminent water crisis in the country entail a pressing need for the best potential use of water as well as technological advances to augment the fresh water by various means like desalination process, water treatments, etc.Emerging technologies have the potential to provide a long term solution for water quality, availability and viability of water resources, such as through the use of advanced filtration materials that make possible greater water reuse, recycling, and desalinization[17,18]

III S & T INTERVENTION FOR PURIFICATION

CSIR and other competing institutes have various technologies for specific/multicomponent water contaminant removal (Table2)

Table 2 :
S & T Intervention for water purification by CSIR and other competing institutes[16,17,18]

Contamination	CSIR S & T	Other S & T Options
Arsenic	Arsenic Field testing kits : IMMT, Bhubaneswar NCL, Pune Arsenic Resin membrane –(CSMCRI) Ceramic membrane based Arsenic Rem Technology- (CGCRI), Sand based technology (NML) Chemo-dearsenification (NEERI), Tube well attachable arsenic removal u –CSIR-NEERI	MERCK-HS IEHS-China (UNICEF) Jal TARA Mini Kit- Arsenic Test Kit (DRDO). Filter-Tablet system, Jabalpur University Arsenic Filter (Modified Laterite) IITGP Arsenic Filter -IITK Arsenic Removal – ARUZIF-IITB Arsenic detection - Gold Nanoparticles-HCST-UP
Fluoride	Fluorine test kits: NEERI, NCL Defluoridation-Biopolymer comp beads-(IMMT) Electro-deionization process- (CSMCR Electrolytic fluorination technique CSIR-NEERI Nalgonda Techniques (cl defluorination)- CSIR-NEERI NIRMAL new adsorbent material fo fluorination. CSIR-NEERI RO technology, IICT Hyderabad Electrochemical Defluoridation techni CECRI RO based technology and waste treatm CSMCRI	CPCB-MP MERCK Jal TARA, Jal TARA-MP BARC- Fluorination unit TERI Fluorination unit Defluoridation - Amine based polymer adsorbent-DTU Membrane separation-ICTB Defluoridation Magnetic and NanomagneticBiochars-JNU Delhi Defluoridation-Regeneration of activated alumina-HCS Rajasthan

Iron	Iron Removal Unit : CSIR-NEERI CSIR-NCL CSIR- IICT Ceramic membrane based Iron Ren Technology (CGCRI) Hand Pump attachable removal unitNE NEERI-ZAR, Red clay based 'Terafil (IMMT)	Membrane Assisted Iron Removal Technology-BARC IIT, Madras (Point of Use technology)
Salinity	LTEK-NCL Improved Desalination - RO -CEERI Desalination- Indigenous-CSMCRI	Field test kits – CPCB MERCK-IIS LTTD technology t- NIOT, Chennai. Desalination Unit- BARC Desalinization unit –TERI Dolphin desalination unit
Nitrate	LTEK-NCL (NO_3)-Improved	MERCK (NO_3) CPCB Ion exchange India ISEP Nitrate Removal System Nitrate removal - Bismuth media-IIT(BHU)
Biological	A process for the purification of Escherichia coli contaminated water for reusable option.-CLRI A process for recovery of salt from salt laden water containing dissolved organics for reusable options- CLRI A novel catalyst useful for the removal of pathogens from waste water- CLRI	Back-washable Spiral Ultrafiltration (UF) technology for domestic and industrial water purification-BARC
Multicomp-onent	Arsenic & iron -Ceramic Membrane-CGCRI Terafil Filters - pilot scale-Iron/Heavy metals/Microorganisms-IMMT	Ozone microbubbles - removal of ammonia, arsenic and odorous compounds-IITG Adsorbents from waste rubber tire- Mesoporous material-Chromium/Aniline derivatives/Pilot scale for Toxic metal_IITR Arsenic and Microbes removal using Nanotechnology-IITR Bio-coagulant/microalgae- Tertiary/Quaternary treatment - heavy metals/toxic organic compound-IITD Electro coagulation- Arsenic/Fluoride –IITGP Activated carbon-Multipollutant- Jadavpur Univ.-WB .Arsenic, iron and fluoride removal – Biosorbants- Guwahati university Biopolymers-Multipollutant- Thapar University-Punjab

IV RESULTS AND DISCUSSION

It is interesting and important to note that in terms of impact (number of people and states affected), iron contamination is at the highest place; however, in terms of severity (health impact), it is the fluoride contamination that appears to be more severe, affecting about 8.9 million people across 19 states. The fluoride contamination severity takes increasing importance in view of relatively recent finding of association between fluoride contamination and bone cancer.

It may be also noted that for most of these contaminations technologies are available; however, their deployment status is not always clear. Besides, there are competing institutional (like DRDO and BARC) and commercial technologies available. Since for the policy makers it is the efficiency (effectiveness, cost, accessibility, maintenance) of the solutions, rather than their origin, is critical, an in-depth study of CSIR technologies in relation to the other technology options is necessary.

V CONCLUSION

CSIR and other institutes already have a bunch of potential technologies seems a promising solution for the niche water related problem like Arsenic, fluoride contaminations, salinatisation, monitoring , Waste water treatments, monitoring the water quality etc. Efforts should be make towards screen some useful technologies as per their value proposition and Nation 's priorities and upgraded these technologies to highest technology readiness level i.e. market launch (commercialization)

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