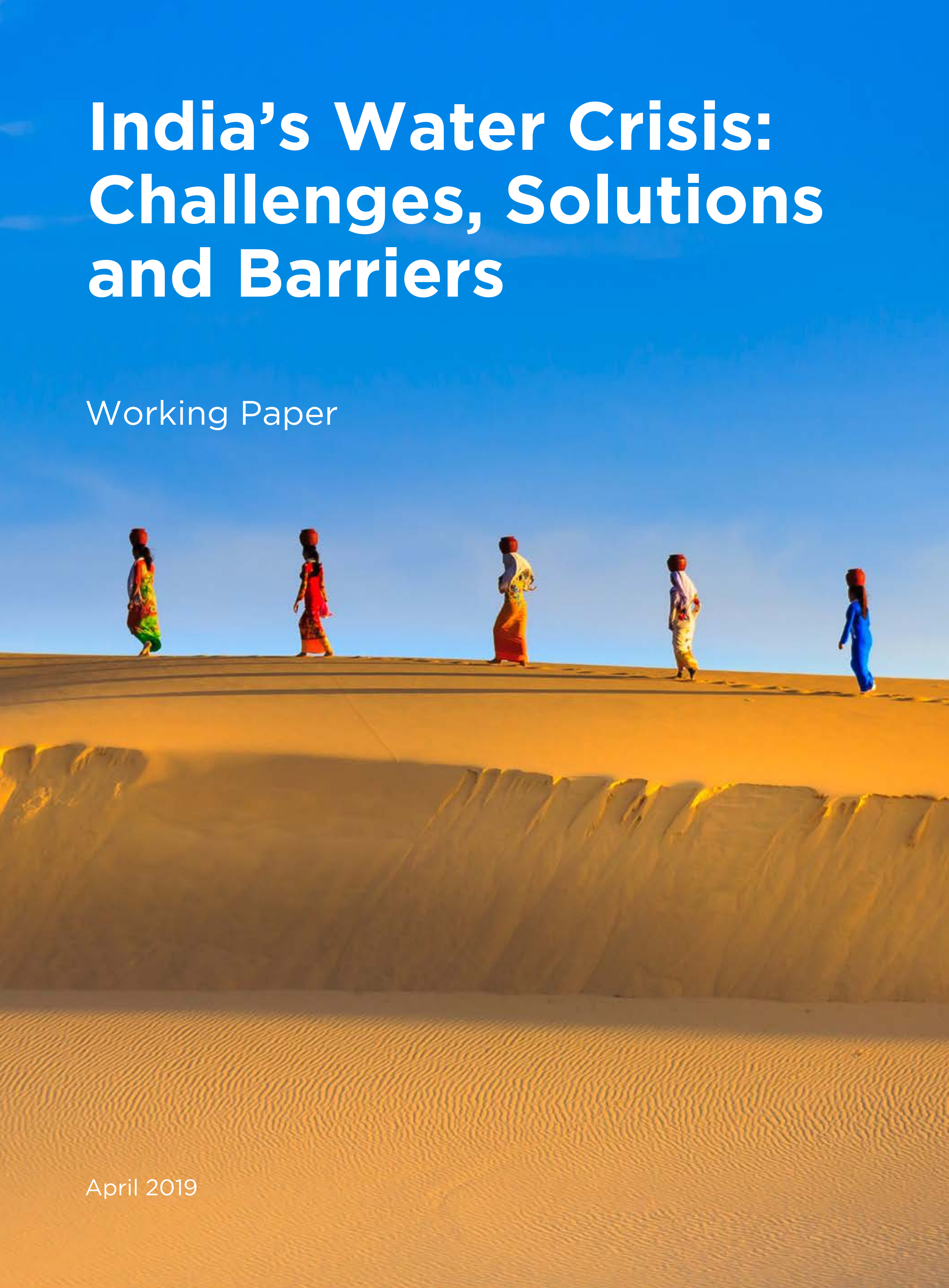
India's Water Crisis: Challenges, Solutions and Barriers

Working Paper



April 2019

RAJIV GANDHI
INSTITUTE FOR CONTEMPORARY STUDIES

Authors:
Jeet Singh, Associate Fellow, RGICS
Jasleen Kaur, Junior Policy Associate, RGICS

Review and Editing:
Mr. Vijay Mahajan, Director,
Rajiv Gandhi Institute for Contemporary Studies (RGICS)

Cover photo by Quang Nguyen Vinh from Pexels

Published by:
Rajiv Gandhi Institute for Contemporary Studies, New Delhi

India's Water Crisis: Challenges, Solutions and Barriers

Working Paper

Jeet Singh, Associate Fellow, RGICS
Jasleen Kaur, Junior Policy Associate, RGICS

April 2019

Contents

India's Water Crisis

Challenges, Solutions and Barriers

Introduction

India, accounting for around 17 per cent of the world population has been endowed with just four per cent[1] of the world's fresh water resources, which clearly highlights the need for its judicious use. Following the *Falkenmark Index*, more than half of the twenty river basins have water scarcity conditions with availability of less than 1000 cbm per capita per annum. According to a report of the Union Water Resources Ministry, total water demand in the country is estimated to increase by 34 per cent by 2025 and over 78 per cent by 2050, indicating a major gap of around 30 per cent with respect to the replenishment rate capacity signaling a serious water crisis in the nation.

This working paper is an attempt to understand the gravity of current water crisis, its future risks, policy solutions and major barriers in implementing sustainable policies. This paper has drawn from RGICS' work on water in last six months, which includes active engagement with leading activists, academicians, expert and policy makers on issues related to water. Our engagement with these different stakeholders in various from ranges from informal/ formal discussion, observing developmental activities in the sector of water and meetings. Additionally this working paper draws from deliberations by leading expert on water in a conference entitled- *'Re-Greening India: Water for All'* organized by RGICS along with Indian National Association Club of Rome in Delhi on 23rd February 2019.

The first section of the paper attempts to provide an overview of water resource potential of India in the form of surface and ground water being largely recharged by precipitation and trans-boundary flows. It also attempt to highlight water shortage in near future because of rapid growth in water demand as against declining availability of fresh water. The second section of the paper recommends supply side and demand side solutions to conserve water bodies and manage fresh water in more sustainable manner. It highlights various policy solutions for judicious use of water in agriculture, which grabs more than 80 per cent of total water consumed in the country. Additionally it touches upon issues related to river basin and aquifer based management of water and ensuring universal access safe drinking water. The third section of the paper briefly discusses social, economic and political barriers in addressing current water challenges.

Water has been identified as a critical resource in India's public policy more than three decades ago. It brought the first national water policy in 1987 and revised in 2002. However, the water crisis continues to augment. In 2012, the government of India adopted a fresh National Water Policy, which provided for significant change in our approach and action. This policy draws principles of water resource management from globally recognized sustainable systems such as Integrated River Basin Management, Conjunctive water management and aquifer as unit of ground water management. However, even after six years of the adoption the policy, there has been no progress on implementation of this policy. On the other hand, the water crisis continues to loom. The objective of this paper is to relate policy solutions with future of water resources.

2. An Overview of the Status of Water Resources in India

2.1 Water Resource Potential of India

The main source of water in India consists of precipitation including snowfall which is estimated to be 4000 cbkm and trans-boundary flows received in its rivers and aquifers from the upper riparian countries,[2] which is approximately 500 cbkm. The average annual natural flow in rivers and aquifers is approximated to be 1869.3 billion cubic meters (BCM) considering the loss due to evapotranspiration. Further, due to various topographical, technological and resource constraints[3], only about 1123 cubic cbkm can be accessed yearly by India. (See Table-1).

Table-1: Water Resources of India

Estimated annual precipitation (including snowfall)	4000 cbkm
Run-off received from upper riparian countries (approx)	500 cbkm
Average annual natural flow in rivers and aquifers	2301 cbkm
Estimated utilizable water	1123 cbkm
(i) Surface	690 cbkm
(ii) Ground	433 cbkm

Source: Water Mission, NAPCC

While the precipitation is major source of water, it is distributed highly uneven across the country and over the year. For a large part of the country, it is concentrated in the Monsoon season during June to September or October. Precipitation also varies from region to region. The annual rainfall varies from 100 mm in western part of India (Rajasthan) to 11000 mm in Cherrapunji in Meghalaya[4]. This flows into nearly 2 lakh km of rivers and 7.5 million hectares of lakes, pond, underground aquifers and reservoirs/tanks constructed by people and governments (see Table-2).

Table-2: Inland Water Resources of India

Length of Rivers and Canals (in Km.)	1,95,095 km
Other Water Bodies (Area in Million Hectare)	
- Reservoirs	2.93 M.Ha
- Tanks and Ponds	2.43 M.Ha
- Flood Plain Lakes & Derelict Water bodies	0.80 M.Ha
- Brackish Water	1.15 M.Ha.

Source: EnviStatsIndia- 2018

Water resources in India is limited and geographical distribution ranges from highly wet areas to extreme dry regions. However, it has been observed that even in traditionally wet regions, people are now struggling for drinking and irrigation water due to many reasons. Therefore, the management of water resources is crucial to use this resource in more sustainable manner. Data shows that 84 per cent of total water demand of India is for agriculture. In 2010, the total demand for drinking water was estimated 56 BCM which projected to increase 73 BCM in 2025 and 102 BCM in 2050. The water demand for industries is also expected to increase sharply in next few decades (See Table-3).

Table-3: Projected Water Demand in India (By different use)
(Projected by Standing Sub-Committee of Ministry of Water Resources)

Sector	Water Demand in cbkm (or BCM)		
	2010	2025	2050
Irrigation	688	910	1072
Drinking Water	56	73	102
Industry	12	23	63
Energy	5	15	130
Other	52	72	80
Total	813	1093	1447

Source: EnviStats India- 2018

To meet water demand there has been a high focus on creating water reservoirs and water storage structures. According to River Basin Atlas published by WRIS in 2010, there were 4728 operational dams and 397 under constructed dams in India. These dams had capacity of storing about 304 BCM water. An additional live storage capacity of six BCM had been created through medium storage projects[5]. However, despite the huge live storage capacity created over the decades, the large population remained deprived of drinking and irrigation water.

The latest NFHS survey (NFHS-4, 2015-16) reveals that more than 10 per cent people do not have access to clean drinking water and more than 50 per cent people do have access to improved sanitation facilities. In terms of irrigation, only about 90 million-hectare land is irrigated. The Maharashtra has 40 per cent of country's large dams but nearly 82 per cent of agriculture land of the state is rain fed[6].

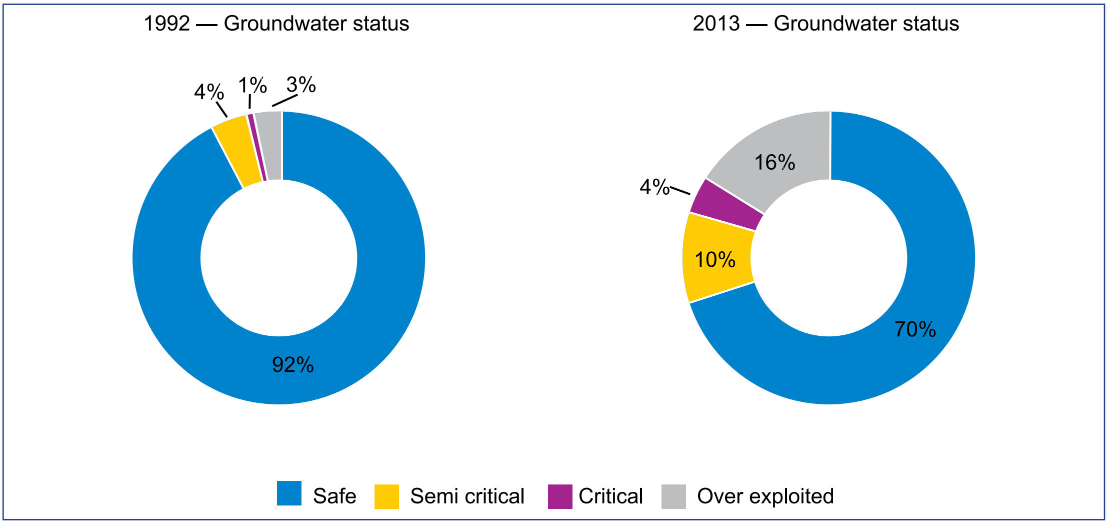
2.2 Major Water Sources in India

2.2.1 Groundwater

The Indo-Gangetic and Brahmaputra plains have enormous ground water reserve. Ground water reserve in hilly areas, western part of India and peninsular areas is relatively less[7]. The estimated total replenishable ground water is 433 BCM. The dependency on ground water in India has sharply increased from 1980s. Currently more than 85 per cent of India's rural domestic water requirements and 50 per cent of its urban water requirements are being met from ground water resources. The excessive extraction of ground water in last few decades has adversely affected the quality and quantity of the water resource.

It has also further led to ecological degradation, depletion of water table, degradation of farmland aggravating saline groundwater intrusion and putting at risk the delicate wetland. A major contributor to this rapid depletion in water tables is the deep drilling of groundwater through overwhelming dependence on tube wells. In fact the use of tube wells to extract ground water is over 40 per cent and is the single largest source of irrigation today[8]. 63 per cent of the net irrigated area in India gets water from tube wells and wells.

Chart-1: Percentage of units under safe, semi critical, critical overexploited categories on the basis of groundwater availability

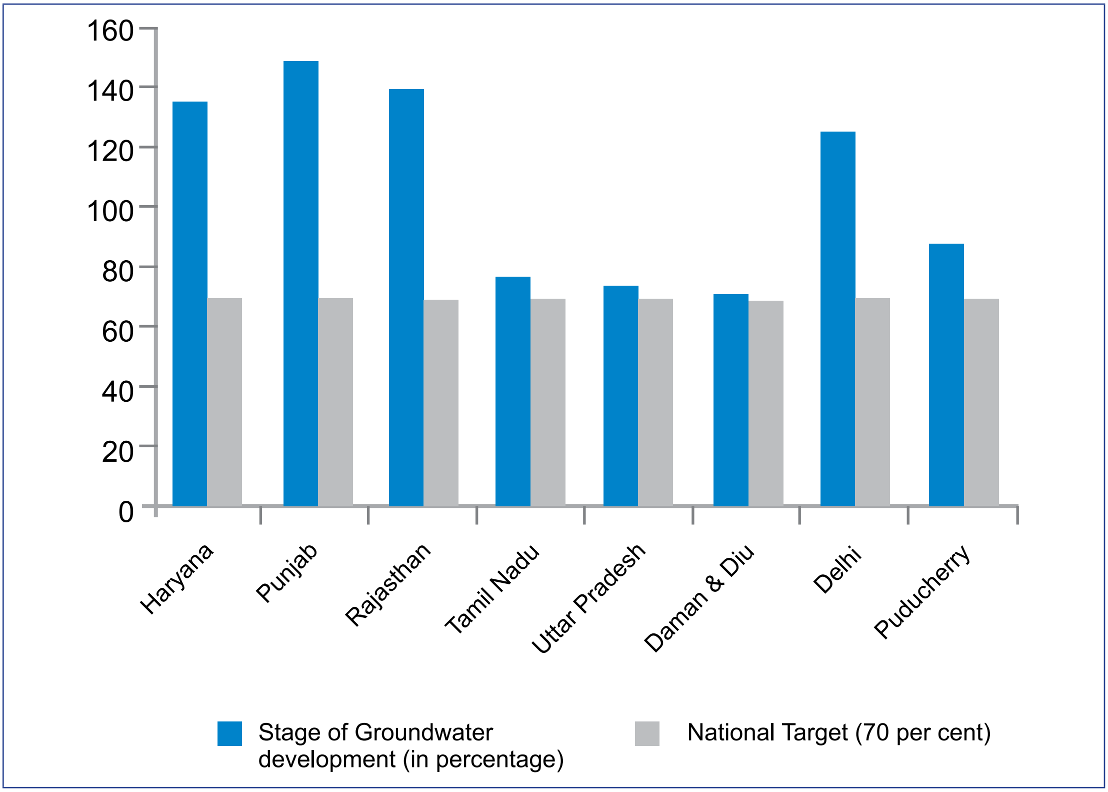


Source: CGWB report, Down to Earth

According to a NITI Aayog report[9], 54 per cent of India's groundwater wells are declining. The chart-1 above shows the percentage of periodically assessed groundwater units, the most recent one relating to 2013, which was released in June 2017[10]. It is clearly evident that the whereas the percentage of semi critical, critical and over exploited areas, combined has increased to a significant 30 per cent since 1992, the safe areas have critically declined to 70 per cent.

The indiscriminate extraction of groundwater, largely for irrigation purposes has resulted in decreasing levels of 54 per cent of India's groundwater wells[11]. While for the country as a whole the Stage of Groundwater development[12] is at 62 per cent[13], there are many states, which have exceeded 100 per cent which means that there annual groundwater draft is more than the net annual availability as against the national target of 70 per cent. The table below shows some of the states, which have experiencing severe groundwater depletion condition. (See Chart-2)

Chart-2: Stage of Groundwater development in Indian States/UTs exceeding the National Target of 70 per cent



2.2.2 River Basins

India is blessed with hundreds of river with huge catchment area and immense water resource potential. The catchment area of these rivers is divided into 20 different basins[14]. The largest river basin is Ganga-Brahmaputra-Meghna with catchment area of more than 11 lakh square kilometers and annual water potential of 1,111 BCM.

The Ganga has largest basin area, which account for 25.6 per cent of country's geographical area followed by Indus (9.5 per cent) and Godavari (9.3 per cent)[15]. Other major river basins of India include Krishna, Cauvery, Subarnarekha, Brahmani, Mahanadi, Pennar, Mahi, Sabarmati, Narmada, Tapi and few more relatively smaller basins. All these 20 river basins cover about 81 per cent of geographical area of the country[16] and provide water for 1394.02 million people[17].

With the growing demand of water for various purposes due to number of reasons, most of basins are in deep water crisis. According to international standard if per capita water availability decreases below 1,700 cbm per year the condition is termed as water stress. If it further decreases and goes below 1,000 cbm per annum the condition is termed at water scarcity.

Ten out of twenty river basins of India are in water scarcity condition as the per capita water availability in these basins is less than 1,000 cbm per annum. These basins includes Krishna, Cauvery, Subernarekha, Pennar, Mahi, Sabarmati, Tapi and few other western and southern river basins.

Moreover, three major river basins namely, Ganga, Indus and Godavari basins are in water stress condition as the per capita water availability is 1,061.74 cbm, 1,270.58 cbm and 1,486.01 cbm respectively.

According to an estimate, Ganga basin will become water scarce by 2025 and Indus basin will attain water scarcity condition before 2050[18]. Water availability estimates for 2010, 2025 and 2050 in all these basins confirms the dwindling availability of water in these river basins.

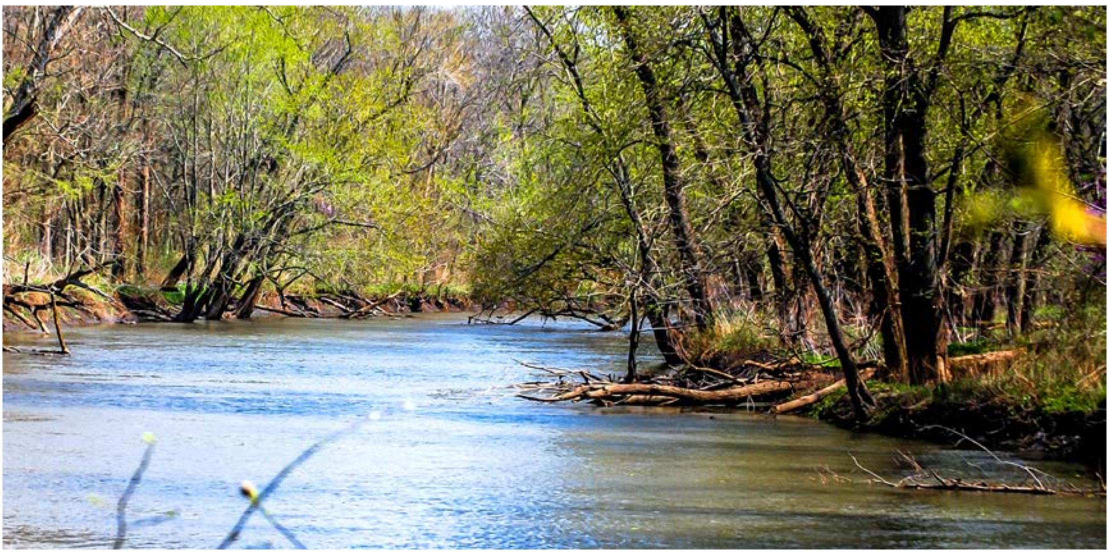
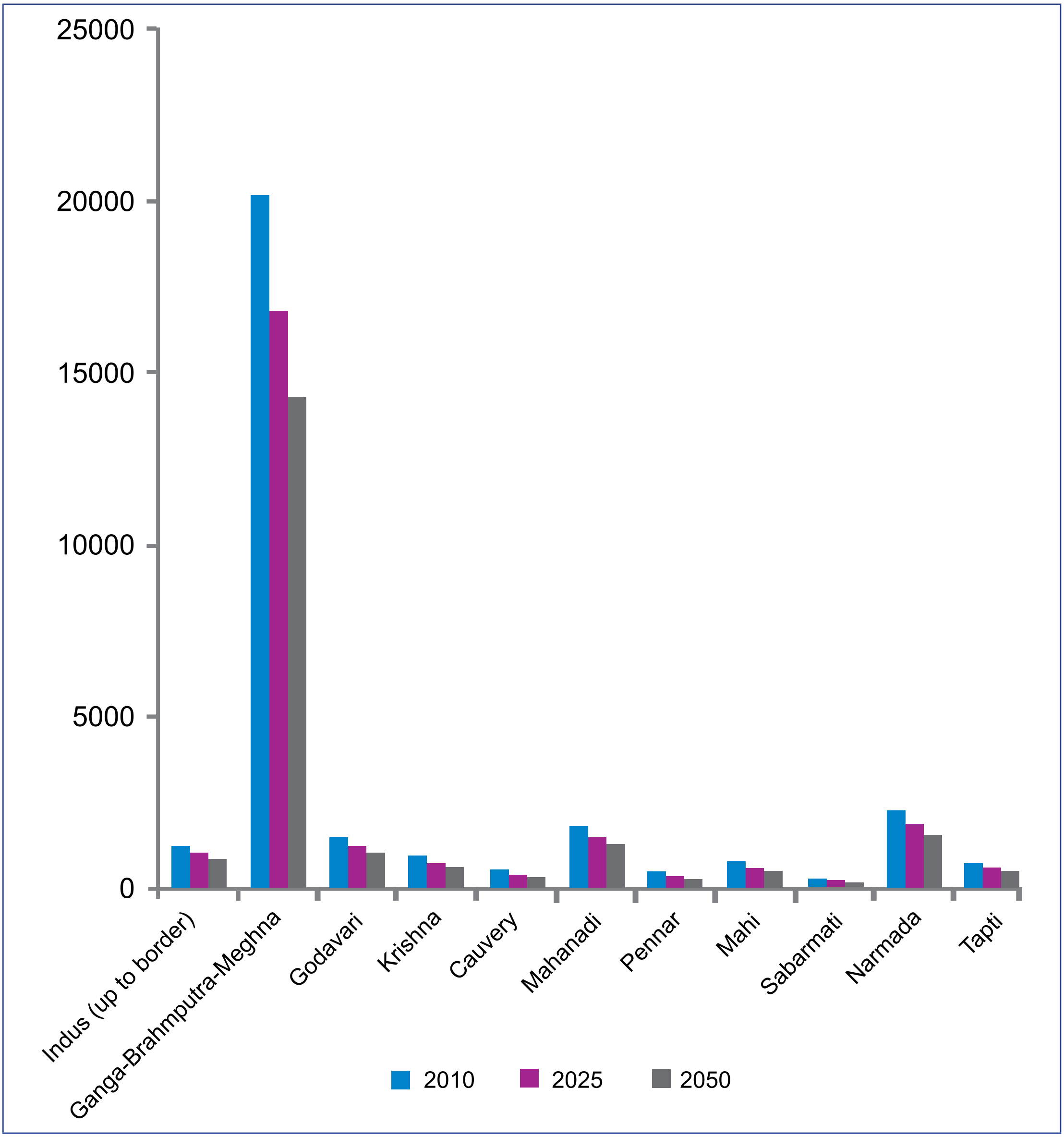


Chart-3: Estimated per capita Average Annual Water availability in some major river basins of India (M3)



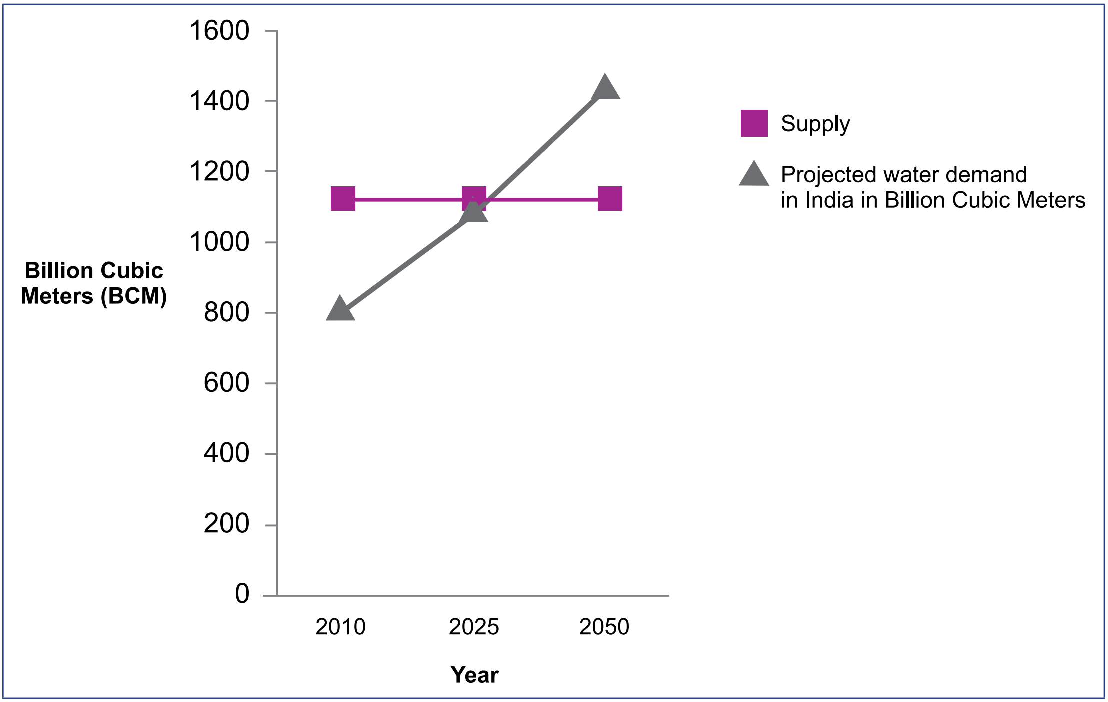
Source: EnviStats-India 2018: Environmental Accounts19

2.3 Demand- Supply Gap

According to the Ministry of Water Resources, the total demand of water in India was 813 BCM in 2010, which is estimated to increase to 1,093 BCM by 2025 and 1,447 BCM by

2050. This clearly indicates the gap in demand and supply, and in the near future, with growing population and thus the demand, the total demand for the country as a whole would be higher than the total replenishable water capacity of India (1,123 BCM).

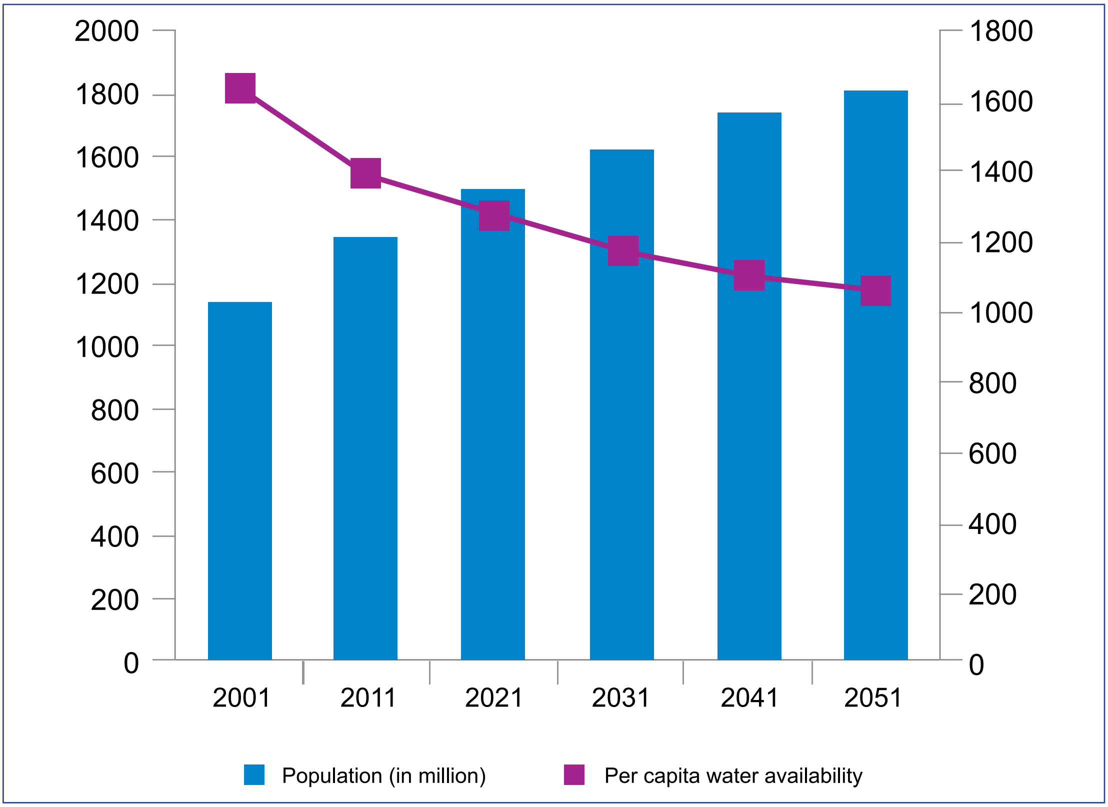
Chart-4: Demand-Supply gap in water availability per capita



Further, the crisis is compounded by an increasing population, which results in a mounting pressure on the water resources of the country. According to the Water and Related Statistics published by the Central Water Commission, per capita annual availability of water in the country has decreased from 1,816 cubic meters in 2001 to 1,545 cubic meters in 2011[20], and is likely to further fall to 1,421 by 2021 and 1,174 by 2051[21]. As per the *Falkenmark Index*, one of the most commonly used index of water scarcity, if per capita water availability decreases below 1,700 cbm per year the condition is termed as water stress. If it further decreases and goes below 1,000 cbm per annum the condition is termed at water scarcity.

While at the aggregate level, the utilizable potential stands at 1,123 BCM, the water availability at the disaggregate level depends on several other factors and it varies both, temporally and spatially. The major source of water for India i.e. precipitation is highly uneven in its distribution. Owing to the large spatial and temporal variability in the rainfall, water resources distribution is highly skewed in space and time[22]. Therefore even while the overall picture shows a demand supply gap which will begin to worsen only in the near future, many regions in the country have already started to witness water scarcity conditions due to shrinking water resources in their close vicinity, including depleting level of groundwater.

Chart-5: Population growth per capita availability of water



Source: Envistats- India 2018: Environmental Accounts[23]

2.4 Rural and Urban Perspective

> ***"While urban water access is high on average, significant gaps remain across the country, and waste water treatment remains stuck at the national average of ~33 per cent."***
> - NITI Aayog's Composite Water Management Index, 2018

The water demand and usage of rural and urban areas vary considerably. In this context, it is important to take a note of the urban and rural scenarios with respect to water availability. In India, the urban population is expected to reach a 5.05 million by 2025.[24]

> ***"21 major cities are expected to run out of groundwater as soon as 2020, affecting ~100 million people".***
> - NITI Aayog's Composite Water Management Index (2018)

This rapid urbanization and industrialization will pose new challenges to water management in urban India. This can be best understood with the example of Bengaluru, where earlier on an average, sweet groundwater could be extracted just within 50 ft, now the groundwater levels are breaching record newer lows. The crisis is going to worsen as demand for water at this consumption rate would easily overshoot supply by 2050 most conservatively[25]. In fact according to Central Public Health and Environmental Engineering Organization (CPHEEO), an average water supply in urban local bodies is 69.25 LPCD[26]. This is against the tenth Plan (202-07) recommendation of ensuring a minimum water supply level of 150 liters per capita per day for metropolitan cities and 135 liters per capita per day for non- metropolitan cities. The Niti Aayog's Composite Water management Index, 2018 also highlights this significant gap as even *"the states with the largest urban areas—Maharashtra, Tamil Nadu, and Kerala—are only able to provide drinking water to 53-72 per cent of their massive urban populations."*

Further, with approximately seventy per cent of the states treating less than half of their waste water, the urban water crisis is nearer; as we are not only depleting and wasting water but also poisoning it. 650 cities and towns across India lie along polluted rivers according to CPCB[27] due to our unfortunate treatment of rivers as drains to untreated domestic as well as industrial waste. Eminent river scientist, Ravi Chopra, contends that most of the drains in Delhi region like most other part of the country were in fact, small river streams. He strongly argues for restoration of all such drains to their original river forms and stresses on decentralized treatment plants and cleaning at the source. Auroville in Pondicherry is a notable successful case in example of Decentralised Wastewater Treatment System (DEWATS).[28]

The water crisis would also have great impact on rural areas where approximately 70 per cent of India's population lives. In rural India, the demand of water is predominantly for irrigation and drinking water. 52 per cent of India's agricultural area remains dependent on rainfall; the future expansion of irrigation needs to be focused on last-mile efficiency and building resilience to climate change.

Further the problem of "slippage" in rural drinking water has threatened water security for Rural India. The issues related to water quality have also emerged as a major new concern over the last decade or so[29]. Even though access to water in rural areas has reached high levels in many states, but water quality remains a huge problem for the country. Currently, only *"~49 per cent of the rural population has access to safely-managed water—which is far behind even our neighbours such as China and Bangladesh"*. This has resulted in one an estimated two lakh annual deaths from inadequate (or unsafe) drinking water in India.

Video Link: Major Challenges before Dying Rivers of India

In the video, Dr. Ravi Chopra identifies the major issues associated with the pollution of rivers in India and proposes practical and implemental results to deal with the same. For complete video click here: https://www.youtube.com/watch?v=dNk3GobpIlI

3. Reducing the Gap: Solutions to water management

The supply of the water is constant and in fact, decreasing but the demand is on rise. Some estimate shows that between 2025 and 2030 the total water demand of India will surpass the total available water. Moreover, the increasing rate of evapotranspiration is major concern, which is resulting into decline in total water available for various human uses. Scientist have observed that decline in the rate of water recharge due to erratic whether, melting glaciers due to global warming and rapid spread of water pollution due to untreated discharge of sewage & industrial waste and use of excessive chemical in agriculture. All these problems are manifestations of unsustainable and consumerist world order, which has now pose serious related to water risks. There are chances to reduce these risks by changing our behaviour and re-working on designing and implementation of sustainable policies. Within the policy space there is a need to adopt integrated approach and address both the issue of supply and demand of water. This section briefly describes possible policy recommendations to address current water crisis in India.

3.1 Supply Side Solutions

India has a strong history of policy driven management of water resources. The First national water policy adopted by the country in 1987 prioritized water uses. The drinking water was given first priority in this policy. We revised our water policy in 2002. The latest national water policy was adopted by the country in 2012 and it emphasizes on adopting integrated river basin management approach to manage water resources in more sustainable manner. The section 12.4 of the policy document reads, *"Integrated Water Resources Management (IWRM) taking river basin / sub-basin as a unit should be the main principle for planning, development and management of water resources. The departments / organizations at Centre / State Governments levels should be restructured and made multi-disciplinary accordingly."* However, the idea of adopting river basin/sub-basin as a unit of water management remained on paper.

A river basin approach comprises the entire catchment area and therefore acknowledges and strives to maintain all ecological services available in the catchment area. According to WWF the integrated river basin management approach rests on the principle that naturally functioning river basin ecosystem, including accompanying wet land and groundwater system[30].

3.1.1 River Basin and Aquifer as Unit of Water Management

To manage supply of water resources in more sustainable manner, the river basin approach is much needed policy intervention. The high powered committee constituted by the government in 2015 led by Dr. Mihir Shah has also strongly advocated for adopting integrated approach to deal with the issue of water crisis. The committee took the idea of the National Water Policy 2012 further and recommended for structural changes in the system of water governance. Now these recommendations need to be converted into policy without any further delay.

Within the integrated approach of water resource management, there is need to change the way we manages ground water. Acclaimed ground water expert Dr. Himanshu Kulkarni, argues

that aquifer is unit of ground water with limit defined by physical and hydraulic boundaries. Major ground water policies/schemes in India looks at the supply and augmentation side of ground water resource without any consideration of aquifer. The Easement Act, 1882 freely entitles the owners of land to collect and dispose the water under their land. This leads to an unregulated proliferation of wells and borewells. There is virtually no legal liability for them to cause any damage to water resources including over extraction of ground water. Dr. Kulkarni advocates for recognizing ground water as public good by removing provisions of the Easement Act, 1882 allowing land owner to extract ground water without any regulations.

Key elements to a successful IRBM initiativedeveloped by WWF

- A long-term vision for the river basin, agreed to by all the major stakeholders.
- Integration of policies, decisions and costs across sectoral interests such as industry, agriculture, urban development, navigation, fisheries management and conservation, including through poverty reduction strategies.
- Strategic decision-making at the river basin scale, which guides actions at sub-basin or local levels.
- Effective timing, taking advantage of opportunities as they arise while working within a strategic framework.
- Active participation by all relevant stakeholders in well-informed and transparent planning and decision-making.
- Adequate investment by governments, the private sector, and civil society organisations in capacity for river basin planning and participation processes.
- A solid foundation of knowledge of the river basin and the natural and socio-economic forces that influence it

Source: https://wwf.panda.org/our_work/water/rivers/irbm/

3.2 Demand Side Solutions

3.2.1 Agriculture and Irrigation

Out of total available water 813 BCM in India, agriculture demands nearly 84 per cent (688 BCM) for production in the form of irrigation. The coverage of irrigation has significantly increased in India after independence and currently it has potential to provide irrigation facility to nearly 113 million hectare land across the country. However only 89 million hectare land actually utilizes irrigation facility provided through various means. This demand will further increase to 910 BCM in 2025 and 1072 BCM in 2050[31]. With this estimate in next 30 years, the water demand for irrigation will overshoot the total fresh water available in the country. According to a recent study by NABARD, the three water guzzler crops namely rice, sugarcane and wheat consumes more than 50 per cent of total water for irrigation in India[32].

Production and Water Consumption by Water Guzzler Crops in India

Crop	Total Cropped Area (million hectare)	% of Gross Cropped Area	Total Production (million tons)	Total Consumptive Water Use TCWU (Km3)	Irrigation coverage (%)
Rice	43	22	110	206.2	59.6
Wheat	30	16	98	82.7	93.6
Sugarcane	4	3	306	57.4	95.3

Source: Agricultural Statistics, 2017 and NABARD, 2018

The three water guzzler crops namely rice, wheat and sugarcane cultivation together consume around 346 BCM water. It accounts more than 50 per cent of total water demand for agriculture in India. Surprisingly larger producers of these crops are state which are water stressed such as Punjab, Andhra Pradesh, Madhya Pradesh, Karnataka, Maharashtra, Haryana and Gujarat. The ground water meets nearly two third of irrigation water in India and the groundwater data shows that states leading in cultivation of wheat, rice and sugarcane such as Punjab, Rajasthan, Uttar Pradesh, Haryana and Tamil Nadu have over extracted their ground water reserve.

These water intensive crops are crucial for domestic consumption and ensuring food security of the country. However, we also export a substantial part of these productions. According to latest Agricultural Statistics report published in 2018 we export nearly 10 million tons rice and 2.5 million tons sugar to all over the world. Export of water intensive product is also known as virtual water export. According to NABARD (2018) with the export of 10 million tons of rice, we export nearly 40 billion cubic meter of water. On the contrary we import huge quantity of lentils and oil seeds, which consume less water as we produce less of them.

With increasing water demand for agriculture and depleting water resources along with severe impact of climate change, the agriculture sector is heading towards deep crisis. A latest study by OECD reveals that India along with China and United State emerges as hotspot of future water risks. The study has identified the north and northwest part of the country including Punjab and Haryana as water stress area. According to the study in next 20-30 years, the production share of major agricultural commodities will sharply decline due to water risks[33].

3.2.2 Suggested Policy Solutions

Re-alignment of Cropping Pattern: the high production of water intensive crops like sugarcane and rice in water stressed states such as Punjab, Haryana, Maharashtra, Andhra Pradesh and Tamil Nadu is because of system of procurement through government at assured price especially for rice and establishment of sugar mills to process sugarcane developed in these states over a period. Surprisingly production of these water intensive crops in wet part of the country such as eastern Uttar Pradesh, West Bengal, Odisha and Assam is less. In order to make our agriculture more sustainable there is need to re-align cropping pattern in the country. Incentivising water intensive crops in the wet part and less water intensive crops in water stressed areas will help in this re-alignment.

Irrigation Infrastructure Improvement: India has spent huge amount to create large, medium and small project for irrigation after independence. However, of the total 113 million hectare irrigation potential, the country is able to utilize only 89 million hectare land. This gap is further increasing as we have paid little attention on distribution of water. While it is necessary to strengthen irrigation water distribution system by involving people and decentralizing them, it is also necessary to promote new and efficient irrigation technologies such as micro irrigation.

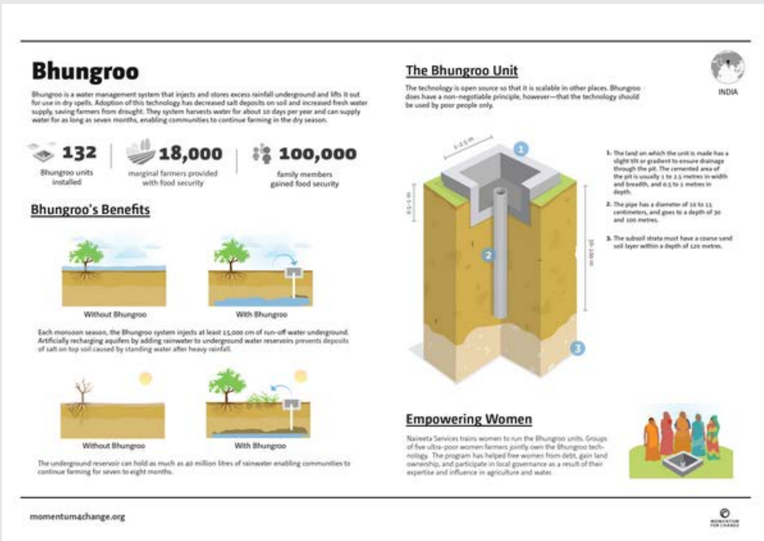
Conjunctive Water Management: The ground water meets nearly two-third of our water demand for irrigation. After green revolution, the share of ground water for irrigation has tremendously increased due to various policy and technological reasons. This has resulted in rapid decline in water table in many states. The conjunctive use of water to meet our various demands is way out. The conjunctive management approach in this sector attempts to use surface water, ground water and other water bodies in unified and comprehensive manner. The conjunctive use must also incorporate new ideas of water harvesting, storage and distribution. Bhungroo technology innovated by social entrepreneurs Biplab Paul and Trupti Jain of Naireet Services[34], based in Gujarat is one such idea. The Bhungroo technology tries to store accumulated rainwater in s specific cavity identified underground through a drilled hollow pipe. This hollow pipe is called Bhungroo in Gujarati, which also can be used to lift water from the cavity for irrigation, when needed.

Climate Resilient Agriculture: with rapid change in climatic conditions and higher risk to crop production, there is need to innovate, promote and adopt climate resilient agriculture. Apart from new technologies on climate resilience, traditional agriculture also teaches us to grow climate resilient crops. There are thousands of indigenous seed varieties for all major crops in India and these variations in seeds used to diversified our agriculture production and sustain us against any drastic climatic change.

Policy Reform: India has large web of policies related to farm and farmer, many of them are unsustainable and risky for the future of agriculture production. For example use of unregulated tube wells with free or subsidised electricity to run them were introduced to solve the problem of irrigation. But, now this solution has become a problem as excessive underground water extracted by these tube wells has drastically depleted the water table. Such policies needs to re-visited to correct them for more sustainable future.

Recharging the Groundwater through Bhungroos

Drought poses a serious issue to the farmers of Gujarat. The limited rainfall that the farms receive brings no respite. It causes flash floods, leading to water logging and soil salinity during the peak cropping season, thus reducing the soil fertility and adversely affecting the agricultural produce and therefore the farmer's income. In fact water logging affects 12 states, encompassing 7 per cent of India's total landmass; and threatens food security and livelihoods of around 2 million marginal farmers.



This situation which arises to temporal variation in availability of water requires efficient management techniques to harvest rainwater and ensure an adequate supply of water round the year. Gujarat has successfully adopted one such innovative technology to manage the limited rainfall, avoiding both water logging and dry spells. Bhungroo, as it is popularly called is a water management system for artificial recharge of aquifers. It injects and stores excess rainwater in a massive underground water reservoir, which can be later utilized during the period of dry spells. The system harvests water for about 10 days and can provide a supply for as long as seven months. The initiative which helps in building resilience against Climate Change has particularly lifted the status of women farmers freeing them from debt and enhancing their incomes.

Source: https://unfccc.int/climate-action/momentum-for-change/women-for-results/bhungroo

3.2.3 Drinking Water

According to an official estimate, the water demand for domestic use is 56 BCM, which is projected to increase by 73 BCM in 2025 and 102 BCM in 2050. The major part of this demand is met through groundwater resources - 85 per cent of India's rural domestic water requirements and 50 per cent of its urban water requirements are met from ground water.

Providing safe drinking water to all is still a big challenge. According to NFHS, 2015-16, more than 10 per cent people in the country do not have access to clean drinking water and more than 50 per cent people do not have access to improved sanitation facilities. According to Ministry of Drinking Water and Sanitation of the total 17,26,031 rural habitations only 77 per cent have access to drinking water.

Water quality for 4.2 per cent habitations is highly contaminated due to sewage discharge and untreated discharge from industries[35].The current gap between demand and supply for drinking water both in rural and urban is huge. We are unable to provide minimum 40 litres per capita per day (lpcd) to all in rural areas. Similarly, the standard water requirement in urban areas is 135 lpcd of which our total urban supply is merely 69 lpcd[36]. This is bound to increase in near future if radical policy interventions are not adopted. Following policy initiatives suggested by various experts and organizations can be adopted to address risks related to drinking water.

Arresting Water Pollution: The water pollution has come up in big way in last few decades and became a major challenge for water portability. Available data suggests that pollution level has increased in surface water as well as ground water. Moreover, the pollution is spreading rapidly and contaminating more water bodies. The main sources of water pollution are discharge from sewage, industry and use of fertilizers and pesticides. The prevention of pollution of water sources is critical in order to continue to portable water supply. The government of India has identified 19 states severally affected high fluoride content in drinking water and at least 10 states suffering from arsenic contamination leading to diseases that affect lungs, skin, kidney and liver[37]. While public awareness and capacity building of local people is important to keep water bodies free from contamination, it is also important to find policy solutions to ensure sustainable use of chemicals and proper treatment of sewage and industrial waste.

Decreasing Slippage: Slippage is yet another major problem in achieving goal of universal access to safe drinking water. Data of Ministry of Drinking Water and Sanitation reveals that the coverage of safe drinking water has only increased from 74 per cent in 2012 to 77 per cent in 2017. Slippage in this context means fully covered habitation slowly slips back to non-covered or partially covered state due to shortage of water. Erratic whether, depletion of ground water, reduction of water bodies and pollutions are some major reason behind slippages. Unfortunately, this has become a recurrent problem especially in rural areas. Therefore, intergraded approach of water resource management is needed for schemes related to drinking water supply.

Curbing Water Leakage and Pilferage: The national water policy, 2012 suggest to local urban bodies to collect and publish water account and audit report to fix the problem of leakage and pilferage. Several studies on water leakages in India indicate that about 30 per cent to 50 per cent water in urban supply is lost due to leakages, theft, unauthorised connections and incorrect metering[38].

4. What Holds Us Back?

The previous sections identified the various gaps in demand and supply, and proposed solutions to manage both demand side and supply sides challenges. Eminent water experts and several government committees itself like the Mihir Shah Committee, in the past have endorsed these and many more solutions to efficiently manage the water resources. However, most of them end up as being mere recommendations on the paper only and remain unimplemented. Therefore, it is very important to understand the underlying causes and issues that hinder the execution of the wisdom proposed and recommended for effective management of water. This section thus points out major impediments that restrain the implementation of effective solutions for water management that will help in reducing the demand supply gap, given the increasing population and mounting pressure on water resources.

4.1 The Political Economy of Water

The political economy of water – the prevailing pattern of control over it - gives rise to a range of inter-related institutional impediments, out of which vested interests of stakeholders, institutional fragmentation and coordination challenges pose great challenges[39]. In case of India, the political economy of water plays a crucial role in determining the water related policies and their implementation. Examining some of these aspects thus becomes necessary.

The major challenge to implement the proposed solutions to ensuring water for all comes from Institutional fragmentation and inter-governmental coordination. "*Institutional fragmentation refers to the division or to the overlap in governance functions across multiple agencies or units, such as when ministries of energy, agriculture, water and infrastructure all play a role in carrying out water planning or other related water governance functions.*"[40] The efficacy of water reallocation depends on water governance institutions, including how they coordinate and cooperate amongst themselves [41]. However, in India, this is flawed since whereas groundwater is managed by Central Groundwater Board, the surface water is managed by Central Water Commission. A recent study[42] published by *Nature* has found that "Ganges river depletion is related to groundwater base flow reduction caused by ongoing observed groundwater storage depletion in the adjoining Gangetic aquifers".

This establishes linkage between depleting groundwater and decreasing quantum of water in rivers and demands a comprehensive and holistic approach to management of water resources. Understanding this, Mihir Shah committee pushed the case for a paradigm shift and institutional reforms, recommending the establishment of a National Water Commission, nation's apex facilitation organization dealing with water policy, data and governance; subsuming the CWC and CGWB. However, due to lack of administrative will and friction to reforms this recommendation lies unimplemented.

4.2 Impact of Data availability

Further, the fragmentation and lack of coordination impacts the data availability and creates a knowledge gap about water resources. It is the adequate and reliable data that drives an evidence based and data driven policy making; and knowledge dissemination promotes transparency, awareness and encourages participatory approach in water governance. A successful example of this was observed in "the FAO-supported APFAMGS programme in Andhra Pradesh that aimed at involving farmers in hydrologic data generation, analysis and decision-making, particularly around crop-water budgeting"[43]. However the spillover of political economy and institutional coordination barriers is all observed in case of data collection and sharing.

Apart from the *inherent complex dynamics of water resources* like aquifers being an invisible resource, is challenge to their monitoring, there exists the issue of *highly fragmented data collection and dissemination*. For instance, collection of physical data such as precipitation comes under different ministry, whereas the user data comes under diverse classifications as public health and sanitation, irrigation and urban planning.[44] This is complemented with the issue that "water" is a State subject, leaving Central agencies to rely on State agencies for any data primarily, thus hampering the accessibility of data within the government agencies itself.

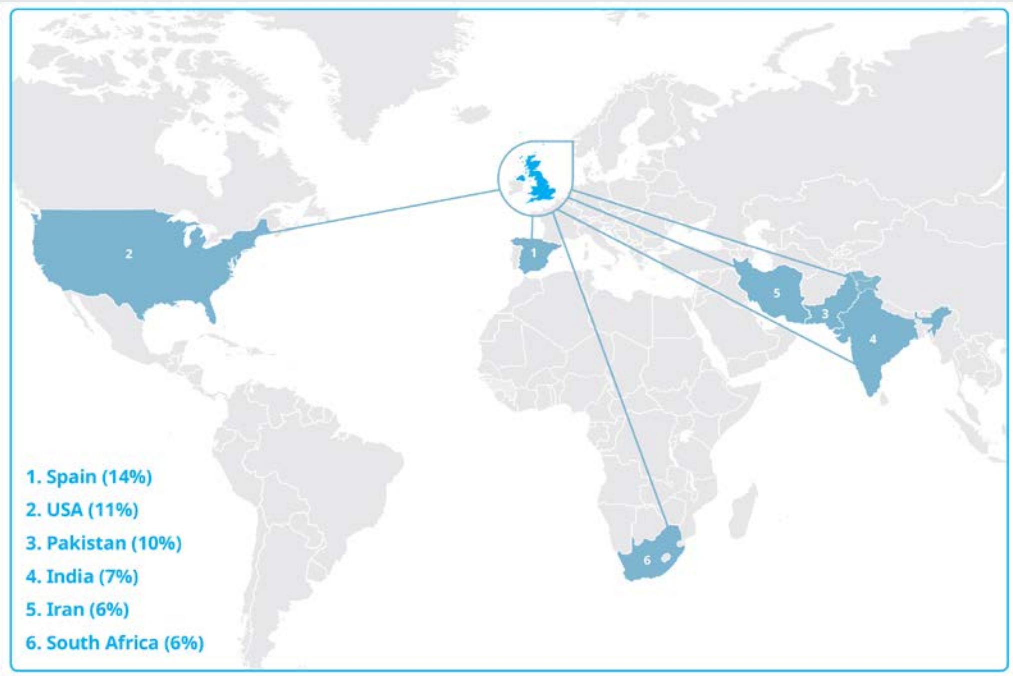
Another case in example is that despite efforts to benchmark water utilities in 2000s, most utilities fail to provide consistent data even on the length of their distribution or sewage network, let alone data on their network performance. This shows that even though a massive data is created, but it ends up contained in the inter-utility and intra-utility silos, consequently these data are unable to talk to each other thus stripping off the *possibility of their integrated meaningful analysis*. Data for pipe breaks, leakages or sewer blockages are least systematized and often not even recorded.[45] This discourages participatory and decentralized approach to water management and impedes the politicization of the issues related to water misallocation in the political discourse.

4.3 Lack of trained professionals from diverse backgrounds and Coordination between stakeholders

Besides recommending a comprehensive governance of surface and ground water, the committee also points out the lack of capacity building of professionals and participation of civil

Virtual Water Exports

Whereas ensuring drinking water and water security is a major concern, the political economy of water is greatly influenced by what is called virtual water exports. The term "virtual water" coined at a seminar at the School of Oriental and African Studies (SOAS), University of London in about 1993, is used to refer to water embedded in products with high water footprints. For example, water is exported virtually in the export of finished cotton since the footprint of manufacturing 1 kg of finished cotton is 40,000 liters. This is gradually leading to redistribution of water reserves and especially as huge volumes of the most precious resource is being exported by the developing countries to the developed nations. The following image explains through example how nearly half of the UK's virtual water imports come from countries with unsustainable levels of 'blue' or irrigated water use. This includes such water-scarce countries as Spain (14 per cent), the USA (11 per cent), Pakistan (10 per cent), India (7 per cent), Iran (6 per cent) and South Africa (6 per cent) with sometimes worrying implications for the exporting areas.



Although the exports earn the developing nations economic wealth, but the unsustainable virtual water exports would impoverish them of the Water Wealth, thus threatening water security of its own people. In a recent report by Water Aid, India is the third largest exporter of groundwater – 12 per cent of the global total. This makes it necessary for the political to consider the contemporary issue of growing virtual exports from India, given the fact that around one billion people in India already live under physical water scarcity. This requires immediate attention and better coordination between ministries. responsible for water intensive export oriented activities in sectors such as Agriculture, Industrial etc.

Source: Beneath the Surface: The State of the World's Water, Water Aid. (2019) https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/beneath-the-surface-the-state-of-the-worlds-water-2019-.pdf society and local community, which impedes a decentralized and participatory management on water resources, especially groundwater. There is an acute lack of professionals from a large number of disciplines, without which these bodies will continue to underperform. For example, without the knowledge of the social sciences and management we cannot expect programmes such as Participatory Irrigation Management and Participatory Groundwater management to succeed.

Similarly, without experts from Agronomy, which crop water budgeting cannot happen and water use efficiency will not improve[46] and without the participation of Ecological Economists, we "will not gain an accurate understanding of the value of ecosystem services, which need to be protected in river systems and River Ecology, which is essential to the central mandate". The report argues to move beyond the approach to water embodied in techno-centric supply-side interventions implemented top-down by fragmented bureaucracies, involving mostly technology, engineering, and public investment in water infrastructure, towards a more people-centred approach to water management that leads to rejuvenation of rivers and aquifers, so that we can sustainably meet the needs of water security of our people and move towards comprehensive drought-proofing.[47]

4.4 The developmental myopia

The short sightedness in Infrastructural development poses a serious threat to water resources, and water and food security of India and hinders the implementation of various solutions and policy framework. The projects either have *"short term economic goals"* or at worse are *"completely divorced from any concerns threatening the availability of water"*. The developmental projects like Chardham highway, over simplistic understanding of surplus-deficit in the proposed interlinking of rivers, indiscriminate dam construction with poor utilization of irrigated potential as seen in the case of Maharashtra show the short term economic goals. Whereas, an example of the latter, where no consideration is made regarding the situation of water resources in the region, is the Delhi Mumbai Industrial Corridor(DMIC) that envisages developing 10 cities with a population of over ten millions. This comes as *"most shocking and least intuitive"* since it covers areas which are some of the most water stressed ones in India.[48].

Due to social heterogeneity given social, income and gender inequality[49]; arise conflicting interests and competition for water among various sectors, and a general culture of water profligacy that poses a challenge to achieve water use efficiency. The most striking contemporary relevant example of this would be of the manufactured bottled water. The growing concerns over the contamination of tapped water and the culture of purified, Reverse Osmosis (RO)s and Ultraviolet rays (UV rays) treated water have led to an increasing demand of bottled water in India and across the world. While bottled water used to be the beverage of only the wealthy, it is now today's drink of choice of both the health- conscious and average consumer.[50]

An example of the ambitious scheme for interlinking of rivers also validates how due to short term perspective of economic development, all the concerns raised by eminent scientists and various committees are ignored. Some issues related to it include the comprehensive proposal to link Himalayan with the Peninsular rivers for inter-basin transfer of water was estimated to cost around Rs. 5,60,000 crores in 2001,[51] adding to it the costs due to land submergence and Rehabilitation and Resettlement package.

4.5 Vested interests and conflicting interests

Vested interests are likely to pose strong resistance to any effort in paradigm shift for better water resource management. The reallocation of water from irrigated agriculture to environmental purposes, cities or other basins is a prime instance when vested interests will oppose reallocation or demand compensation[52]. Lack of bureaucratic will and the prevalent status quo-ist attitudes is also hindrance to bringing about institutional reforms[53] to ensure better governance and it also imposes obstacles to water reallocation.[54] This vested interest is also seen at the public level, which is reflected by a rampant, privatized and atomized extraction of groundwater.

Apart from the high economic costs, the logical issue remains that due to India's dependence on monsoons, rivers having "surplus" water are generally synchronous across the subcontinent. The interlinking which has been proposed time and again as a result of the over simplistic understanding of Surplus and Deficit in the river basins,[55] fails to take into account the reasonable needs of the basin states, which will grow over time.

Further, another example where lack of long vision had marred all the wisdom shared time and again; is seen in the high focus on creating water reservoirs and dams, to meet water demand there has been. According to River Basin Atlas published by WRIS in 2010, there were 4,728 operational dams and 397 under constructed dams in India. These dams had capacity of storing about 304 BCM water. An additional live storage capacity of six BCM had been created through medium storage projects[56].

However, despite the huge live storage capacity created over the decades, the large population remained deprived of drinking and irrigation water. Maharashtra, the state with highest number of dams in India (40 per cent of country large dams) continues to have 82 per cent area of the state as rainfed[57] and is at the epicenter of drought in India. It also raises question regarding the rationality of dam construction, where maximum investments worth thousands of crores occur in constructing the dams and reservoirs and least focus in given to building the channels and reaching out to the farmers' fields, which would help ensure water availability for agriculture, farmer welfare and food security.

5. Conclusion and Way Forward

As has been discussed in the section on *An Overview of the Status of Water Resources in India*, the water resources in the country are under stress. Although India has 4 per cent of the total water resource in the world, but it is much less than proportionate when we take into account that India has 17 per cent of the world population. The demand-supply gap for the country as a whole has been estimated to be imbalanced (with demand over shooting supply) in the near future; however many regions are already suffering from conditions of water scarcity and drought. This situation which impacts both rural and urban areas is further compounded by climate change which not only would lead to erratic rainfalls and shrinking glaciers but also would make the extreme weather events like floods and cyclones much more common. It would put to risk the living standards of 60 million Indians, as has been highlighted by a 2018 World Bank report[58] on *South Asian Hotspots*.

It is thus important to have adequate mechanism and policy framework considering that the supply of water is constant and in fact depleting over time as against rapid increase in demand. The country is already in deep water crisis and it is expected to worsen in near future if radical corrective measures are not taken now. In last few decades, various experts, institutions and policy documents in India have reiterated the need of adopting integrated and sustainable water policies. Some of these policy solutions, both the demand side and the supply side, are highlighted in this paper. However, due to various hindrances these progressive ideas remain unimplemented.

The political economy of water in India and the challenges arising from it remain the largest hindrance to treading the path of solving the water governance and management issues to ensure a sustainable supply. Its impact is seen on the data collection and sharing also that occurs due to lack of institutional coordination. It is also due to the political economic reasons that the already existing bureaucratic and institutional framework offers friction to involvement of professionals from diverse backgrounds and stakeholder participation, which keeps the policies devoid of a holistic and inter-disciplinary perspective on water related issues. Further, the conflicting interests of different sections and their vested interests, deters any reforms in the pattern of control over water resources and this exists not only in the higher echelons but also in the public and communities.

Finally, it has been pointed out that how the myopic outlook of economic development blocks all the wisdom on sustainable use of water and threatens the survival of our water bodies, such as rivers, and lakes, thus directly and adversely influencing the demand- supply gap in water access. Therefore besides addressing the issue of physical scarcity of water, at the same time it is needed to also consider the socio-economic scarcity, which means that the access to water is not threatened by its physical availability but due to lack of investment and political will in harvesting and storing the water and in efficiently and equitably managing its distribution and usage.[59]

End Notes

1 IITM: Climate Change Impact on Water Resources in India, Keysheet-5, IITM
2 National Water Mission under National Action Plan on Climate Change, 2008 (Vol-II), Ministry of Water Resources, Government of India.
3 National Water Mission under National Action Plan on Climate Change, 2008 (Vol-II), Ministry of Water Resources, Government of India.
4 Ibid
5 http://www.india-wris.nrsc.gov.in/Publications/RiverBasinAtlasChapters/RiverBasinAtlas_Full.pdf
6 High Powered Committee Report, 2016, 'A 21st Century Institutional Architecture for India's Water Reforms', July, 2016, Government of India.
7 Ground Water Year Book- India 2016-17, Central Ground Water Board, Ministry of Water Resources
8 High Powered Committee Report, 2016, 'A 21st Century Institutional Architecture for India's Water Reforms', July, 2016, Government of India.
9 Comprehensive Water Management Index Report. June, 2018; Niti Aayog
10 Dynamic Groundwater Resources of India (as of 31 March, 2013), Central Groundwater Authority, Ministry of water resources, June, 2017
11 Comprehensive Water Management Index Report. June, 2018; Niti Aayog
12 Stage of groundwater development is the ratio of annual groundwater discharge to net annual availability of groundwater. Net groundwater availability is the annual groundwater recharge after deducting the natural discharge during the non monsoons season.
13 SDG India Index – Baseline Report. NITI Aayog. (December 2018)
14 National Institute of Hydrology: http://nihroorkee.gov.in/rbis/India_Information/rivers.htm
15 Envistats India, 2018, 'Envi Stats India-2018: Supplement on Environmental Account', MoSPI, Government of India.
16 Water Resource Information System: http://india-wris.nrsc.gov.in/wrpinfo/index.php?title=Basins
17 Envistats India, 2018, 'Envi Stats India-2018: Supplement on Environmental Account', MoSPI, Government of India.
18 Envistats India, 2018, 'Envi Stats India-2018: Supplement on Environmental Account', MoSPI, Government of India.
19 Chapter 3- Water: The Nectar of Life, EnviStats India 2018. (Supplement on Environmental Accounts) http://www.mospi.gov.in/sites/default/files/reports_and_publication/statistical_publication/EnviStats/5_Chapter%203%20-%20Water.pdf
20 Chapter 3- Water: The Nectar of Life, EnviStats India 2018. (Supplement on Environmental Accounts) http://www.mospi.gov.in/sites/default/files/reports_and_publication/statistical_publication/EnviStats/5_Chapter%203%20-%20Water.pdf
21 Chapter 3- Water: The Nectar of Life, EnviStats India 2018. (Supplement on Environmental Accounts) http://www.mospi.gov.in/sites/default/files/reports_and_publication/statistical_publication/EnviStats/5_Chapter%203%20-%20Water.pdf
22 http://www.fao.org/nr/water/aquastat/countries_regions/IND
23 Chapter 3- Water: The Nectar of Life, EnviStats India 2018. (Supplement on Environmental Accounts) http://www.mospi.gov.in/sites/default/files/reports_and_publication/statistical_publication/EnviStats/5_Chapter%203%20-%20Water.pdf
24 Sivaramakrishnan K. C., Singh B. N., Paper on Urbanization, Research Project on India- 2025. http://planningcommission.nic.in/reports/sereport/ser/vision2025/urban.pdf
25 https://scroll.in/article/884229/zero-day-looms-as-india-consumes-poisons-and-wastes-more-water-than-any-nation-on-earth
26 https://www.teriin.org/article/indias-rampant-urban-water-issues-and-challenges
27 India Spend: https://archive.indiaspend.com/cover-story/groundwater-levels-plunge-contamination-rises-crisis-grows-37036
28 Interview with Ravi Chopra at RGICS. YouTube Link: https://www.youtube.com/watch?v=dNk3GobpIlI
29 High Powered Committee Report, 2016, 'A 21 st Century Institutional Architecture for India's Water Reforms', July 2016, Government of India
30 WWF: https://wwf.panda.org/our_work/water/rivers/irbm/ , Accessed on 28.03.19

31 Envistats India, 2018, Envi Stats India-2018: Supplement on Environmental Account, MoSPI, government of India.
32 NABARD, 2018, Water Productivity Mapping of Major Indian Crops, NABARD, India.
33 OECD, 2017, Water Risks Hotspots for Agriculture, OECD, June 29, 2017, Accessed from: http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=COM/TAD/CA/ENV/EPOC(2016)4/FINAL&docLanguage=En
34 https://www.naireetaservices.com/
35 Water Aid India: http://wateraidindia.in/faq/drinking-water-problems-india/ , Accessed on 30.03.19
36 TERI: Syed Qazi, Waming Ali and Nathaniel B Dkhar, 'India's rampant urban water issues and Challenges' December, 2018, TERI, Accessed from: https://www.teriin.org/article/indias-rampant-urban-water-issues-and-challenges , Accessed on 29.03.19
37 Water Aid India: http://wateraidindia.in/faq/water-quality-quality-water-available-india/ , Accessed on 30.03.19
38 Public Information Bureau: http://pib.nic.in/newsite/PrintRelease.aspx?relid=84072 , Accessed on 30.3.19
39 Grafton, R & Evan Garrick, Dustin & Horne, James. (2017). Water Misallocation: Governance Challenges and Responses.
40 Grafton, R & Evan Garrick, Dustin & Horne, James. (2017). Water Misallocation: Governance Challenges and Responses.
41 Moore SM. The development of water markets in China: progress, peril, and prospects. Water Policy 2015, 17:253–267. doi:10.2166/wp.2014.063.
42 Mukherjee, Abhijit; Bhanja, Soumendra Nath; Wada, Yoshihide (2018)"Groundwater depletion causing reduction of baseflow triggering Ganges river summer drying"; Scientific Reports 12049 Vol - 8 IS - 1 https://doi.org/10.1038/s41598-018-30246-7
43 High Powered Committee Report, 2016, 'A 21st Century Institutional Architecture for India's Water Reforms', July, 2016, Government of India.
44 High Powered Committee Report, 2016, 'A 21st Century Institutional Architecture for India's Water Reforms', July, 2016, Government of India.
45 Baby, K. (2017, September 25). Data analytics to redefine India's water future. Retrieved March 18, 2019, from https://www.ircwash.org/blog/data-analytics-redefine-india's-water-future
46 High Powered Committee Report, 2016, 'A 21st Century Institutional Architecture for India's Water Reforms', July, 2016, Government of India.
47 High Powered Committee Report, 2016, 'A 21st Century Institutional Architecture for India's Water Reforms', July, 2016, Government of India.
48 Dr. Ashok Khosla; RGICS-CoR seminar on Regreening India: Water for All. (February 23rd, 2019)
49 Dr.AshokKhosla, Prof. A. K. Gossain; RGICS-CoR seminar on Regreening India: Water for All. (February 23rd, 2019)
50 BOLDT-VAN ROOY, T. (2003). "Bottling Up" Our Natural Resources: The Fight Over Bottled Water Extraction in The United States. Journal of Land Use & Environmental Law, 18(2), 267-298. Retrieved from http://www.jstor.org/stable/42842816
51 High Powered Committee Report, 2016, 'A 21st Century Institutional Architecture for India's Water Reforms', July, 2016, Government of India.
52 CHALLEN, R. 2000. Institutions, Transaction Costs, and Environmental Policy: Institutional Reform for Water Resources, Edward Elgar Pub.
53 Dr. Mihir Shah; RGICS-CoR seminar on Regreening India: Water for All. (February 23rd, 2019)
54 Grafton, R & Evan Garrick, Dustin &Horne, James. (2017). Water Misallocation: Governance Challenges and Responses.
55 Dr. Ashok Khosla; ; RGICS-CoR seminar on Regreening India: Water for All. (February 23rd, 2019)
56 http://www.india-wris.nrsc.gov.in/Publications/RiverBasinAtlasChapters/RiverBasinAtlas_Full.pdf
57 July 21, 2015. CM in State Assembly debate. Cited by Mihir Shah Committee report.
58 Mani, M., Bandyopadhyay, S., Chonabayashi, S., Markandya, A., & Mosier, T. (2018). S*outh Asias Hotspots: The Impact of Temperature and Precipitation Changes on Living Standards*. The World Bank Group. doi:doi:10.1596/978-1-4648-1155-5.
59 2019, Beneath the Surface: The State of the World's Water, Water Aid. https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/beneath-the-surface-the-state-of-the-worlds-water-2019-.pdf

RAJIV GANDHI
INSTITUTE FOR CONTEMPORARY STUDIES

Rajiv Gandhi Institute for Contemporary Studies
Jawahar Bhawan, Dr Rajendra Prasad Road, New Delhi 110 001 India
T 91 11 2331 2456, 2375 5117 / 118
E info@rgics.org **W** www.rgics.org