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Adriān

An ENVIS Newsletter on Water Management and Climate Change

- An exclusive interview with Dr. Anandi Subramanian P. 30

WATER ECONOMICS

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डा० आनन्दी सुब्रमनियन
Dr. Anandi Subramanian

सत्यमेव जयते

वरिष्ठ आर्थिक सलाहकार
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Foreword

Climate Change, owing to its multi-dimensional impacts on the entire ecosystem, has emerged as a major area of concern and one of the most serious policy challenge that humankind has faced in the 21st century. Climate Change's threat to the environmental resource management and sustainable development requires a cohesive response.

This July, Cape Town in South Africa is expected to run out of water, an event termed Day Zero. The 'Water Gap' for India estimated by the Water Resources Group Report, 2009, is an alarming 50 per cent. Data from the World Resources Institute also shows that India is among the highly water-stressed countries in the world. Climate change has complex implications on the pattern of availability of water resources, including changes in precipitation, ground water recharge etc, as well as water quality issues. In the most water-stressed states of India, annual groundwater consumption is reported to be more than annual groundwater recharge. Apart from water scarcity, leakages and inefficiencies in the water supply system lead to wastage of about 50% of usable water. About 60% of India's districts are reported to be facing the problem of either groundwater contamination or scarcity or of both. India's water crisis poses a threat to its economic, environmental and social development. Corrective steps need to be taken urgently to reverse the depletion and contamination of India's water resources and to prevent India's cities and villages from facing the fate of Cape Town in the coming years.

I congratulate ADRI-ENVIS Resource Partner in the Centre for Environment, Energy & Climate Change (CEECC) working in the thematic area of Water Management and Climate Change, in releasing 'Adrian', the ENVIS news letter whose current issue is centred on the broad theme of "Water Economics". It aims to showcase various research initiatives in the field of water management nationally as well as globally with a greater focus on South Asia.

The thematic areas covered include issues related to water efficiency through traditional water management and other technologies, cost of water pollution, its valuation, efficacy of polluter pays principle, demand management, economics of virtual water footprint, water pricing etc., which will help policy makers in framing a comprehensive Water Policy. It will also be of immense help to Researchers, Academicians and Practitioners. The Newsletter, which will have monthly e-versions and quarterly printed versions for wider information dissemination, will also create a base for dialogue and showcase complex interdisciplinary interface of various issues pertaining to Water Management and Climate Change.

I would like to place on record my appreciation of the tremendous efforts put in by the staff and editorial board of the ADRI-ENVIS under CEECC, resulting in this fruitful synergised knowledge product.

I wish 'Adrian', the ENVIS Newsletter, the very best for its inaugural edition and hope its future editions continue to help fill the gaps in information collection, compilation and collation that will eventually help in creating a sustainable low-carbon future.

Anandi

(Dr. Anandi Subramanian)

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MESSAGE

Water is a finite resource and needs measured utilization. In an overpopulated country like India, water resources are already under huge pressure although India receives plenty of water from its numerous rivers along with monsoon precipitation. Moreover, climate change and associated events have significant role in altering national water reserve. Economic development, population growth and rapid urbanization are posing added threat to it.Though India is not a water scarce country, due to mismanagement of available water resources, inefficient governance, lack of policy and regulations, over-exploitation, lack of technological interventions, conflict over water and above all spatial mismatch of supply and demand of water is leading India towards an uncertain future.The development of this natural resource is happeningin an unscientific and unorganized way, leading to its further depletion. The poor and the marginal are mostly affected by this menace.

In this context, ADRIAN, an ENVIS newsletter on Water Resource Management and Climate Change,published by the Centre for Environment Energy and Climate Change (CEECC) at The Asian Development Research Institute (ADRI),will showcase the research initiatives undergoing in the relevant field,both nationally and globally.The newsletter will be published in both e-version (monthly) and printed version (quarterly). It can guide and support policy framework, technological innovation and transfer of technology for sustainable water management taking best implementation references from around the world. It can be a valuable resource to cross check and referred back for water resource management across all sector. Looking in to the pan India mandate of the ENVIS Resource Partner for water management and climate change, this newsletter will be an effective tool for information dissemination for wider population.

I would like to congratulate theentire ENVIS team of CEECC at ADRI for bringing out the very first edition of ADRIANon the theme of Water Economics. I am confident that the administrators, policy makers, planners, researchers, academicians and other stakeholders will find this newsletter informative and quite useful in the context of water resource management. I genuinely wish that ADRIAN will go a long way and establish itself as an impactful knowledge repository and an authentic source of information in the field of water resource managementand climate change. I am hopeful that ADRIAN will be able to highlight the emerging research arenafor academicians and a reference guide for those who are involved in planning, policy making and budgeting in this sector.

(SHAIBAL GUPTA)
Member Secretary

Editorial

The year 2018 has already witnessed a larger glimpse of what it can be in the purview of Water Shortage rather crisis, where cities like Cape town have already been declared Day Zero, and estimates reveal that India would have its five major cities in the catapult of Day Zero. Water experts and policymakers around the globe manifest a notable level of consensus on the diagnosis that water crisis is a direct outcome of "governance crisis" regardless of the diverse disciplinary backgrounds and ideological orientations. Development literature abounds these days with statements that reflect the gravity of water crisis as it exists or that may arise in the foreseeable future in many countries. Reports such as: 'the next world war may be over water', 'about 40 countries will not have adequate water supplies in the near future', 'the drought-affected area in Africa is spreading at a rate of 2.3 million sq. miles a year', 'the worldwide irrigation boom is over', etc., may reflect the seriousness of the scarcity of water.

The earth is covered with 70% of water, however, only 2.5% of it is freshwater and just 1% of it is easily accessible; this makes the management of water resources as a crucially important matter of subject. 54% of India's total area is facing high to extremely high water stress which puts at risk the lives of millions of people. Besides the management of freshwater, the governments around the globe are also looking forward to exploring the economy generated from the oceans (70% of the earth) which has the capacity to generate trillions of dollars and India is getting actively involved in the planning. However, the poor handling of the resource, overexploitation due to population explosion and pollution have jeopardized the economy that can be generated from water-sources. Plastic pollution, untreated sewage, uncontrolled use of freshwater, the absence of regulation and minimal research in the field (water economics, water-footprint etc.) are some major problems. More research should be promoted and there has to be a nexus between research and policies and moreover the implementation needs to be regulated at regular intervals. The authorities have to be extra-cautious while dealing with such a vulnerable resource; however, that does not negate the fact that managing this crucial resource demands a collective effort by all the individuals, corporate sectors, civil societies, authorities and all the sections of the society.

The inaugural issue is an attempt to understand the gamut of the Water Economics from a genre of inter disciplinary plethora which characterizes the factual undermining of the larger context where it's a baseline issue at all levels ranging from blocks to countries and needless to flag that it has quite an exponential impact at transboundary level. Since this knowledge product will glance us in terms of providing a clearer picture in terms of the Engineering vs. the Political logic and understand the generic issues beyond the entrenched hagiolatry of rivers. The river cleaning stratification is often characterized as a perfect mismanagement of deliverables and plans where often bad bureaucratic science is blamed. Till the systems rise above and understand the blame vs. reform dynamics related to the water resource management, this edition will provide a streamline amalgamation of the facts and figures to understand and unveil the sources of water economics as a subject which has a larger anthropocentric purview than it is expected or even estimated to be. Before we as a society can convert the falling water from a low caste "natural calamity" to a high caste "economic resource", our society must undergo austere penances.

(Prabhat P Ghosh)

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Investing in Water Infrastructure

Dilip Sinha

With 2.4 percent of the world's landmass and 4 percent of its renewable water resource India cannot complain of being water deficient. But overpopulation means that the per capita availability of water in India is very low. The Ministry of Water Resources estimates that by 2025 India will become 'water stressed' and by 2050 'water scarce', which means that its per capita water availability will fall below 1000 cubic metres. Besides, India gets 80 percent of the precipitation in 3 to 4 months which implies that despite a healthy average annual rainfall of 110 cm requires meticulous management of water is needed to make it available all the year round and be equitably shared. Proper storage and distribution are critical for this as, is the need for water treatment to augment supply and provide clean water.

Investment in the infrastructure for water management has to be taken up as the nation's highest priority. It is more important than, say transport or energy, and can in fact augment both. Reservoirs can be used to generate electricity in the hills and canals can serve as waterways. Environmentalists fret over their environmental and social impact. These concerns have to be taken into account and addressed with proper planning, but they should not be allowed to block projects. The consequences of not investing in water infrastructure will be disastrous.

Rainfall brings about 4000 billion cubic meters (BCM) of water but despite about 3600 large dams and several more small ones the live storage capacity is only 253 BCM. The average storage capacity in India in rivers is about 30 days, as against 900 days in Colorado River in the United States and the Murray-Darling basin in Australia. While some of this can be attributed to India's geographical conditions, most of it due to inadequate allocation of resources and other hurdles. More storage is required in all rivers, particularly in the Himalayas and the Western Ghats where the rainfall is high and the mountainous terrain is ideal for ponding. The reservoirs in the Western

Ghats can be used to feed the rivers flowing in the rain-shadow areas to the east.

The replenishable ground water is estimated at 432 BCM but the water table has dropped in many parts of the country and continues to fall. Siltation of lakes, draining of swamps and loss of green cover are hindering the replenishment of ground water and global warming is shrinking glaciers, the lifeline of the Himalayan Rivers. Check-dams are very effective in replenishing ground water. Some villages have done it successfully. These need to be replicated across the country so that rainwater does not go waste and there is popular participation in water management.

While creating reservoirs and replenishing ground water are important, water treatment and recycling are critical. Overuse of fertilisers and pesticides in agriculture and untreated industrial waste and urban sewage have degraded the quality of water in our rivers to pathetic levels. Namami Ganga is the largest river cleaning project in India. This Rs 20,000 crore plan launched in 2015 to be implemented in 5 years follows several equally ambitious schemes going back to the mid-1980s. A CAG report in 2017 found that only 63 percent of the funds had been utilised in the first three years and most projects were delayed. In 2015, the National Water Mission estimated that of the 62,000 million litres of sewage generated per day (MLD) in urban areas there was treatment capacity only for about 23,000 MLD. It is no wonder that most rivers are highly polluted and several are now referred to as nalas.

Ensuring availability and sustainable management of water and sanitation for all is Goal No. 6 of the Sustainable Development Goals. This is not merely a desirable development goal but an essential requirement for survival. Cape Town in South Africa may be the first major city in the world to run out of water by April if there are no rains. In India Latur faced a similar crisis some years ago and had to be supplied water by trains. Water shortages will cause fall in agricultural output and lead to destabilising migration.

Both the national and international legal frameworks create an uncertain environment for investment in water. Water is a state subject under the Constitution. The National Water Policy of 2012 had identified the need for a national legal framework for water management but a draft framework bill is languishing since 2016. Inter-state river water disputes take years to resolve in courts. A permanent tribunal for this purpose has been mooted but is still just an idea.

International agreements on sharing the water of international rivers for consumptive use are rare. The UN Convention on Non-Navigational Uses of International Watercourses was negotiated in 1997 and came into force in 2014, but only 36 countries have ratified it. Neither India nor China has done so. Upstream dams on the Nile in Ethiopia have created a rift with Egypt. In Afghanistan, the Salma dam is being protested by Iran. Syria and Iraq dispute dams built by Turkey. For India, the dams being built by China in Tibet to divert waters to the north will seriously impact the flow of water in the lean season. India is the middle riparian in some major rivers but while it has water sharing agreements with its lower riparians, Pakistan and Bangladesh, China refuses to talk either with India or with the countries of South East Asia with whom too it shares rivers. Reduced flow from Tibet will mean that India will have to depend solely on its monsoon rains and will have to invest in the infrastructure to ensure storage and distribution. There are reasonable grounds to fear that in this century water will be a major cause of wars.

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Arsenic contamination in ground water: Effect on human capital – A literature review

Arundhati Char

Introduction

Water, the epitome of life, defines all form of existence, be it for plants, animals, and social humans. However, with growing population and depleting groundwater, it is fast becoming scarce. The quality of groundwater is also questionable, with hoards of pollutants including biological, toxic, and other wastes feeding into it. Groundwater contamination is persistent across India and affects over 500 million people across 23 districts of India. (1). Bihar and West Bengal are the worst affected in India, with respect to ground water contami-nation, and specific arsenic contamination (defined as the occurrence of high arsenic (0.05 mg/l) in groundwater). It is estimated that the total vulnerable population in Bihar alone is about 10.4 million people, across four districts along the banks of river Ganga (1).

Water contaminations can be of several forms - those caused by geogenic, biogenic and anthropogenic sources. The geogenic contaminants include salinity, iron, fluoride, and arsenic which have a long-term impact on health. Specifically, arsenic contaminated drinking water causes skin pigmentation and skin cancer, and long-term use of fluoride in drinking water leads to tooth decay and crippled bones (3). To put this in perspective, there is a possibility that water could be scarce owing to extremely poor water quality. This could, in turn, limit its availability for both human uses and to the ecosystem as well. A literature review on arsenic contamination on drinking water shows its serious effect on human health. Studies show that arsenic in drinking water can cause cancer. (4, 5, 6). It is also known to have a negative health consequence on the reproductive system, birth defects and harm the central and peripheral nervous system (4). Arsenic exposure during pregnancy can adversely affect several reproductive endpoints (7, 8). The fertilizers used for the agricultural purpose also cause arsenic contamination. A study by Brammer (2008) found that arsenic-polluted water used for agriculture is a health hazard for the people eating food from the crops irrigated in the areas of India, Bangladesh, and Nepal. (9).

The social impact of arsenic contamination

Arsenic poisoning mostly affects people from the lower socio-economic strata of society. (3). Access to the safe water supply is one of the most important determinants of health and socio-economic development (10). Besides having an impact on health per se, arsenic contamination and exposure cause social problems to humans as well. There is a lack of awareness among communities with regard to the side effects due to arsenic exposure, causing people to often mistake symptoms for leprosy or other contagious skin diseases. This has an impact on marriage prospects, employment, and even the simplest social interaction for the exposed and affected. Besides physical effect, it also has an impact on the mental health of the person, leading to depressing or even suicidal tendencies. Finally, studies have shown that arsenic contamination affects the economically poor, women more than men, young children more than adults. It also leads to social exclusion, and finally overall socio-economic impacts of the affected population (3). In short, one of the gravest impacts of arsenic poisoning is the inability of the affected persons to contribute productively in society.

The economic impact of arsenic contamination

Having understood the health consequences that arsenic contamination has, there is bound to be an economic cost due to this exposure that is important to study. Roy (2008) and Khan (2007) carried out studies based on the economic cost imposed on households due to arsenic contamination in water. The studies found that poor households incurred the largest number of sick days and suggest that children and women are more prone to diseases caused by long term exposure to arsenic. Arsenic groundwater contamination has a severe economic effect on the people residing in the areas where the menace is found. (11, 12). Economic burden of the family with at least one person affected by arsenic poisoning increases. In a state like Bihar which is mainly an agrarian society, arsenic poisoning affects agricultural outputs; due to the various health problems, it affects participation in work and eventually, the expenses related to treatment further increases the economic burden on the already impoverished families. (3). Roy, (2008), estimated the economic costs imposed by arsenic-related health problems, by using the household health production function model and household demand function for mitigating and averting activities to estimate the benefits from a decline in arsenic concentration in groundwater. Primary survey of 473 households (Midnapore and 24 Parganas districts of West Bengal) on three equation system (averting actions, medical expenditures, and a sickness function) was carried out and it was found that if arsenic concentration was reduced to the safe limit of 50 mg/l, the monthly and annual gains per household would be Rs. 297 and Rs. 3,573, respectively, and if the arsenic contamination was reduced by half of the present level, economic benefits would be Rs. 161 and Rs. 1,934 monthly and annually per household, respectively. Poor households incurred the largest number of sick days and person suffering from arsenic disease worked only 2.73 h per day compared to 8 h work per day. (11). Khan (2007) studied health impacts and costs associated with arsenic groundwater contamination using primary data from Bangladesh, where arsenic problem is considered as a major public health concern. The study follows the household production function on 900 tube-wells and 878 households and estimates that 7 to 12 million man-days per year are lost as a result of arsenic exposure and the sick spend between the US $3.5 to $6.25 million per year for medical help. The total cost of illness from arsenic was found to be US $9 to US $17 million per annum which was nearly 0.6 per cent annual income of the affected households. The study finds that the threat of various forms of cancers like Melanosis and Keratosis is high when there is cumulative exposure, and it is more commonly found in the poorer class rather than richer class because richer households are taking mitigation measures to reduce the risk of a health threat. This study also suggests that children and women are more likely to get affected by inflammation of the respiratory tracts which is caused by long term exposure to arsenic. Therefore, economic costs are involved in the arsenic contamination and poor suffer most from that. (12). Khan and Haque (2011) measured the private cost of arsenic exposure in Bangladesh. They found that households spend Bangladesh Taka (BDT) 1,057 per year for arsenic related ailments, which is nearly 0.73 per cent of the income of the household. This is a huge financial burden for poor households, considering that most of the population live on less than $2 a day. (13). Thakur and Gupta (2016), tried to estimate the average health costs that could be attributed to water contamination in Bihar, with inputs from specialist doctors. According to the study, total average health cost of the households for 6 months came to US$ 69.8. The monthly average cost of the households was US$ 11.6 and per person, the household cost was US$ 1.4. (14).

Arsenic contamination and agricultural productivity

While consuming water laced with arsenic poisoning is one way of exposure, arsenic contaminated groundwater used for agricultural irrigation also results in the excessive amount of available arsenic in the crops and thus enters the food chain, particularly use of contaminated rice followed by vegetables. This water contamination leads to decreased agricultural productivity, soil fertility, and also creates health problems with contaminants entering the food chain. (3,9). It has been suggested that the sooner we find a suitable and sustainable solution to resolve this problem, lesser will be its future environmental, health, socio-economic and socio-cultural hazards. (15). There is a possibility that fertilizers and pesticides used for the agricultural purpose also cause arsenic contamination. Rice and vegetables are more affected by arsenic contaminated water. Brammer (2008) in his study suggested that arsenic-polluted water used for agriculture irrigation is a health hazard for the people eating food from the crops irrigated in the areas of India, Bangladesh, and Nepal in recent times (8). This poses a serious risk to sustainable agricultural production and also the livelihoods and health of the affected population (9). There is an urgent need for possible mitigation strategy and measures. Urgent research should be undertaken to find alternative irrigation sources in the affected areas. Second, use of technology to remove contamination of water should be explored. (3).

Conclusion

It is clear that arsenic infested groundwater, as well as its presence in the food chain, is increasing the disease burden and in turn, has a significant socio-economic impact on the population where it exists. This form of water contamination affects more than 70 countries either directly or indirectly, and around 150 million people across the globe. (3). Three countries in south Asia, India, Bangladesh, and Nepal, are affected the most due to arsenic contamination in the groundwater. This, in turn, has a negative impact on the health and socio-economic outcomes of the population that it affects. While the effects of arsenic poisoning on human health and wellbeing have been well-researched, there need to be concerted efforts to mitigate this condition on an urgent basis. While the urban communities use various means to purify drinking water before consumption, the majority of the rural communities drink water directly from wells, or hand pumps, making them most vulnerable to the ill-effects of arsenic contaminated water. Most of our rural communities (over 70 percent) still depend on groundwater sources for their drinking and cooking purposes (3). In the rural areas, alternative safe sources of both drinking water and water for irrigation need to be determined. It is believed that once groundwater is clear of all its pollutants, soil contamination will also reduce.

Attempts have been made so far to combat the menace of groundwater arsenic contamination, include identifying the causes of contamination, providing arsenic free drinking water to the affected people who depend on the groundwater resources. To reduce the socio-economic problems and to develop cost effective technology for the eradication of arsenic contamination have proven inadequate, fragmented and less responsive, as evident from the rise in a number of arsenic affected areas with every new survey. There is an urgent need to create awareness among people and educate the villagers on the dangers of arsenic toxicity and importance of using arsenic free water. This can only be achieved by active community participation among the affected stakeholders, fully supported by the government and identified stakeholders.

Disclaimer: This work is a review of a few published researches on the topic of Arsenic contamination in India and particularly Bihar state. The author thanks Dr. Barun Thakur and Dr. Vidya Gupta for their kind permission to cite their work throughout this article.

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Why recycling water makes a good socio-economic case for municipalities, specially in water stressed areas?

Shaily Maloo[1]; M.Suneela[2]

Hyderabad is the capital of the newly formed state of Telangana. Hyderabad is a land-locked riverine city located 548m above mean sea level and the sixth largest urban agglomeration in India, with a metropolitan population of 7.75 million. It has evolved into a hub of information technology and has witnessed rapid expansion due to an industrial boom and increased trade opportunities. The city population has in the last decades grown at a rate of 30% and its slum population has increased from17% in 2001 to 32% in 2011. It houses second largest number of people per household after Kolkata among major cities in India.

Water system of Hyderabad

It has a rolling terrain and it is estimated that more than 90% of the water in Hyderabad rolls towards river Musi by gravity. Musi River, which carries most of the city's treated and untreated sewage, runs about 20 kms within the city limits, and passes downstream through a length of about 150 kms before joining the River Krishna. Musi is a non- perennial river, which today functions mainly as a sewerage carrier. However, Hyderabad is historically blessed with a large network of interconnected natural and manmade lakes which support the hydrology of the city. Currently, Hyderabad has over 200 lakes which are not operating optimally due to climate change and urban sprawl.

So, how does Hyderabad meet's its water requirement? 70 to 80% of the city water is sourced from rivers like Krishna and Godavari which are located more than 100 km away from the city. While remaining water requirement is met through underground water either through bore wells or tankers brining bore well water to the consumer. This means that to meet future water demands of the rapidly growing financial hub of Telangana, the government is continuously working to large scale projects which bring piped water to the city from 100's of km from Krishna or Godavari.

Let's look at the sewerage system of the city. In Hyderabad, only 55% of the city is covered by the sewerage network. Due to the limited sewerage treatment facilities, the rest of the waste is discharged untreated into the river, which means approximately 700MLD of water is treated and nearly same quantity of water goes untreated into the river. This mixed wastewater is used by of the area in and around Hyderabad for cultivation. As per the study conducted in major cities in India, this is the largest area under sewerage cultivation. However, waste-water recycling is only 3%. Currently, the recycled wastewater is used primarily by only one bulk consumer (i.e. Rajiv Gandhi International Airport).

This leads to fresh water being used for nearly all the activities in the city of Hyderabad. Considering, that Hyderabad is located in semi-arid region and in one of the 9 most water stressed states in India there is severe pressure on fresh water resources available to Hyderabad.

Climate change is not making it any easy for Hyderabad for the obvious reasons of changing rainfall and heat pattern in the city and the region. Hyderabad has in the last decade experienced situation where the water supplies were close to the brink. So the question in hand is a. Is brining water more and more water from far of sources the only solution b. Is it economically the best solution? Certainly not!

A small analysis has been conducted to estimate the possibilities of wastewater recycling in the city and the broad economics of this system.

City treats about 710 MLD of the sewerage and intends to set up STP to treat another 600 MLD of its wastewater through 10 decentralized STPs. The city faces a current water deficit of about 300 MLD. The Outcome 3 of the project activity intends to increase the wastewater usage to 28% from the 580 MLD of wastewater planned to be treated under the project. As per, Central Pollution control board (CPCB) of India's revised norms for discharge of wastewater into water bodies and land disposal BOD and COD should be not more than 10mg/l and 50 mg/l respectively. In view of the above, it is likely that the proposed STPs in the city will adopt tertiary treatment practices.

Thus, after tertiary treatment the option is either to let all the treated water find its way into river Musi or to recycle this water.

Recycling options and challenges

Recycling water to the residential areas involves several challenges like- Dual piping system is essential in recycling/ reuse of water by existing household whereas Most of the old or existing infrastructure does not have this system, installation of such system by individual households will be a costly and tedious task and above all the social bias in using recycled water in residential areas is likely to be very high. Mitigating the bias will be a challenge.

The other option is to use recycled water in industrial parks/areas and institutions spread across the city. The bias in applying water to these uses is expected to be lesser than in residential areas. It was found that each of the 10 STPs wastewater can be supplied to one or two industrial parks and institutions. Together these have the capacity to absorb 164MLD of treated wastewater i.e. 28% water recycling can be achieved.

Transportation of sewerage in controlled and labelled tankers from crowded locations will add to several challenges like adding large number of sewerage carrying tankers, adding to traffic woes and attracting public bias on recycled water. So, the option is to construct a pipeline for carrying recycled water to these supply areas which are 10-20 km from the proposed STPs and make provision for sump at the destination. From the sumps the recycled water can be carried to short distances of 1-2km by tankers.

Is it cost effective? Yes. The initial work suggests that cost of recycling and distributing 1MLD of treated wastewater will be about INR 1 crore per MLD. Whereas it costs INR 45to produce 1KL of water in Hyderabad. It will save equivalent amount of freshwater uptake. This implies that water board save INR 270 crore by recycling this water instead of letting it into river, leave apart the saving achieved due to delay in investment in new water uptake infrastructure, as this will contribute to about 17% of the new water supply schemes capacity (i.e. 172MGD of Godavari water phase II scheme).

The social benefit is also enormous as the water available for slum population which receives water supply every alternate day will be sufficient i.e. 150MLD per day. The other positive intangible impacts that it will have are climatic resilience of urban water system, meeting the National Water Policy requirements, SDG requirements etc.

The approach just needs thinking and going beyond the regular, not for environment alone but for socio-economic benefit of recycling to municipalizations.

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Quantum Cleaning to Quantum Expenditure : Demystifying the Economics of Ganga Cleaning

Abinash Mohanty[1]; Rahbar Ali[2]

ABSTRACT

Ganga has been in limelight especially cleaning of Ganga from more than two decades. Hence this manuscript is an attempt to understand, characterize and evaluate the quantum of spending that have gone through in cleaning Ganga and its efficacy in terms of cleaning ratio. Cases after case are being filed, National Green Tribunal has also directed many a times trying to make Ganga cleaned. Extending through about 1,600 miles, the Ganges is also a pecuniary livewire and a vivacious lifeline for the country. The river bids water to about forty five percent of India's population across eleven 11 states, serving an estimated 900 million people. It is home to at least 170 species of animals and marine life, irrigates some 140 million acres of arable land in the basin alone, and contributes about fifty four percent of India's gross domestic product. The manuscript provides a fund allocation and spending semantic purview with respect to the pollution load and show cases crater gaps. The trends in spending to the cleaning are well represented and viable gaps filling is analysed, evaluated and characterised.

1. Introduction

The panacea to all the issues related with environmental resource management schemes is accountability, transparency and well defined responsibility coupled with financial autonomy. But the biggest irony is whether always the financial autonomy can deliver results when it comes to policy welfare, resource management shielded with rich culture and tradition, these words of context setting is enough to hint at the irony that the most precious and personified river of India has gone through over last couple of decades in terms of its cleaning. The Ganga is reflected sacred by societies for providing the life-giving and life-sustaining aid for the milieu and ecosystem[1]. Currently, Ganga has been spun into a rotten stream critically polluted with abrasive sewage, industrial effluents and wastes, or agricultural runoffs, interrupted by colossal alteration of flows, and trespassed upon, parting a languid flow in places in slender month. Overall twenty seven main cities scrap heap zillions of litres of sewage and industrialised waste into the river every single day which is amplified with the

Figure 1 popularly called as Ganga Aarti at the banks of Ganga in Bihar[2]

faith that Ganga has self-cleansing properties and can intake any amount of contaminants. To battle against these comprehensive jumbled contributors list Ganga Action Plan was aligned even before two decades. Hence this manuscript is an attempt to demystify the quantum economics involved in cleaning of the Ganga. However Ganga Action Plan Stages I and II encountered with only little success. The major contributors of the reduced amount of success were failure on the government's part to internalise the larger public participation. The sewage pumps breakdown during the flood season frequently prolonged' impeding in entire drainage of the city's sewage into the river. On the other hand the treated effluents from STP caused health hazards, ruined crops and polluted groundwater[3]. The Ganga River Basin Authority had propelled the most ambitious project "Mission Clean Ganga 2009" with an allocated buffer fund of 150 billion estimating to around fifteen thousand crores in INR aimed at revamping and purifying the plants by the year 2020[4]. The above stated scripted plan enumerates the fact that no waste generated by municipal agglomerates will be allowed to discharge into the Ganga. In the background of these commitments this manuscript is an attempt to analyse and evaluate the quantum of money spent post year 2009.

2. Curated Economics of Cleaning Ganga

The National Mission on Clean Ganga MCG has a buffer allocation of 200 billion dollar amounting to twenty thousand crore INR which is funded by the central government and is of non-lapse nature and is spread across 290 projects[5]. The table 1, illustrates the quantum of allocation for various projects under the NMCG. In return, the government offers to contribute 40% of the capital costs upfront and disburse the rest

[1]Das, Subhajyoti. "Cleaning of the Ganga." Journal of the Geological Society of India 78, no. 2 (2011): 124.

[2]Picture courtesy- @Green Milieu_2018- https://greenmilieublog.wordpress.com/

[3]Mishra, Veer Bhadra. "The Ganga at Varanasi and a travail to stop her abuse." Current science (2005): 755-763.

[4]Mallikarjun, Y. "Pollution levels in Ganga alarming." The Hindu, Sep 15 (2003): 2003.

[5]https://www.thehindu.com/opinion/op-ed/why-clean-ganga-project-has-a-long-way-to-go/article24575876.ece, August/September, 2018, , accessed August/September, 2018, https://www.thehindu.com/opinion/op-ed/why-clean-ganga-project:

— with a profit margin — over 15 years subject to performance indicators being met. The mission also has projects to clean the ghats, rid the river of biological contaminants and improve rural sanitation and afforestation.

Table 1 Year wise allocation to Ganga cleaning[6]

Year	Expenditure on NMCG (In Crores)
2009-2010	50.30
2010-2011	113.64
2011-2012	263.36
2014-2015	170.99
2015-2016	602.60
2016-2017	1062.81
Total	**2523.05**

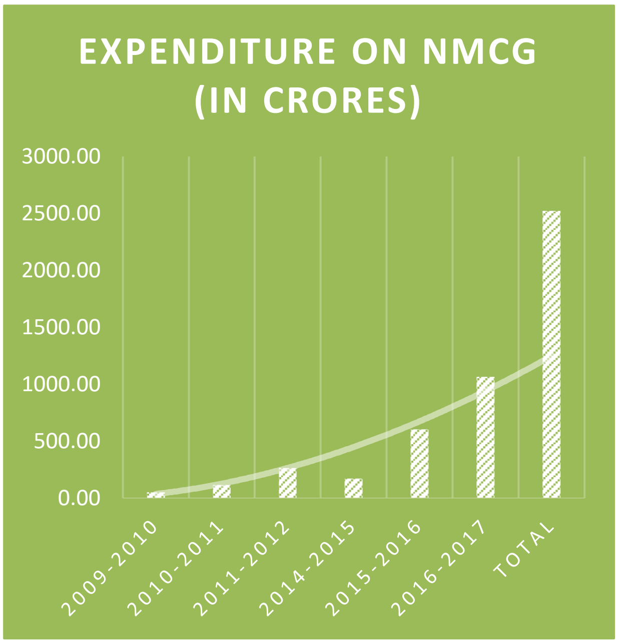

Figure 2 Graphical representation of the year wise allocation of the funds under NMCG

Majority of the pollution load is catapult around five major states i.e. from Uttarakhand in North, via Uttar Pradesh, Jharkhand, and Bihar to West Bengal in the east. As per estimates the pollution load is of 12000 million litres/ day out of which the current controlled treatment can abate around 4000 million litres/ day. Though the allocations and the funds tends to be huge sums, the harsh reality is that only 15 % of the allocated sum is being released in between 2014-18. The Ministry of Water Resources, River Development & Ganga rejuvenation has well scripted to funding gap through corporate contributions. It is estimated that through Clean Ganga Fund 255.02 crores has been funded[6]. As per National Green Tribunal, 2017 it was stratified that even after spending 900 crores for the same not even a single drop of Ganga was cleaned[7]. At Varanasi roughly around 30 million deceased human bodies are burnt each year resulting in 100t of ashes being dumped in the river per month. An electric crematorium was built under GAP, but had to close down after 6 months of operation due to air pollution problems[8].A CAG report has revealed that during 2016-17, the level of pollutants in the river across Uttar Pradesh, Bihar and Bengal was six to 334 times higher than the prescribed levels. With all these curated economics, the precursor to cleaning of Ganga is far too robust to be a gestured in article with blinkered arithmetic and statistics. Policy arrangements in India are perceived, assembled, and executed by

[6]https://www.thehindu.com/opinion/op-ed/why-clean-ganga-project-has-a-long-way-to-go/article24575876.ece, August/September, 2018, , accessed August/September, 2018, https://www.thehindu.com/opinion/op-ed/why-clean-ganga-project:

[7]Tare, Vinod, Purnendu Bose, and Santosh K. Gupta. "Suggestions for a modified approach towards implementation and assessment of Ganga action plan and other similar river action plans in India." Water Quality Research Journal 38, no. 4 (2003): 607-626.

[8]Roy, Aparna. "Ganga Won't Be Cleaned Even after 200 Years … Unless We Learn Why Generous Flows of Funds have failed so far." Https://blogs.timesofindia.indiatimes.com/toi-edit-page/ganga-wont-be-cleaned-even-after-200-years-unless-we-learn-why-generous-flows-of-funds-have-failed-so-far/. February 15, 2018. Accessed August 16, 2018.

different departments and agencies with diminutive discussion, not to mention synchronisation. The number-metrics of the Ganga cleaning which is too high to be curated through an economic bifurcation of the segmented opportunity cost of these schemes which still remains unanswered. As per some latest revelations from the Ministry of Water resources through an answer to the Rajya Sabha Question in 2018 stated that more than 40,000 million litres of waste enters to the major river, water bodies and even percolates into the ground every day. As per CPCB 61, 948 million litres of urban sewage is generated on a day to day basis, but the story unveils that the installed sewage treatments have only 38% remediation capacity[9]. The cut the long plethora of events in a crisp range of success that figures in the generic surface cleaning, is that around eleven skimmers have been stressed along the Ganga stretch cities and around 1.35 million toilets have been built along the rural areas of Ganga which is cutaneous to the fact these villages have almost 99% house hold toilets[10]. Now it is indeed the need of the hour to ask, speculate and answer the fact that is this quantum expenditure sufficient to tackle the issue that is growing larger and bigger as each day progresses. Unbridled urbanisation has impeded river Ganga no longer being just a cradle of water but a lotic dump yard in receipt of and conveying urban waste[11]. Before the section is presented with some more factual undertaking and the trends it is important to understand that why Quantum allocation or spending are not able to deliver proper results. As per a recent survey conducted by the Centre for Science and Environment the social perception that urbanisation has triggered the pollution load and the survey has some an imperative story to define i.e. around eighty percent of livelihood dependent communities and around fifty five percent of tourists have a convicted perception that ghats have no contribution to pollution discharge to the rivers.

3. Bridging the Gap between the Quantum Spending to Quantum cleaning-

The STP undoubtedly are the need of the hour but much narrowed thinking is clustered around the re-usability of these treated effluents from the sewage treatment plants. The enormous gap between the Cleaning Programmes and an exponential city infrastructure building needs to be addressed effectively. A decentralised cleaning module along the lines of centralised cleaning techniques can result in deep rooted viable results. The nudging economic aspirations and theories need to be side-lined while characterizing some of these robust river cleaning schemes. This will be able to solve a major junk of the issue. Availability of the sustained data along with variability definition can also help in taking forward the discussion for a more effective monitoring schedule and evaluation of the control measures. The cosmetic approach otherwise can be stated as pro development modules which have already

[9]Kumar, Sunil, Stephen R. Smith, Geoff Fowler, Costas Velis, S. Jyoti Kumar, Shashi Arya, Rakesh Kumar, and Christopher Cheeseman. "Challenges and opportunities associated with waste management in India." Royal Society open science 4, no. 3 (2017): 160764.

[10]Gupta, Nidhi, Pankaj Pandey, and Jakir Hussain. "Effect of physicochemical and biological parameters on the quality of river water of Narmada, Madhya Pradesh, India." Water Science 31, no. 1 (2017): 11-23.

[11]UPJN, UPPCB. "CPCB (2017) Assessment of pollution of drains carrying sewage/industrial effluent joining River Ganga and its tributaries." A joint report by Uttar Pradesh Jal Nigam (UPJN), Uttar Pradesh Pollution Control Board (UPPCB), Lucknow and Central Pollution Control Board (CPCB).

contributed and compromised the natural e-flow, need to be retraced by traditional wisdoms and age old retraction. Capping the use and convergence of the political economy of the water pricing needs to be categorized through an inter-disciplinary thrust and not through silo's decentralised approach. The endorsement that proper accounting, auditing and budgeting are to be well understood and implemented else the whole gamut of water consumption in real to that of the apparent losses would never ever be mapped nor channelized. Since rivers are not just a subject of economics but also caters anthropology and history which drives the sheer political economy with a blended characterization of the tradition and culture in India, a multifaceted approach which is adopted need to have bottom to top uptake and reform to actually equate the quantum spending and quantum cleaning equations.

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Economic Water Scarcity: The Beginning of the End of Growth Story

Prangya Paramita Gupta

Introduction

When Cape Town is approaching the "Zero Day", with the planets second largest population at 1.3 billion (and expecting to be 1.7 billion by 2050), India is also struggling to ensure this basic tenant of our existence is safe and secure for majority of its population (United Nations, 2013). India possesses only 4% of world's freshwater resources to serve 17.74% of world's population. As population grows and resources shrink this contrast becomes prominent. As per the international norms, countries with per-capita water availability less than 1700 m^3 per year is categorized as water stressed. Following the norms, India, with per capita available water of 1545 m^3 is already a water stressed country (India-WRIS wiki, 2015). Furthermore, it is projected that per capita water availability in India may drop down to 1401 m^3 and 1191 m^3 by 2025 and 2050 respectively, which will eventually turn India to a water scarce country (India-WRIS wiki, 2015; Gangwar, 2013). Booming economics, population growth, and rapid urbanization are some of the major contributors to this issue, especially in urban areas. Urban areas which accounts for only 3% of Earth's total landmass is home to 54% of world's population, and by the end of 21st century it is expected to rise up to 66% and India is no exception. Now the big question is India with so many major and minor rivers and water bodies, rich groundwater resources and blessed by monsoon how is becoming a water scarce country?

Water scarcity: physical and economic

The main long term driver of water scarcity is unprecedented urbanization leading to growing demand and subsequent consumption of fresh-water and/or depletion of freshwater resources predominantly due to climate variability and alike phenomena. According to UN-Water "water scarcity is defined as the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully." Water scarcity can be a natural as well as an anthropogenic phenomenon. Often multifunctional and heterogeneous nature of water resources causes scarcity. Water security is also a function of access to water resources. Based on the causes, water scarcity can be of two types: physical (absolute) water scarcity and economic water scarcity.

Physical water scarcity occurs when sufficient water is not available to meet the demand of the region. Arid and water stressed regions are most often suffered by physical water scarcity, though recently new trend of artificial physical water scarcity is observed in other climatic areas due to over allocation and over-development of water resources. Environmental degradation and conflicts over water resources triggers physical scarcity of water. On the contrary, Economical Water Scarcity emerges due to poor management of water resources, lack of good governance, non-investment on sustainable water infrastructure or lack of human capacity to meet the water demand even places with abundant resources. In economic scarcity access to water is not limited by its availability, rather influenced by institutional and financial constraints over distribution of water. Natural hazards like floods and droughts also develop economic scarcity through poor access to water. Human interventions such as reservoirs, dams, and irrigation measures though increase water availability for one region but often push the water scarcity problem downstream.

Where do we stand?

Looking at the global water scarcity scenario, it is evident that almost all the states of India are under some form of water scarcity (Fig. 1). Entire north east India, Bihar, UP, Chhattisgarh, parts of MP, Gujarat, Rajasthan, Chandigarh, Punjab, Haryana and Odisha suffer economic water scarcity. This implies that Centuries of mismanagement of abundant water resources, socio-political and institutional incompetence, severe lack of regulation, over privatization, general neglect and government corruption along with steadily increasing population and sudden emergence of new class of population demanding more water and water intensive protein rich diet are driving the country to economic water scarcity.

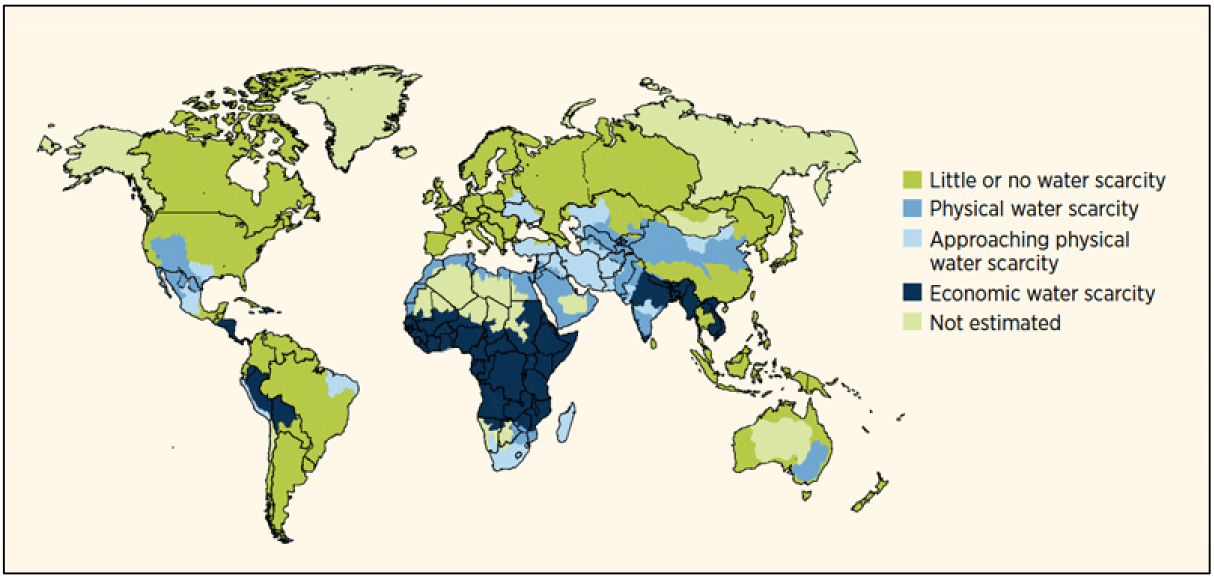

Figure 1 Global physical and economic water scarcity (WWAP, 2012)

The states under the lens are agricultural hot spot in India. Agriculture is a major consumer of both surface and ground water in agri-based countries like India. Indian agriculture accounts for 90% of its water used (Dhawan, 2017). 70% of country's groundwater withdrawn is used for agriculture. Irrigation also has a significant role in boosting Indian agro-production to compensate irregular precipitation and weak monsoon. Thus groundwater resources are over exploited in some states (e.g. in Punjab, Haryana, and Rajasthan) ironically with government interventions in form of subsidies in irrigation, which have developed economic water scarcity in those states.

Table 1: State wise annual groundwater draft and its future availability for irrigation by 2025

State Name	Current groundwater draft for irrigation (bcm)	Available groundwater for irrigation by 2025 (bcm)
Gujarat	10.75	5.87
Haryana	12.35	-3.31
Punjab	34.17	-14.83
Delhi	0.14	0.01
Uttar Pradesh	48.74	19.64
Madhya Pradesh	17.48	13.9
Rajasthan	13.13	0.91
Bihar	10.25	14.1
Chhattisgarh	3.43	7.44
Odisha	3.81	11.64

Source: (Central Ground Water Board, 2014)

Comparative study on the current and projected future (2025) water availability for irrigation in India revealed that all the mentioned states, except Bihar, Odisha, and Chhattisgarh will be highly water deficit with respect to irrigation water demand (Table 1). Though Bihar, Odisha, and Chhattisgarh will have enough storage of groundwater, the apparent economic water scarcity scenario in those state are the result of poor governance. India has a rich cultural heritage of water harvesting and there are ample examples of traditional water management structures such as tanks, wells, and canals across the country but they are either not maintained or poorly maintained. Moreover to meet the quench of ever increasing population number of bore wells/ tube wells has dramatically increased over the years to aggravate the situation (Figure 2). There have also been regular and long term issues of mismanagement in water allocation, e.g. sharing of Cauvery water by Tamil Nadu and Karnataka, which is not because of lack of water but due to reckless overuse. In contrast, China uses a quarter less fresh water than India to support its larger population. Contamination of fresh water resources due to discharge of untreated wastes from domestic, agriculture as well as industrial sources has sullied the water of major rivers in India. Limited or no initiatives and infrastructure development observed in water recycling, especially in industries and energy sectors.

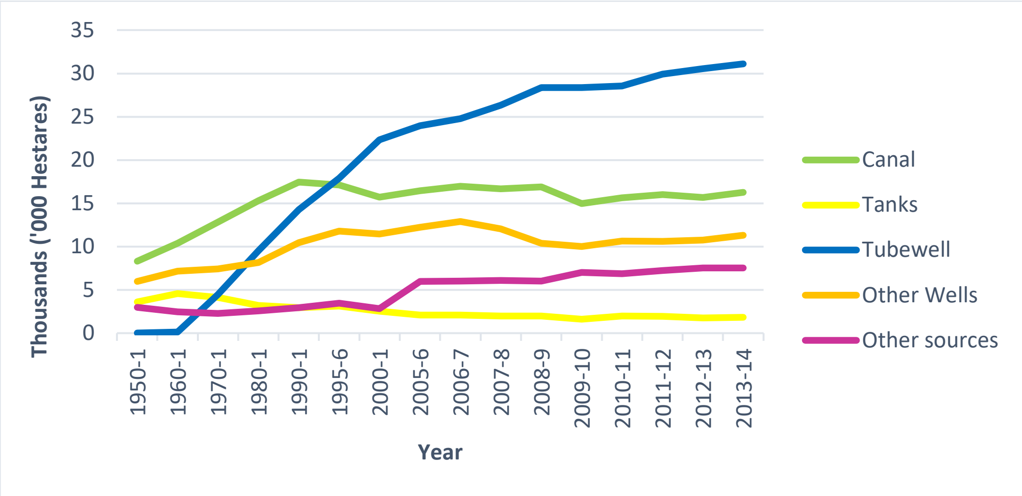

Figure 2 Modes of irrigation in India
(Ministry of Statistics and Programme Implementation, 2017)

Economic implications

Water is used very inefficiently in industry, agriculture and domestic sectors in India and much of it is wasted without properly valuing it and without analysing the economic benefits. Unlike other commodities, scarcity of water cannot be overcome by replenishing it from the water abundant area, because transporting water is expensive both economically and ecologically. Water scarcity has a deep impact on all the economic activities such as food and energy production, manufacturing and infrastructure development. Poor allocation and wasteful use of water impede GDP growth and affect trade balance and industry structure. Computable General Equilibrium Model based on different probable scenario shows that water deficit has pounding impact on different variables of economy i.e. production, consumption, investments, trade flows etc. As different economic sectors are inter-related, negative impact in one sectors can reverberate through the national economy. Water scarcity also gives rise to conflicts over water allocation. A global study by World Bank based on the impact of water scarcity on GDP of countries shows that water scarcity can cost up to 6% of GDP by 2050 if water smart policies are not undertaken (World Bank, 2016). The study also reveals that in business as-usual scenario India can lose 6% of its GDP by 2050 due to water scarcity, but with efficient water, policies can make a gain up to 2% (Fig 3). Both agriculture and industries are water intensive and to some extent interlinked, hence water scarcity in any form will be an obstacle to the growth and development of these sectors, affect livelihood of millions of people and stagnant the millennium Development Goal (MGD 1) of poverty alleviation. It is a matter of concern for India as both of these sectors are significant contributors to the national GDP (17.35% by Agriculture and 28.84% by industry) (World Bank, 2018; Department of Agriculture, Cooperation & Farmers

Welfare, 2015). Around 70% of rural households and 54.6% of total population of India depends on agriculture as their primary mode of livelihood (FAO, 2017). Water scarcity in form of drought is a major factor in deciding the fate of these population since monsoon precipitation has become unpredictable due to climate change. A study by associated Chambers of Commerce and Industry of India found that US$ 100 billion was the cost of drought in Indian economy in 2016 (Govind Katalakute, 2016). Drought itself damage quality and quantity of agri-produces which impacts the economy of agriculture and allied sector. Moreover, a common practice in Indian states is to claim additional economic benefit/ one time grants from the central government during drought events rather than improve water management practices, which pose economic burden to the government.

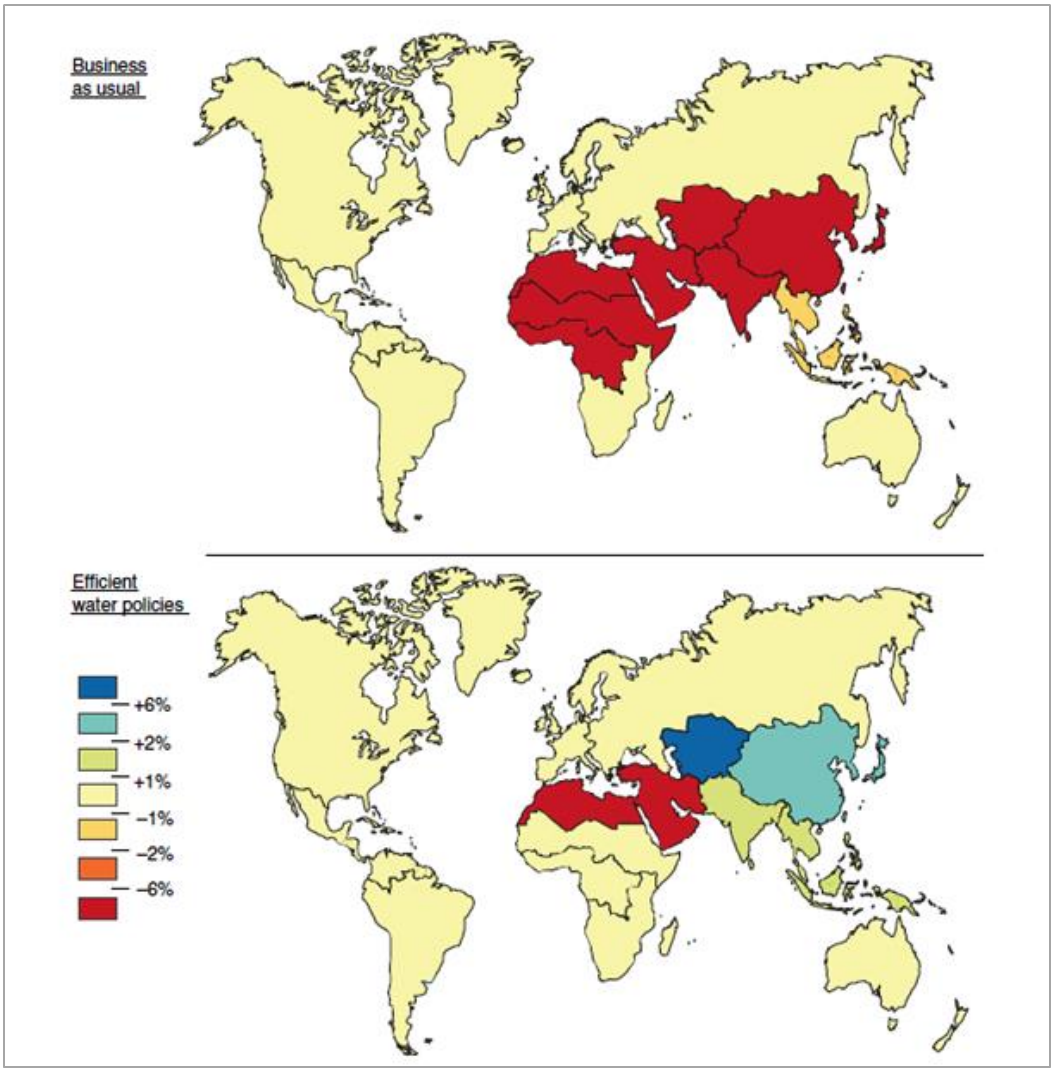

Figure 3 Estimated impact of water scarcity on GDP in 2050 under two policy regime (Source: World Bank, 2016)

Water scarcity affects the access to safe drinking water and sanitation, especially due to water pollution and post-disaster (e.g. flood) infrastructure damage. This has considerable impact on the economy. It has been reported that some developing countries in Africa and Latin America could gain approximately 5% more over their GDP after achieving the Millennium Development Goal (7) to half the proportion of people without sustainable drinking water and sanitation and universal access could make gain of up to 15% of GDP (HSBC, 2012). In India, the potential gain can be up to 5.2% in terms of GDP if universal access to drinking water and sanitation is provided if India could achieve MGD 7. However, in rural India alone 63.4 million people are still living without access to clean water (WaterAid, 2017). Water pollution also creates economic water scarcity and has high socio-economic cost and subsequent impact on GDP. India lost Rs. 366 billion due to water pollution and poor sanitation through outbreak of water borne diseases in 1995, which is equivalent to 3.95% of GDP (Murty& Kumar, 2011). Investment required to this abates water pollution through formulation of rules and policies and provide better sanitation facility to the population additionally cost 1.7 – 2.2% of GDP. A relatively recent report from World Bank estimated that annual cost of poor water supply and sanitation can cost India as high as Rs. 610 billion per year (World Bank, 2013).

Way forward

A crisis of this magnitude cannot be solved with lip service and short sighted solutions. India needs to be water-smart. The incidence of severe drought in Latur in 2016, when trains carried millions of litres of water there, wasting of thousands of litres of water scrubbing a helipad or watering a cricket ground at the same time are the height of mismanagement of water in India. To avoid economic water scarcity either the supply of water should be increased, or the productivity of water use should be increased or the demand of water should be decreased through changes in water using activities. As there is limited scope of increasing water availability in India, Government should focus on judicious use of water and increase water use efficiency across all sectors. Water conservation needs to be promoted and mandated in daily life. Irrigation water management and adaptation of water smart technology needs to be given priority. Massive investments in alternative energy should also be vigorously pursued. Wastewater treatment needs serious attention. Nonetheless, economic water scarcity can be addressed quickly and efficiently with good governance and effective policy interventions.

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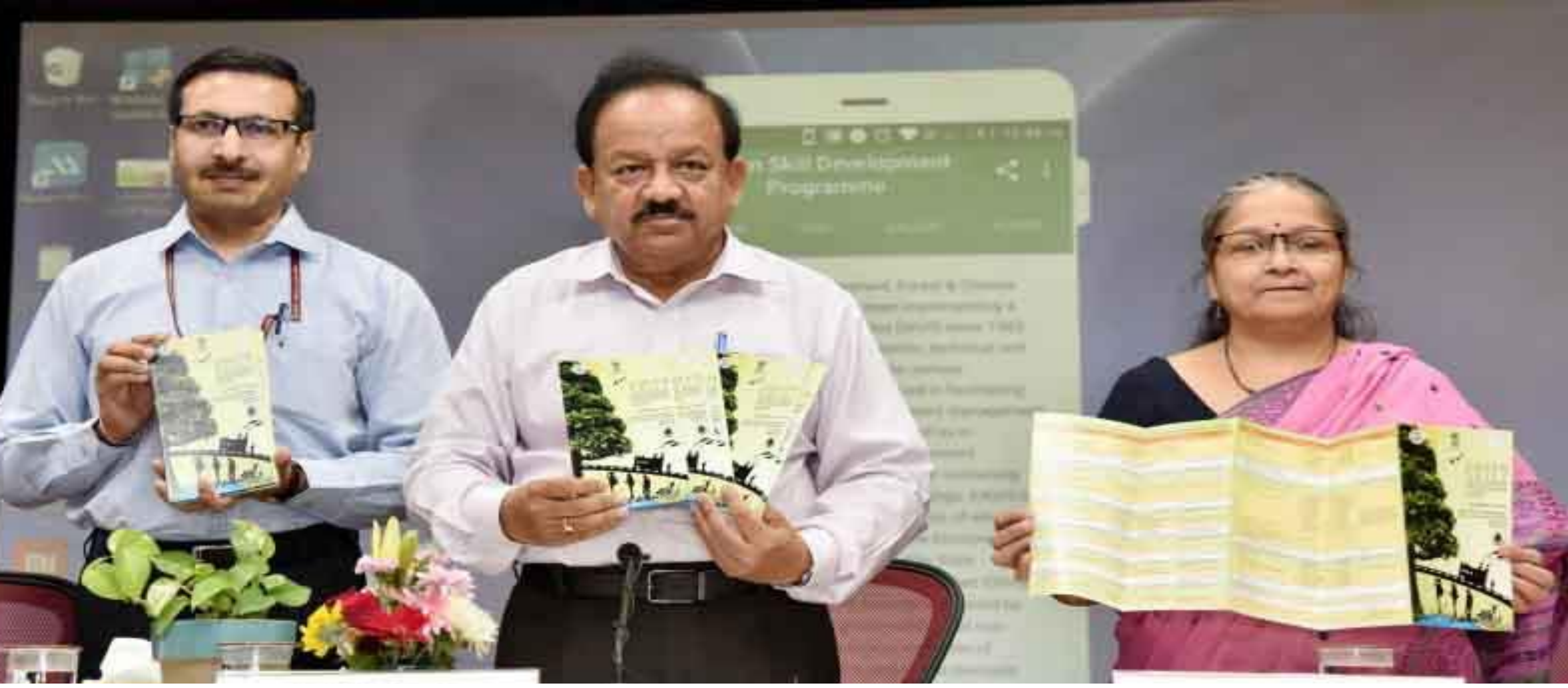
Prangya Paramita Gupta is an Environmental Specialist with expertise in Natural Resources Management using Earth Observation and Geo-informatics tool. She is presently working as an ENVIS resource partner Information Officer at Centre for Environment, Energy and Climate Change, ADRI.



An exclusive interview with Dr. Anandi Subramanian, Senior Economic Advisor, MoEF&CC

Vivek Tejaswi

She speaks on the reasoning behind Green Skill Development Programme (GSDP) in Indian context, and how, in the coming years, this will help bridge the green skilled workforce deficit in the environment sector and contribute towards nature conservation and restoration in India.

Dr. Anandi Subramanian, Senior Economic Advisor, has developed the concept of GSDP. It is a unique skill development training initiative that comes under the ENVIS Scheme of the MoEF&CC, to cater to skilled workforce demand in the environment and forest sector. The larger goal of the initiative is to enable India's youth to get gainful and/or self-employment in the environment sector. The programme endeavours to develop green skilled workforce having technical knowledge and commitment towards sustainable development. The programme will help towards attainment of the Nationally Determined Contributions (NDCs), Sustainable Development Goals (SDGs), National Biodiversity Targets (NBTs) as well as frameworks under the latest Waste Management Rules.

According to Hon'ble Environment Minister Dr. Harsh Vardhan, GSDP targets to impart green skills to 80,000 youth by 2018 and cumulatively to about 5 lakh youth by 2021. More than 30 umbrella programmes have been identified, which will be conducted in 84 institutions across the country. He also stressed that such an initiative will complement the vision of the Prime Minister, Shri Narendra Modi, of skilling India's youth and strengthening the resolve to conserve and protect the environment.

Ques 1. If not wrong, the term "Green Skill" is being heard first time in Indian academia. How did the idea of introducing completely new skill development course germinate?

Well, yes GSDP is unique. While doing an impact evaluation of all ongoing schemes of the MoEF&CC, I had discussions with several officers/officials across states and understood the current scenario of workforce in the environment field. There is a huge deficit or gap between demand and supply of skilled workforce in environment & forest sectors. Further, about 31 percent of children drop out of school at the Secondary stage itself. Thus an idea germinated to skill the school pass/dropout youth and a concept note on GSDP was generated. It was also decided to tie-up with the National Skill Development Agency (NSDA), Ministry of Skill Development and Entrepreneurship (MSDE).

Ques 2. Past experiential studies shows, the success rate of skill development programmes in India is very poor. In India, bigger skilling initiatives like National Skill Development Corporation (NSDC), Pradhan Mantri Kaushal Vikas Yojna (PMKVY) etc. have not created much impact on employability of unskilled youths.

How GSDP initiative is differentiating the odds of previous skill development programmes and what has been added or subtracted to make GSDP more impactful and sustainable?

Figure 3 Field training under GSDP programme. (Photo source: http://gsdp-envis.gov.in/)

I will elucidate about the GSDP. Its design and functioning is not based on PPP or franchise training model. Instead, MoEF&CC is making use of the existing network of Environmental Information System (ENVIS) comprising ENVIS Hubs in State departments and Resource Partners (RPs) in recognised Institutes/Organisations located across States. It is close network loop under the supervision of MoEF&CC.

A pilot programme was launched by Hon'ble Minister for Environment, Forest & Climate Change on June 4th 2017. Based on the positive feedback of the trainees of the pilot programme, and after rigorous homework on the additional courses and centres that could undertake them, the GSDP has been expanded to include more than 40 diverse courses with duration ranging from 80 hours to 550 hours based on the skill requirement or demand of the environment sector. Training will be provided in 84 ENVIS Hubs/RPs/Autonomous Bodies & Subordinate Offices under MoEF&CC/GSDP Partners across India. At first, it is proposed to skill Master Trainers/Specialists who are mostly graduates, who would then help in further skilling the dropout youth, in both urban and rural areas.

The course design is based upon the niche demand of the skilled workforce in a particular domain. For instance, training on Para-Taxonomy including Peoples Biodiversity Register will cater the skill demands of Biodiversity Management Committees as well as institutions like Botanical Survey of India (BSI), Zoological Survey of India (ZSI).

The course modules for all courses have been drawn up by experts in these institutions. The skilling partners will undertake any modification or alteration in the prescribed course, if required, after due consultation with other partner institutes. They can conduct training based on their understanding and suitability of trainees, within the contours of the course module.

We are particular about the programme's sustainability. The successful completion of GSDP pilot training with Botanical Survey of India (BSI) and Zoological Survey of India (ZSI) in 2017 has shown the potential of the programme. As already stated, training will now be focused on creating an effective pool of Master Trainers who have the qualification and attitude to train the school pass/dropouts. Further, there will be a placement cell/officer in every skilling partner institute who will try to facilitate placement of trainees by networking with user groups. But the final employment will depend on user groups (stakeholders) and the trained individual's skillsets. However, not all trainees seek employment. It is noteworthy that there are students who undertake the course and then pursue higher studies/research in that field.

Figure 4 Community Outreach for conservation of biodiversity in Dunda District, Uttarkashi under GSDP programme. (Photo source: http://gsdp-envis.gov.in/)

Apart from this, a district wise National Environment Survey under the Grid-based Decision Support System (GRIDSS) programme of the ENVIS Scheme is also on the anvil. It involves environment resource mapping &data collection exercises on natural resources in districts across India under taken through the ENVIS Hubs and RPs. To conduct such intensive survey, there will be a huge requirement of skilled workforce at the grass-root level. Individuals trained under GSDP would also be a good resource pool for these future activities.

Ques 3. In press conferences, Hon'ble Environment Minister Dr. Harsh Vardhan has said that the GSDP aim to get 80 thousand green skilled individuals by the end of this year which will be increased to cover 2.25 lakh by 2019 and 5 lakh (cumulative) by 2021. How and where do you see all those individuals will get employment?

As I have already mentioned, there is a latent demand for 'green skilled workforce' in conservation and protection of environment sector. Areas of employment includes Institutions under MoEF&CC/ Biodiversity Management Committees; Central Pollution Control Board (CPCB)/ State Pollution Control Board (SPCB)/ Local bodies/industries/ firms/effluent treatment plants/ wildlife & bird sanctuaries/ zoos/national parks/ wetland sites/ Eco Tourism/ Wildlife Tourism/ etc.

In addition, to carry out the GRIDSS programme, the skilled workforce is not adequate. These will be created under GSDP. There will thus be a direct requirement of trained individuals at district level, who can help in filling the data gap, which will further help district and state government policy makers to analyse the impacts of a particular environmental damage or intervention.

Ques 4. After listening to you, the programme looks well designed and futuristic. As you mentioned that ENVIS Hubs and RPs will be playing an important role in training and facilitating placement drive for the trained individuals will there be any certification or letter of recommendation from MoEF&CC after completion of the training?

Yes, on successful completion of GSDP training, trainees will be awarded certificates from MoEF&CC, with skill levels based on the National Skill Qualification Framework of NSDA. The certification will give a national recognition, and will also help in an individual's development and in finding new career opportunities in environment conservation and protection.

Ques 5. Is there any collaboration with related government institutions or bodies who could directly or indirectly help in creation of demand for such green skilled individuals?

The entire programme is extremely flexible and lends itself to refinements as and when required to cater to future demands. We have already listed out 84 ENVIS Hubs/RPs/Autonomous Bodies & Subordinate Offices under MoEF&CC/GSDP Partners across India who are on board for training. They are either research based think-tanks or government institutions, each specialized in their domain. We have sent communications to the Chief Secretaries as well as Principal Chief Conservator of Forests of each State/UTs, requesting their intervention in recognising the skilled workforce created under GSDP and providing employment opportunities to them. The ENVIS Hubs and RPs have also been asked to hold stakeholder meetings at the State and District level for this very purpose. With greater awareness of the potential of GSDP skilled manpower, I am very sure that in the coming years there will be greater demand for the 'green skilled workforce'.

Dr. Anandi Subramanian joined the Indian Economic Service (IES) in 1982, and has since worked in various capacities in both the Central as well as State Governments.

She obtained a Master's degree in Economics from Stella Maris College, Chennai; a MSc degree in 'Social Policy and Planning in Developing Countries' from the London School of Economics, London and doctorate in the field of Demographic Economics from the SNDT Women's University, Mumbai.

Her tenures, inter alia, were in Ministry of Small and Medium Enterprises; Planning Commission; State Planning Commission of Tamil Nadu; Ministry of Consumer Affairs, Food and Public Distribution; Commission for Agricultural Costs and Prices, Ministry of Agriculture; Ministry of Finance.

Since November 2015, she is posted as Senior Economic Adviser (Additional Secretary equivalent), in the Ministry of Environment, Forests and Climate Change. Dr. Subramanian has been instrumental in conceptualizing and developing the GSDP with a great vision of not only tackling unemployment, but also combating issues related to environment, forest and climate change by creating a 'Green Skilled Workforce'.

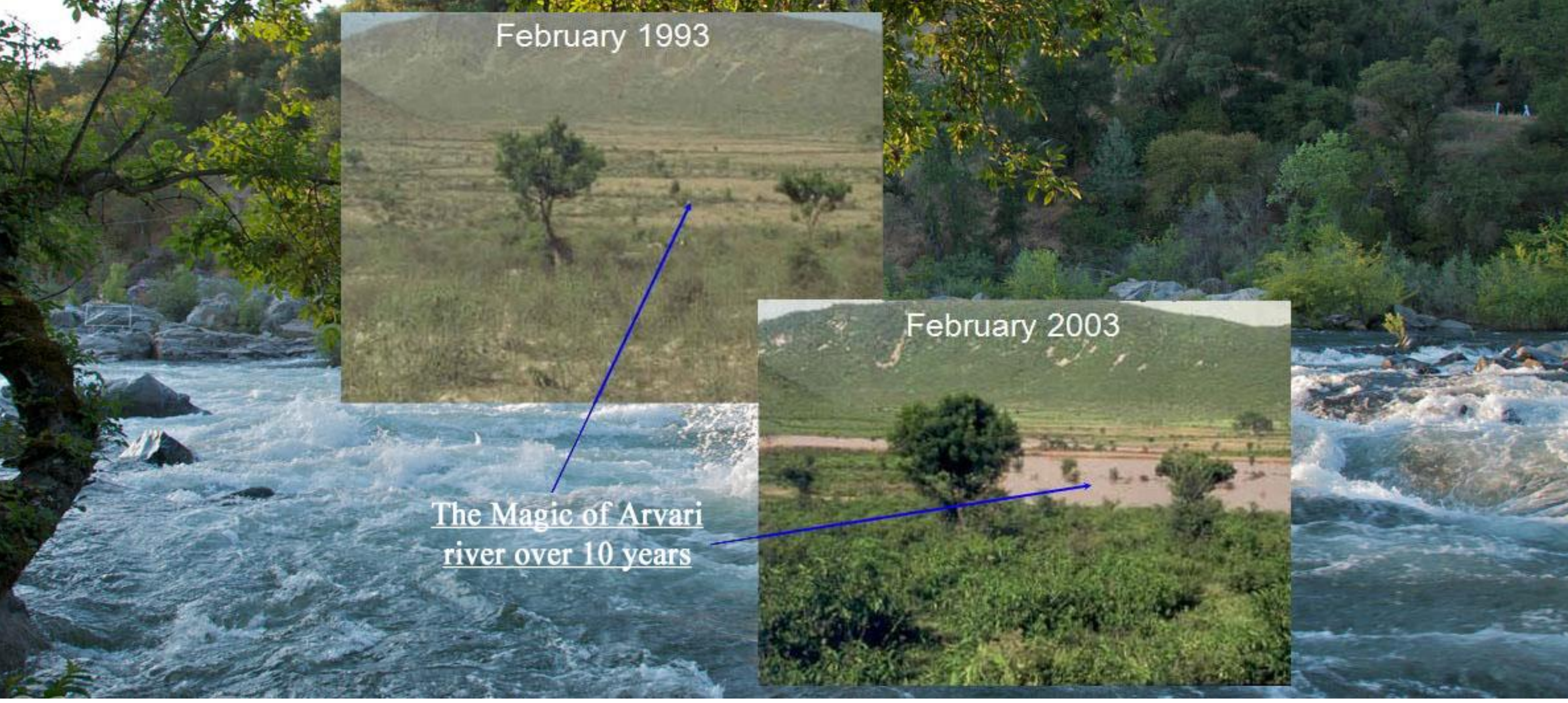
Case Study 1: Social Networks in Water Governance and Climate Adaptation in Kenya

Water scarcity in Kenya was a cursed affair but Kenyan Government was able to solve this problem through a result-oriented community-based approach wherein all important stakeholders cohesively participated in the governance schedules. They applied the decentralized governance method with effective climate change adaptation strategies in the water sector. Their government applied Integrated Water Resource Management (IWRM) at the small scale of community level in rural part of Loitokitok district which is located at southern Kenya.

Loitoktok district in Kenya is inherently water scarce due its arid to semi-arid physiography. Some of the other reasons that led this region to water insecurity are, recurrent drought due to climate change, widespread deforestation and poor land management and governance. According to Kenyan government 2009b report, only 647 m3 per capita per annum water available in Kenya whereas the international benchmark of 1000 m3 per capita per annum. To address the issues Kenyan government adopted Integrated Water Resource Management (IWRM) based on the decentralization principle involving a network of water governance actors namely Public actors (government agencies manage the water resources in Loitoktok district), Private actors (foreign government or international organization actors that usually collaborate with the Kenyan government), Non-governmental actors (NGO work to increase water provision, distribution, and building capacity in the district) and Civic actors (66 water project and several business groups licensed sell water to the community). The actors are interlinked with each other on the basis of three activities - financial support, research and technology development, and/or project implementation in water governance at Loitoktok. Throughout the implement-tation phase the public actors strengthened technical know-hows of water harvesting and efficient irrigation practices. Private actors like UNICEF, SNV and Red Cross worked on WASH to reduce waterborne diseases. These private actors along with other civic actors initiated leadership interventions for increased collective actions in water infrastructure. With all these supports and activities the Loitoktok community should have become technically sound and equipped in water governance, provided the actions were integrated. However, the improvement was not up to the mark.

To find out the level of coherence among stakeholders in water conservation and adaptation implementation the author carried out Social Network Analysis in this study. "Social network analysis is an approach that analyses relationships among various social actors as real interactions with local potentials and liabilities that influence success of any decision-making process" (Lourenço et al. 2004). It can also reveal the deficiencies in the existing system, which can be used to formulate improved policy framework for future challenges. Though the structural policy of IWRM enables the stakeholders and actors to work on water management synergistically from a single location, the social network analysis of Loitoktok district reveals low and/or incomplete interconnectivity and coordination among stakeholders involved in water governance. This has led to development of many structural holes that hindering spread of adaptation strategies to the wider community and results in independent implementation of water conservation measures. The case study of Loitoktok confirms that through individual effort to implement IWRM can gain success at small-scale in securing water for the region, but at the national level implementation of IWRM essentially require synchronization among stakeholders to upscale existing adaptation measures for water management. There is also need for alignment between national development objectives and rural strategy plans, as the competition over water across all sectors increases with population growth and industrialization. Increased synergy among actors will reduce conflicts over water, enhance water security and open up new opportunities for livelihood.

(Source: Grace W. Ngaruiya, Jürgen Scheffran and Liang Lang, (2015), Sustainable Water Use and Management: Examples of New Approaches and Perspectives, Springer International Publishing, Switzerland.)



Case Study 2: RWH Impacts – Case Study of the Arvari River Watershed

A new research report titled, "Rainwater Harvesting Market – Global Industry Analysis, Size, Share, Growth, Trends, and Forecast 2017 – 2025" has been added to the comprehensive repository of Market Research Reports Search Engine (MRRSE). According to the report, the global rainwater harvesting market is likely to grow at a CAGR of over 5.70% during the assessment period 2017-2025. Rain Water Harvesting (RWH) is a long established solution adopted in arid/ semi-arid regions around the world for supply-side water management. With this growing market feasibility RWH seems to be a feasible option and has socio economic implications as well. The brief tries to evaluate and present the Arvari River Watershed (ARW) (476 km2) in Rajasthan, India, which is placed in a semi-arid region and is predominantly agrarian but suffers water scarcity during non-monsoon seasons. Since 1985, there has been significant investment in RWH in ARW involving communities and local NGOs and 366 RWH structures were built in form of Anicuts, Bandhs and Jhodas. However, rainfall is a very localised and variable phenomenon in this region. So, the RWH structures though filled up during monsoon becomes almost empty, through evaporative loss, lateral sub-surface flow and recharge. This case study analysis intends to find how effective RWH system has been in supply-side water management for agriculture in ARW.

A conceptual water balance model was built to capture the large scale watershed effects and changes in the water balance due to RWH in the ARW. The results indicate that though the RWH is a more viable system for irrigated agriculture compared to a system without RWH, sustainability sometimes decreases when the irrigated area per structure increases. A greater degree of RWH development can also decrease the social, economic and environmental marginal benefits of additional RWH structure because of low aquifer storage capacity. That means there is a limit in the area of RWH that gives maximum recharge benefit beyond which the benefit is marginal. However, the RWH structures alleviate some of the deficit in below average rainfall years through recharge of aquifers, but cannot compensate for long term drought. Moreover, as RWH leads to an increase in 'green' water used for irrigated agriculture upstream, this will affect 'blue' water availability for downstream users. The study also shows that if the supply of groundwater increases due to RWH, then local demands increase. This means for sustainability of groundwater, demand-side management as well as conflict over resources must be addressed.

For demand-side management, Arvari River Parliament (ARP) was initiated in the year 1998 with 110 representatives from 72 villages of ARW to give resource property rights to the community so that they can manage commonly owned water resources. Through this initiative, 85% of RWH structures benefited small and marginal farmers in terms of increasing irrigated area and decreasing dependency on rainfall. ARP formulised the following informal rules:

- Water-intensive crops such as sugarcane, rice, and cotton are not to be planted
- No one shall draw water from the river or RWH structures except those people, who gave their land for RWH structures or whose land is under water because of RWH.
- No commercial fishing is allowed in water stored in RWH structures
- Tube wells, which tap deeper aquifer, are not allowed
- Construction and maintenance of RWH is encouraged
- The land is not to be sold for mining/quarrying or any other industrial activity
- Protection and planting of forests in encouraged

Despite the presence of the informal rules of the ARP, unrestricted use of groundwater still occurs within the ARW. Enforcement and monitoring of the rules have been a challenge. The users are heavily dependent on the resources, however, the boundaries are not clear. Currently, the ARW is not facing serious supply issues because of fewer consumers, but as the population grows longer-term water table decline patterns could appear. In this regard, ARP should be pro-active in the demand-side management of groundwater. This also includes enabling groundwater resource users to balance their demand for groundwater in parallel with RWH construction, which must consider water balance trade-offs across the larger watershed.

(Source: Claire J. Glendenning and R. Willem Vervoort (2015), Sustainable Water Use and Management: Examples of New Approaches and Perspectives, Springer International Publishing, Switzerland.)

Tourism: a contributor to global carbon emission

Global comprehensive tourism footprint is growing fast and responsible for 8% of global GHG emission, as found by a research by a team of researchers in University of Sydney, Australia and published in *Nature Climate Change*. US has the lion share of the tourism related GHG emission with Canada and Germany as prospective nations in this respect. Small islands also share dispropor-tionately high emission because of international arrival. The study along with emissions from the mode of travel the tourists takes, also includes the goods and services the tourists enjoy at the spot. The research recommends that there should be financial and technical support to minimise tourism related impact on climate. (Source: http://www.thehindu.com, May 03, 2018).

Photo credit: *Times of India*

Eco-restoration drive for water bodies

An innovative step is taken by the Chennai Corporation to reclaim and restore 206 polluted water-bodies in Chennai. As part of the project they are going to remove municipal solid waste from the water-bodies and engage local community and corporate to adopt and maintain them. Civic amenities will also be created around the water-bodies. As pilot OmaKulam in Madhavaram zone has been cleaned up to improve the water quality after several complains about ground water pollution flagged by local residents. 70% of restoring work has, so far, been accomplished. (Source: http://www.thehindu.com, May03, 2018)

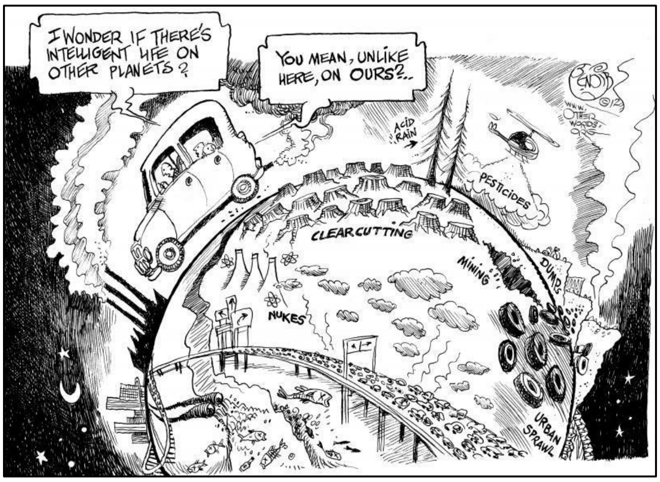


Photo credit: https://www.conservationbytes.com

India lost 2.54% GDP through desertification, Land degradation and Drought

According to a recent study commissioned by the Ministry of Environment Forest and Climate Change, India has lost 2.54% of its GDP through desertification, land degradation and drought in 2013-15 financial years. The full report on the study entitled "Economics of Desertification, Land Degradation and Drought (EDLDD)" was released in Asia Pacific Regional Workshop of the United Nations Convention to Combat Desertification (UNCCD) (april-24-27, 2018) by Union Environment Minister Mr. Harsh Vardhan. The report also highlighted that 20 million tonnes of food grains are lost in a year due to drought and desertification. (Source:www.timesofindia.indiatimes.com, Apr 27, 2018)

Photo credit: *UNESCO*

News

Photo credit: *Altaf Qadri, AP,* ustoday.com

Mega drought event identified in mid-Holocene period

Uranium–Thorium dating of a portion of stalagmite from Kotumsar cave in Central India revealed 70-100 year long mega drought event during mid-Holocene period (about 7000 years back). The analysis revealed that a major interpret sub-annual to sub-decadal variations in the monsoon occurred from 8500 years ago to 6500 years ago. The summer monsoon started declining during this period causing century long drought scenario in that region and impacted agriculture practices of early humans. Post-drought event the summer monsoon again started to increase gradually between 6500 years ago to 5600 years ago. Also the interrelationship of Indian summer monsoon and El-Nino Southern Oscillation has been observed in this study. (Source: http://www.thehindu.com, May 12, 2018).

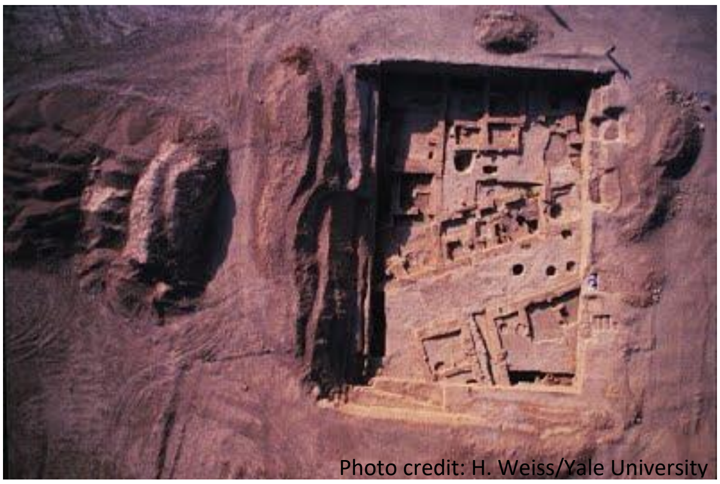


Photo credit: H. Weiss/Yale University

India manages to reverse the wheel of air pollution in cities

Ministry of Environment Forest and Climate Change in response to WHO's data on India's air pollution status, claims that the air pollution level is decreasing from 2016 to 2017 and 2018, post government's serious effort to combat air pollution. According to WHO, Delhi was the sixth most polluted cities in the world with PM 2.5 of 143 $\mu g/m^3$, whereas MoEF&CC says it was 134 $\mu g/m^3$ in 2016 and 125 $\mu g/m^3$ in 2017 quoting CPCB. MoEF&CC added – 'there has been further improvement of air pollution level in 2018. (Source: http://www.thehindu.com, May 03, 2018).

Photo credit: NASA JPL

Carbon satellite to measure Earth's carbon balance

A group of researchers from the University of Copenhagen has developed a new method of satellite imaging to estimate Earth's carbon balance. A French satellite has been tested for this purpose which uses aerial photography and low frequency passive microwave to measure the biomass of above ground vegetation. It records carbon emission from all parts of vegetation (e.g. trunks and branches along with the crown) which was not possible so far with available technologies. The pilot study has already been done in Africa and detailed map of carbon balance has been prepared for the whole continent. This technology can become crucial for policy makers like UN and IPCC and climate change experts in decision making. (Source: www.sciencedaily.com, May 03, 2018).

Event Gallery

Consultation meeting on
A cohesive action plan to combat climate change on 03.07.2017

Release of Report on Financial Framework for Sate Action Plan on Climate Change on 26.09.2017

Expert's Consultation workshop on
Development of Risk Index for Agriculture & Allied Sectors on 12.12.2017

Debate competition on
"Development and Environmental Balance are Contradictory" organised by CEECC-ENVIS & Dept. of Env. & Forest, GoB on 24.03.2018

Release of GSDP module on Water Budgeting & Auditing launch by Shri Tripurari Sharan, PS, Dept. of Env. & Forest, GoB at East India Climate Change Conclave on 24.06.2018

Trainees of Water Budgeting & Auditing Course under Green Skill Development Programme at CEECC, ADRI (Session: July–August, 2018)

Trainees of Pollution Monitors: Air & Water Pollution Course under Green Skill Development Programme at CEECC, ADRI (Session: July–August, 2018)

Event Calendar

Sl. No.	Event	Date
1.	Stakeholder's Consultation Workshop on Air Quality Assessment Report of Patna	May 09, 2018
2.	Round Table on Transboundary River Dialogue	May 04, 2018
3.	International Conference on Karl Marx - Life, Ideas, Influence: A Critical Examination on the Bicentenary	June 16-20, 2018
4.	East India Climate Change Conclave	June 24-25, 2018
5.	Valedictory Session of GSDP Course on Water Budgeting & Auditing and Pollution Monitors-Air & Water Pollution	August 24, 2018
6.	State Level Inception Meeting on Air Pollution	August 24, 2018
7.	Inception-cum-Capacity Building Exercise on State Action Plan on Climate Change Financial Framework	Sept. 7, 2018
8.	Validation Workshop on Clean Air Action Plan	Sept. 15, 2018

Publication list

1. Ganguli, Barna, Rahbar Ali and Bakshi Amit Kumar Sinha (2017): '*Pattern of Urbanisation in Bihar (1961-2011)*', Journal of Indian School of Political Economy (JISPE). XXIX, 3 &4, 491 – 512.
2. Ganguli, Barna and Bakshi, Amit Kumar Sinha (2017): *'Strengthening Agricultural System: New Approaches' in Kurukshetra.* The Indian Journal of Rural Development. 65, 7, 20 – 23.
3. Manjunath, Soumya, and Elumalai Kannan (2017): "*Effects of Rural Infrastructure on Agricultural Development: A District Level Analysis in Karnataka, India*",Journal of Infrastructure Development.9, 2, 113-126.
4. Mohanty, A., Rumbaities Del Rio, C., Kumar, P. and Sinha, R.R. (2018). *Climate Change and Environment Variance Tool for Strengthening Climate Change Cooperation and Governance Among Nations,* Journal of Sustainable Finance & Investment, Ecological Economics 66, no. 2-3 (2018): 218-227.

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