2015
ANNUAL
CONFERENCE

THE CLUB OF ROME | INDIAN NATIONAL ASSOCIATION

SECURING WATER FOR ALL

The Critical Need for Coherence in Policies and Actions

A Report to the Club of Rome
Indian National Association

Water is a fundamental human need and a critical national asset. India's huge and growing population is putting a severe strain on its water resources. Water along with food, energy and land forms a critical part of the 'new security agenda'. The drivers of future water challenges are tied to development and economic growth, with agriculture as the largest spender of water, at more than 80%. Moreover, some 21% of communicable diseases in India are related to unsafe water; diarrhoea alone causes more than 1,600 deaths daily—as if eight 200-person jumbo-jets crashed to the ground each day.

'Policy Coherence Analysis' attempts to integrate the economic, social, environmental and governance dimensions of sustainable development at all stages of domestic and international policy.

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FOREWORD

The 4th Annual Meeting of The Indian National Association for the Club of Rome (CoR-India), focussed on "***Securing Water for All***: *The Critical Need for Coherence in Policies and Actions*". Held in New Delhi on November 18th-19th, 2015, the conference sought to evaluate and determine coherence in water security policies where water along with food and energy forms a critical part of the 'new security agenda'.

The interdependence of Food-Water-Energy is central to understanding how present and future populations can be provided for, within the ethical, ecological, societal and economic touchstone. In 2014, we discussed the need for coherent policies for 'Food and Nutritional Security' for the rural and urban poor. Last year, we deliberated on the second principle - "Water Security", at the forefront of policy and scientific debate because of its impact on energy and food security.

As aspirations rise, so will the demand for water. In a situation where the gap between demand and availability is rapidly widening the question is: Where will the water come from? This recognition can help to identify sustainable solutions to challenges across different sectors. Governance, women empowerment and socio-economic issues revolve around the ideal on one hand, and climate change induced environmental and ecological concerns, on the other. 'Water Security' can be enhanced with appropriate adaptation measures built on low-carbon and natural systems, to foster resilience to climate change. Without healthy ecosystems in well-functioning watersheds, the infrastructure built for irrigation, hydropower or municipal water supply does not function sustainably, and is unlikely to achieve the economic returns necessary to justify investments.

The purpose of this Conference, therefore, was to explore the various facets of water, and how to develop coherent policies to eliminate water insecurity from India and the world. As a forum, it plans to help design policies that can meet the aggregate demand for water among increasing competition from households, industry, and agriculture. Our aim is to contribute to improvements in social well-being and inclusive growth. Meeting the needs of food, water, energy and land - in conjunction with climate-change and population growth, will enable humanity to be more resilient to numerous security and security issues.

S. Ramadorai
Chairman
The Club of Rome-India

Ranjit Barthakur
Secretary General
The Club of Rome-India

Message from the Trustee, Club of Rome-India

Dear Colleagues,

While India has unquestionably made some progress in its journey towards improving the lives of its citizens, the social, economic and environmental goals it set for itself at the time of independence still remain intolerably out of reach. The goals and aspirations of today's generation are even further out of reach. Distracted and side tracked for seventy years by largely dysfunctional party politics, the proper job of policy making and governance in the broader interest, has largely been eclipsed mostly by the hijacking of government by "leaders" with narrow, short-term self-interest as their primary driving force.

In this situation, how could our institutions and their policies and programmes be anything but fragmented and disjointed in their vision and approach, which, indeed, is what happened. And this has meant that instead of the coherence and convergence that is needed among different sectoral polices for synergy and mutually reinforcing outcomes to take place, we have far too many mutually countervailing, energetic outcomes.

In 2014, the Indian National Association for the Club of Rome launched a 6-year series of annual meetings on the imperatives of Coherence and Convergence in Policy Making. Given the Club of Rome's commitment to systemic consideration of complex societal issues, particularly those that have a strong science-policy nexus, it was natural to address over the course of these meetings what the nation needs to do, and which kinds of policy instruments it needs, to secure the basic resources that are key to sustainable development.

The subjects that we identified for this series were *Securing* our nation's primary resources: Food; Water; Forests, Land and Soils; Energy; and Materials.

Securing Food for All was the theme of the 2014 Annual Conference and *Securing Water for All* was the theme of our Conference in 2015, the subject of this report. We hope that the report will contribute to the policy dialogue in India on how to bring about rapid improvement in people's lives while ensuring that the economy does not transgress the limits of our natural endowment.

Dr. Subhrankar Mukherjee formally joined the Club of Rome as Secretary at the time of the 2014 Conference and was responsible for the preparation and implementation of the 2015 Conference. He was in the process of finalising this Report, when in January 2016, alas, he passed away at a tragically young age. Subra, as he was known to his friends, was truly an outstanding gentleman and a scholar of great rigour. He left a highly promising career in corporate management and at considerable personal cost decided to devote his professional skills to promoting sustainable development. He was totally committed to fairness and justice and to bringing the fruits of cutting edge science and practice into the lives of the poor and marginalised.

We miss him very deeply.

Ashok Khosla
Chairman, Development Alternatives
Co-President, Club of Rome (2005-2012)
President, IUCN (2008-2012)
Chairman, International Resource Panel (2007-16)

This report is dedicated to

Late Dr. Subhrankar Mukherjee

Chief Conference Rapporteur

Ex-Secretary - The Club of Rome-India

who departed this life in January 2016.
A remarkable person, whose intellectual contributions
and enthusiasm enabled us to raise the agenda and operations
of the Club of Rome in India to new heights.

Mr. Suresh Prabhu

Minister of Railways, Government of India

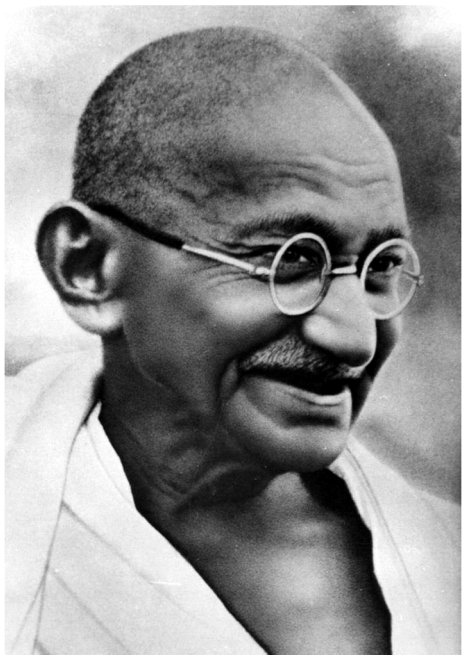
"Water cannot be manufactured... first, there is a need to take care of the source, that is, the ecosystem. Second, there is a need to allocate it judiciously, which is a bigger challenge and, lastly, there should be a formula that is acceptable to all..."

SECURING WATER FOR ALL

The Critical Need for Coherence in Policies and Action

November 18-19, 2015

India Habitat Centre, New Delhi



The earth, the air, the land and the water are not an inheritance
from our forefathers but on loan from our children.
So, we have to handover to them at least
as it was handed over to us.

- Mahatma Gandhi -

SECURING WATER FOR ALL

The Critical Need for Coherence in Policies and Action

CONTENTS

INTRODUCTION

This publication reflects the proceedings of the 2015 Annual Conference of The Indian National Association for The Club of Rome - "SECURING WATER FOR ALL – *The Critical Need for Coherence in Policies and Action"*, held at the Indian Habitat Centre, New Delhi on November 18 - 19, 2015. The objective was to review specific policies and actions in the field of Water Security' and determine, which can be recommended to government, business, civil society, academic institutions and the media for action collectively and in their respective domains.

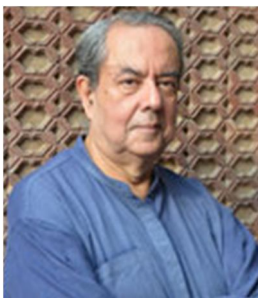
In 2010, the World Health Organization estimated that 97 million Indians lack access to safe water, second only to China, although other researchers suggest that the figure could approach 350 million people - up to almost a third of the Indian population! The Conference, as it will be referred to henceforth, therefore, focussed on the critical need for coherence in the nation's policies and actions in different sectors and regions, to raise the supply of and access to water and limit the demand for it so as to fulfil all the immediate and future needs of society.

Many meetings take place every year on the subject of '***Water Security***'. This conference convened by the Club of Rome-India (CoR-India) offered an opportunity to probe the fundamental, root causes of water scarcity and find solutions that can be translated into policies and actions on the ground, to enable the country to find affordable and natural solutions for water security for all its citizens. In particular, it sought to identify the areas of policies in different sectors, in some cases not often recognised to be related to water resources that have a semi-direct or indirect impact on these resources. A major example of this is the choice of crops in a particular region, irrespective of its demand for water, or the selection of energy technologies that are consumers of water. Often these choices imply the need for making trade-offs that take account of the true and opportunity costs of water, which has often not been the case.

The **Conference** was enriched by the presentations and interventions of international and national thought leaders, who shared their wisdom and knowledge generously, such as: **Mr. Anupam Mishra** spoke with refreshing candour on the need for the government to understand the public, who he said are not foolish. A Gandhian and an environmental activist, he is one of the most renowned persons in India on traditional water harvesting systems. He illustrated how through the ages, the Indian community has created dams without engineering knowledge, technology, steel, iron or skill - but with just will, local materials and local knowledge. The Club of Rome's 'Limits to Growth', must be recognised as unconstrained growth and development has hurt us, and instead, commended small, local acts that are making the difference.

Dr. Rajendra Singh, an eminent environmental activist, popularly known as "Waterman of India", had a similar message that the government should understand the people, not consider them unintelligent and must consult with them. Dialogue can ensure that the process of implementation and enforcement of ideas is done effectively. Conferred the prestigious Stockholm Water Prize this year for his innovative water restoration efforts and extraordinary courage to empower communities in Indian villages he saluted indigenous and traditional knowledge that conserves nature without modern technology. However, he warned that the Third World War could be fought over water issues.

Ms. Katharine Cross, Program Coordinator at the International Water Association, put the spotlight on the current and impending water scarcity scenarios where 50% of irrigated agriculture is in areas of high and extreme water stress. She underlined the need for innovative and systems approaches that optimise the interdependencies of water, energy and food. Her presentation on Securing Water for All, highlighted services from ecosystems and natural infrastructure that underpin each of the three securities. Making the case for collaborative platforms in South-Asian countries, Ms Cross envisaged a future where the environmental, water, energy and food sectors working together identify and solve the real problems.



Dr. Ashok Khosla, *former President, The Club of Rome and Chairman, Development Alternatives*, used powerful graphical interfaces to explain, among other topics, the essence of the '*debate needed today*' for policy coherence, revolving around: (a) Social **E**quity; (b) Healthy **E**nvironment and (c) Viable **E**conomy. He said that we should move away from conventional, narrowly defined approaches that focus primarily on specific projects and activities - such as big dams and large-scale transfer of river waters, and instead embrace natural approaches that have succeeded in India and other parts of the world. Dr. Khosla informed the Conference, that an evaluation of Water Security in India, focusing on the coherence - or lack of it - in policies and actions that could and should be done differently had already been undertaken. Meanwhile, the huge 'gorilla' in the room was, of course, the unmitigated growth of population in India, galloping ahead and projected to exceed China's as early as 2030. This failure to mitigate population growth in India - in terms of conceptualisation, design and implementation of coherent policies - and the issues that highlight the scenario of 'off shooting', has been predicted by the seminal book 'Limits to Growth' (published by the Club of Rome in 1972).The incompleteness of our socio-economic and environmental achievements over the past 67 years, since independence, therefore stands exposed.

The growing scarcities of land, water and other natural resources and the sudden contraction in several such indicators since 2007-2008, he pointed out, are factors of concern not only for today, but also of deeper worry for tomorrow since they will be compounded by issues of population growth, climate change, and acceleration of social and economic aspirations. All these are still further compounded by an increasing lack of policy incoherence, not only in India but globally, as well. Failure to mitigate any and all of these concerns, can mean that a sudden catastrophic outcome cannot be ruled out, regionally, nationally or even globally.

As the problems of access to food become complex and multi-dimensional, conference participants made it abundantly clear that the key to success for change management is the ability, not only to innovate and 'think-outside-of-the-box' to formulate solutions, but also to identify change agents with interdisciplinary skills who can bring in new ideas, methods and field work experience, to make these changes happen and remain sustainable.

However, we have to be constantly reminded that poor people, smallholder farmers and others who are going hungry NOW because of our failure to understand and work within our limits to growth, cannot wait while we address imbalances in our social, environmental, capital and human resources, at our pace. We need not only better and faster solutions, but we need to see them implemented on the ground almost on a 'yesterday' basis, if we are to avoid massive and sudden dislocations in our society. There is a critical need for coherence in policies and actions and continuing our intense focus on our resources, this year, Water Security became central to the discussions at the Conference. Many ideas, perceptions and measures were received from the participants, which helped clarify the issues. We hope this publication will contribute to the generation of more fruitful ideas.

Vishal Massey
COO, The Club of Rome-India
April 2016

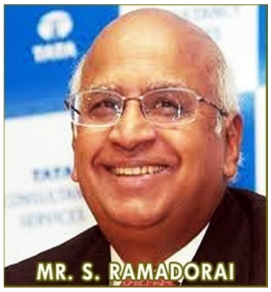
HIGHLIGHTS OF THE ANNUAL CONFERENCE

Summary

A. Opening Session

Mr. Ranjit Barthakur, Secretary General, The Club of Rome-India

Setting the tone for the Conference, Mr. Ranjit Barthakur, Secretary General, The Club of Rome-India called for an innovative, simple and sustainability-oriented approach that must become the central subject of debate in India. Water Security being one of the most important goals for the future health of the nation, the national debate needed to change in order to develop a policy framework towards a truly sustainable future. He proposed the deliberations adopt a systematic approach to water requirements that can lead to a powerful set of proposals, which the Government will be likely to accept.



Mr. S. Ramadorai, Chairman, The Club of Rome - India

In his opening remarks, Mr. S. Ramadorai, Chairman, The Club of Rome-India pointed out that it was important to recognise the Food-Water-Nexus so that the rural and urban poor can also afford nutritious diets usually associated with the urban middle classes. To enable this understanding, last year, the need for coherent policies on 'Food and Nutritional Security' was the focus. This year, the attention is on 'Water Security' and in continuation, maybe next year 'Forests, Land and Soils Security' and thereafter 'Energy Security'. He recommended a review will help determine policy coherence on these issues.

Outcomes are often oriented in different directions and goals, he pointed out, but the views of the Conference delegates and the focus on such specific agendas will certainly crystallise towards the common goals to attain a healthy environment.

The chief guest at the opening and plenary sessions was Mr. Suresh P. Prabhu, Minister of Railways, Government of India and the opening remarks were given by Mr. Ranjit Barthakur, Secretary General-CoR-India, Trustee-Balipara Foundation and Co-author of the Water Book and Mr. S. Ramadorai, Chairman, Indian National Association for the Club of Rome.

B. PLENARY: SYSTEMS, INTERLINKAGES and POLICY COHERENCE

Address by Chief Guest, Mr. Suresh Prabhu, Minister of Railways, Government of India

The plenary session was opened by the Chief Guest, Mr. Suresh Prabhu, Minister Railways, Government of India, who cautioned that since water cannot be manufactured, taking care of its source - the ecosystem, becomes the first priority. Thereafter, dealing with the challenges of its judicious allocation is essential and finally, such formulae must be acceptable to all, he advised. He pointed out that the country faces a water crisis if the current water usage continues. Urging the delegates to understand the problems first and then make coherent policies, he emphasised that '*Water for All'* means for ALL living things and not only for humans. Mr. Prabhu said that some farmers have opposed the Government's approach to Water for Bird Sanctuaries. The agricultural sector needs to understand that it has to be more efficient and all natural resources protected.

Another issue the minister raised was of 'too much or too little water' being a problem and advised that the creation of a model that effectively addresses both scenarios is essential. Using Zubin Mehta as an example, Mr. Prabhu remarked that a review of the different water policies can bring about coherence much like the conductor draws out beautiful music from a wide spectrum of musicians and instruments in his orchestra.

Dr. Ashok Khosla, Chairman – Development Alternatives

Clarifying the approach of the 2015 conference, Dr. Ashok Khosla, Chairman – Development Alternatives, said that prime focus on Water is part of the Lecture Series; whereas 2014 was on Food and Nutrition Security; the 2016 lecture will be on Forests, Land, and Soils and Security for Ecosystems. The essentiality of water for healthy robust ecosystem services across the world must be central to the discussions. He called for a database and scientific reasoning across regions and segments. For this, he pointed out that it was vital that people are brought into an alliance.

Dr. Khosla advocated the moving away from conventional, narrowly defined approaches that concentrate primarily on specific projects and activities. These include the building of large dams, large-scale transfer of river waters in big dams, the ill-conceived river action plans, unrestricted pumping of ground waters and wide-spread contamination of water from extensive use of agro-chemicals. Similarly, activities that were water bodies destroyers like water intensive crops grown in water scarce places; bad land-use practices; dumping; soil erosion and alien species must be rejected. He gave examples to support his argument, where 40,000 litres of water are used to get 1 kg of finished cotton and 2.5 times more water goes into making plastic bottles.

It was critical that communication channels between the Ministries are managed in a sustained manner if water woes were to be dealt with. Dr. Khosla observed that it was far cheaper to have high pressured water available 24x7, than having rationed low-pressure supplies.

Commenting on Mr. Anupam Mishra and Dr. Rajendra Singh questioning the basis of the nexus, Dr. Khosla concluded that they were probably right and 'we did create the problem by trying to solve it'. Traditional approaches in the food-water-energy-soil nexus had emerged after local experiments and were, therefore, better suited to local social, soil and climatic conditions. Modern technology brought in large scale external solutions, with scant understanding of the needs of the people. The natural solutions were abandoned and the complexity of modernisation has driven the rural people to extremes of deprivation and irreversibly degraded the lands and environment.

Ms. Katharine Cross - Program Coordinator at the International Water Association

The impact of water scarcity on energy and food security was a major apprehension highlighted by Ms. Katharine Cross, Program Coordinator at the International Water Association. A systems approach for South-Asian countries was essential and needed to be adopted as early as possible. While expressing concern on Asia being the driest area among all continents, she however believed that the Hind-Kush Himalayan region may provide the solutions.

But, before that, she drew attention to the need for adequate and verified data from the local people for conservation. Thereafter, reallocation of resources could be done judiciously and by bringing together different people from various countries will lead to acceptability. This could ensure a natural integration of solutions.

Dr. Rajendra Singh, Water Conservationist and Founder, Tarun Bharat Sangh

Dr. Rajendra Singh, the eminent environmental activist, saluted indigenous and traditional knowledge that conserves nature without technology, also mentioning the significant work done by 'barefoot engineers' in Rajasthan. India, he pointed out, has gender equality because of the traditional NEER-NARI-NADI-RISHTA, or the relationship between water, women and rivers. However, he was unhappy with the unbalanced development after independence as people are not conscious that their development was hurting others, leading to corruption and other ills.

He was apprehensive that the third world war could be fought over water issues. This was because global migration was arising as water-scarce were seeking water-rich European nations. Degraded and barren lands lead to migration; if recharge and discharge is not balanced, then all rivers will run dry. Therefore, there must be respect for water, and it should be recycled and reused and for this the education system needs to be fixed for natural systems to be respected. The government, Dr. Singh noted, should understand the people and not consider them foolish. They should be consulted and a dialogue initiated so that the process of implementation and enforcement of ideas are done peacefully.

Mr. Anupam Mishra, Gandhian and Water Conservationist

Water is a global problem, but the solution is local was Mr. Anupam Mishra's proposition. A Gandhian and an activist, he said water, meant peace, prosperity and beauty, because where there is water, there is food, livestock and livelihoods and people do not leave. A 21st century education does not teach the meaning of development and he pointed out that Indian villagers have created dams without engineering knowledge, technology or steel but, with just will. The government, he reminded, must understand its people and consult them.

He alluded to the CoR's Limits to Growth and acknowledged that development was hurting people and nature. He recommended using nature as in the sun, which he believed to be the best desalination process to make clear, pure water.

Dr. John Todd of the John Todd Ecological Design Systems

A video presentation by Dr. John Todd on Green Eco Machines demonstrated abundant hope for possibilities of natural cleansing of eco-systems. These Living Machine Technologies are based on natural, bio-mimicry approaches for the treatment of polluted water. Basically, they are ecologically waste water treatment systems and for the remediation of degraded water bodies. Essentially, waste water or degraded water bodies are taken up by the bacteria, and sunlight, bio diversity and natural processes create clean water with by-products of natural gasses and biological material. Waste water and water bodies are converted to high quality reusable water streams.

The moderator for the plenary session was Dr. P. R. Sinha, Country Representative, IUCN, and the conference was introduced by Dr. Ashok Khosla, Former President, Club of Rome and Chairman, Development Alternatives. The opening interventions were made by Dr. Rajendra Singh, Water conservationist and Founder, Tarun Bharat Sangh, Ms. Katharine Cross, Program Coordinator, International Water Association (IWA), Video Presentation: Dr. John Todd – The Green Eco-Machine, and Mr. Anupam Mishra, Gandhian and Water Conservationist.

C. CLIMATE CHANGE SESSIONS

SESSION 3: IMPACT of CLIMATE CHANGE on WATER SECURITY

MODERATOR: Mr. A. B. Pandya, Chairman, Central Water Commission (CWC)

Opening the Climate Change session and its impact on Water Security, Mr. A. B. Pandya, raised the need to address the issues both at policy and programme level for equitable and optimal water distribution. There were several problems, which need to be understood such as India not being a water rich country; reduction of water resources due to climate change; waste of huge amounts of water owing to poor management; Northern Ganga basin having rich resources, whereas the Southern basin has few and finally, population growth having been misjudged and plans not made systematically. He added that the water demand pattern is bound to change with lifestyle and that constant demand versus skewed availability. Water use efficiency and ensuring sustainability for storage and sources are key to city planning. With climate change setting in, there further remains a need to have carry-over storages, to tide over years of low rainfall.

Mr. Pandya mentioned some possible lines along which these concerns can be addressed, such as, augmentation and migration of usage pattern and working towards a regime with equitable distribution and sustainability.

Dr. A. K. Gosain, Professor Indian Institute of Technology, Delhi

Groundwater will continue falling in the context of climate change (CC), reminded Dr. A. K. Gosain and therefore, society and the government need to look after basin health and groundwater levels. A simulation approach can help to understand the case. Hydrological modelling, that is, mimicry, of nature, will lead to better appreciation of the impact of CC. Sedimentary erosion data indicates the impact in general but all the components must be given due respect before moving forward. He recommended that storage mechanisms can be over ground or underground. The professor believes that the present requirements of the water sector include the implementation of a national spatial database infrastructure philosophy, a framework for conversion of scales and an integrated approach in its' true sense.

Mr. Shyam Khadka, Representative FAO, New Delhi

While agricultural production is sufficient to cater the minimum needs of today; Mr. Shyam Khadka cautioned that water will be in stress because of climate change, and this will impact agriculture. With 18% of world population and only 4% share of world's fresh water in India, the deficiency of water can become a crisis. The situation is worse than it was sixty years ago, he remarked. Displacing millets with rice and wheat was not a good idea for nutrition security and the Green Revolution methodology was over-dependent on water. Measures can be taken to assure water security in India like changing the groundwater governance system and cropping patterns. People adapt quickly to the groundwater methodology. He also recommended that rice should be moved north-east for agriculture production as it is a highly water intensive crop.

Mr. Sushil Gupta, Advisor, National Water Mission

Both surface and groundwater management were essential to Water Security against the backdrop of Climate Change, stated Mr. Sushil Gupta. Understanding demand, water availability and developing water management strategies were a priority. He detailed groundwater features and the importance of this source but, he added that artificial groundwater recharge which is polluted will not be successful. With changing climate scenarios and increase in urbanisation, efficient use of water and converting wastewater to usable and potable water generated also holds importance. He urged that policy interventions for systematic water resources planning and development be rationalised and implemented.

Dr. V. C. Goyal, Head, Research Management and Outreach Division, National Institute of Hydrology (NIH)

The impact of climate change on natural water systems such as monsoon patterns, melting glaciers and polar ice, rising sea levels, water related natural disasters, storm surges and high rainfall intensity were brought up by Dr. V. C Goyal in his intervention. Other alarms raised by him dealt with low water availability leading to competing demands between agriculture and industries and storm water management in urban areas.

Against this background, he declared that the new mantra should be Integrated Water Resource Management and hydrologists should work with ecologists, economists and planners. There should be a scientific understanding of the interaction of groundwater and surface water systems and study of the interplay between water and its environment. This would entail using science and technology in planning for water availability during disasters, efficiency in water usage and distribution and in designing sustainable water systems. To execute this, Dr. Goyal wanted capacity building of institutions and individuals to keep pace with research and policy making.

Dr. Marcella D'Souza, Executive Director, Watershed Organization Trust (WOTR)

In the context of coping with climate change at a local level, Dr. Marcella D'Souza observed that rise in temperature, drought, heavy rainfall and mechanical farming all impact soil quality. Therefore, it was fundamental to have a holistic understanding of local people, policy makers and other key players for developing a framework towards water stewardship. However, she elucidated that it was necessary that certain steps be first taken like: identification of localised climate vulnerabilities such as drought, delayed monsoons and hailstorms; understanding the coping mechanisms of people, service providers and government; and the drivers and pressures.

Moreover, Dr. D'Souza believed that a study of the state of the biophysical context as in water, forests, biodiversity and land use; understanding the existing capabilities of social and human capital and the state of the main rural livelihoods such as agriculture and livestock were prerequisites. Drawing on the resilience theory, she recognised that adaptive capacities can be built and co-management approaches developed for advancing socio ecological resilience.

The moderator for this session was Mr. A. B. Pandya, Chairman, Central Water Commission (CWC) and the panellists were Dr. A. K. Gosain Professor, IIT-Delhi, Mr. Shyam Khadka, FAO Representative in India, New Delhi, Mr. Sushil Gupta, Advisor, National Water Mission, Dr. Ravi Chopra, Director, People's Science Institute, Dehra Doon, Dr. V. C Goyal, National Institute of Hydrology (NIH), Dr. Marcella D'Souza, Executive Director, Watershed Organization Trust (WOTR) and Mr. Anand Kumar, Programme Director, Development Alternatives (DA).

SESSION 3.1: CLIMATE CHANGE ADAPTATION for WATER SECURITY

MODERATOR: Dr J. S. Samra, CEO (Retired), National Rainfed Area Authority

Dr. S.N. Pandey, Senior Programme Director, Development Alternatives, New Delhi

Water management strategies were the focus of Dr. S.N. Pandey's address, for developing adaptation measures for dealing with climate change for Water Security. The strategies should include a role for industrialists and the system modified to be a more participatory one. Ground level players must be empowered and connected to policies. Dr. Pandey indicated that the Decision Support System is not an integrated one and all professional resources need to be properly maintained. The focus on methodological and regional weather systems is not adequate.

Dr. Rajendra Singh, Water Conservationist and Founder, Tarun Bharat Sangh

Systems are crucial for preparing for adaptation for climate change advocated Dr. Rajendra Singh. Land records must be maintained and an exercise for notification, identification, and demarcation of water bodies would be beneficial. Climate change may impact the rain pattern, and along with this, the crop pattern as well. Therefore, farmers and scientists jointly examining and studying rain and crop patterns would be useful.

He further counselled that the debate must move beyond human rights and the discussions focus on of river rights.

Mr A. R. Shivakumar, Indian Institute of Science (IISc), Bangalore

Advancing the agenda for conservation and rain water harvesting as adaptive measures, Mr. A. R. Shivakumar Bengaluru's Rain-Catcher, said that this was most likely through a decentralised and sustainable system. Even though, traditional lakes and tanks have been converted into housing complexes and stadiums, he was optimistic that it was still possible to solve the water problem in his city which had only one source, that is, River Cauvery.

Giving the example of the Challaghatta Valley tank, he urged there should be recognition of past practice that allowed the landscape of naturally undulating valleys and hills to be developed into lakes and tanks. Ground water basins, rainwater harvesting and high volume filtration should be encouraged to capture and store rainwater. Roof top water harvesting and groundwater recharge in public places and in private homes has been proven successful and mandatory laws and incentives passed in Bengaluru for this. Mr. Shivakumar emphasised that multimedia, technology and demonstration must be used for dissemination of information and plumbers trained in these practices.

Mr. A. Ravindra, Director, Watershed Support Services and Activity Network (WASSAN), Telangana

The focus should be clearly on Watershed Management for rain fed agriculture and drinking water, declared Mr. A. Ravindra, if we are to have Water Security. A dichotomy has been created on all aspects of rainfall because of climate change and the onset and fluctuations of rain are an unknown for farmers. Low rainfall and drought spells are a serious problem for farming, food and livelihoods now.

Yet, Mr. Ravindra held that if the irrigation policy of the country can be altered and sufficient reworking done on the framework of irrigation, there was potential for adaptation to climate change. The policy should include micro irrigation he proposed to manage water resources for drinking and irrigation.

Dr. S. P. Sharma, Ministry of Water Resources, Government of India

Dr. S. P. Sharma from the Ministry of Water Resources, Government of India, acknowledged that farmer suicides have been due to unseasonal rainfall, floods and cyclones and poor quality of crops, which reduces their prices.

Minimum Support Prices are not a solution. The uncertainty of monsoons is leading to a serious imbalance in the supply and demand in pulses, oilseeds, onion, and sugar. Climate change, consumption patterns and migration are exacerbating the situation, he pointed out.

Instead, he suggested, policy changes for water management in areas such as micro irrigation, repair of old canals and surface water bodies and the diversion of East India surplus water to the West; farmers' welfare and promotion of micro financing; mixed crops and crop rotation and support to animal husbandry. Dr Sharma specified that research and development has to be stepped up for drought area crops. Effectively promoting these policies is essential and regular and effective co-ordination among Ministries of Agriculture, Water Resources, Rural Development, and Environment and Forests must be ensured.

Closing Remarks

In his closing remarks the moderator, Dr. J. S. Samra, CEO (Retd.), National Rainfed Area Authority called for better water management strategies and recommended that the concurrence and synergy of policies is essential for the adaptive measures to succeed. While a change in crop pattern may be useful, the focus must be primarily on the formation and execution of policy required to deal with the impending crises.

The panellists who participated are Mr. Rajendra Singh, Water conservationist and Founder, Tarun Bharat Sangh, Dr. S. P. Sharma, Ministry of Water Resources, Mr. A. Ravindra, Director, Watershed Support Services and Activity Network (WASSAN), Telangana, Mr. A. R. Shivakumar, Indian Institute of Science (IISc), Bangalore, Dr. Veena Khanduri, Executive Secretary, India Water Partnership and Dr. S. N. Pandey, Development Alternatives (DA).

D. OTHER SESSIONS AT THE CONFERENCE

SESSION 4: SYSTEM DYNAMICS of POLLUTION, EXPLOITATION and ENCROACHMENT of RIVERS

SUMMARY OF SESSION

Moderator: Dr. Anupam Saraph, Member, Club of Rome-India

This Session recognised that Water Security, Food Security and Bio Diversity Conservation were systemically dependent on the protection of the country's rivers. While the challenge was coming from several natural and man-made forces such as droughts, floods and climate change, a real concern was about how natural resources such as water were being exploited and encroached upon, leading to irreversible damage to the ecology, environment and species. An analysis of the economic development reveals that the quality of water in streams and rivers has reduced dramatically because of exploitation.

The panellists expressed deep concern about the pollution arising from effluents, waste and sewage water entering rivers that has increased the toxicity of this precious life support waterway. Encroachment is a part of the development process; and dams have led to both displacement of people and encroachment of water. Traditional local systems had systems thinking, but these are now managed by different agencies, which are not really systemic. Strangely, there is no government department explicitly charged with listing or protecting rivers in the country. There is therefore, policy incoherence for conservation of rivers. Water managed at the local level, is now being handled at the national level and losing its roots approach.

Consequently, there was a united approach among the panellists on addressing the problems from a system's perspective, that is, what is the dynamic problem and solution? The ecology of the river basin and the water environment needs to be seen as a holistic system. Sector wise division of water resources has to be ensured for better functioning and understanding the problem. Symptoms and causes for pollution and water depletion are to be identified such as activities that impact the biological, ecological as well the hydrological integrity. The main complications existing in the prevention of water pollution and encroachment need to be factored in.

The strategy and principles for water basin pollution control have to evolve consensually taking local dynamics into consideration. The key solutions for water problems must be first established and then recommended. The panellists believed that policies and regulations may have the capacity, but the power to implement and the financial resources to back them must be part of the methodology. Laws need to be passed to protect and conserve rivers both at the national and local level. The session concluded that once there is security and comprehensive water environment management of India's streams, rivers and river basins, both the economic and the ecological dynamics would be better addressed.

The session was moderated by Dr. Anupam Saraph, Member, Club of Rome-India and the panellists who participated were Mr. Dirk Walter, Program Head, Deutsche Gesellschaftfür Internationale Zusammenarbeit (GIZ), Dr. Indira Khurana, Author of 'Reflections of Managing Water', Professor Vijay Paranjpye, Chairman, Gomukh Environmental Trust for SD, Pune, Professor Krishnayya, Member, Club of Rome-India, Professor V. B. Gupta, Head, School of Future Studies and Planning, Indore and Mr. Swapan Mehra, Executive Director, IORA.

SESSION 5: GLOBAL and NATIONAL POLITICS for COHERENCE in WATER POLICY

SUMMARY OF SESSION

Moderator: Mr. Nitin Desai, Member, Club of Rome-India and Former Under Secretary General, UN

The effective management of water resources demands a holistic methodology, linking social and economic development, and should be based on a participatory approach involving users, planners, and policymakers at all levels. Sustainable water security has to be guided by the principles of balance between reasonable distribution versus physical availability. The critical need for such an approach was the prime concern raised by the panellists in this session. Global and National politics should, therefore, be based on such principles to secure water for all.

Further, the protection of the environmental aspects such as the natural ecosystem, including land and water linkages, catchment areas and ground water aquifers must underlie the physical and the socio-economic aspects. It is estimated that of the annual renewable fresh water available on the planet only 22.5 % can be utilised by its people. Water is a common source and the politics of boundaries of countries and states are exacerbating water stress in the world, pointed out the panellists. About 783 million people do not have access to clean water and over 2.5 billion people do not have adequate sanitation. India has 18% of world population and only 4% of water resources. The panellists urged for a change in risk perception and scaling, as three billion will be at risk of water scarcity by 2020.

Water security is linked to national security and the complexities are heightened by strong emotional and religious values. Thus a frame of reference and coherence in narratives, taking into consideration the pattern of water resources, the sharing of trans-boundary rivers, as in India and China and allocation of funds becomes imperative. In such cases global and national politics have to play significant roles to safeguard the interests of all nations sharing the river basins, recommended the panellists.

Inter-sectorial policies are needed as long term water security is only possible if there is coherence and synchronisation of policy across relevant sectors. For example, 90% of rainfall in India is in 30 days, hence dams and other water management technologies ought to be planned for 2-3 decades, backed by data, research and finances. Effective governance of water resources will be key to achieving water security, as also allocating water resources fairly and settling water related disputes, advised the panellists.

The session was moderated by Mr. Nitin Desai, Member: Club of Rome-India and Former under Secretary General, UN and the participant's included Ms. Katharine Cross, Programme Coordinator, International Water Association (IWA), Dr H. R. Sharma, Dr. Nitin Pandit, CEO, World Resources Institute, India and Dr. Biksham Gujja, Director AgSri, Sustainable Management of Agricultural Water Resources.

SESSION 6: COUNTERINTUITIVE POLICIES in WATER SECURITY

SUMMARY OF SESSION

Moderator: Dr. Rajendra Singh, Water Conservationist and Founder, Tarun Bharat Sangh

Since Water Security issues are so complex and immense, this session believed that it makes eminent sense to explore counterintuitive policies to address water security challenges properly. Innovative production practices in agriculture that use less water and follow sustainable methods must be adopted for both Water and Food Security to complement each other. The panellists observed that the focus should be on common science and common sense rather than sophisticated ways. The Rajasthan model[1] can be replicated all over, as it has been tested and should be useful in similar situations. But, there should be sufficient investment in both training and capacity development.

The panellists observed that a well-designed framework is needed to handle the wide and complex aspects of water security. Such a framework of ideas should be presented to the government so that it can envision better planning and implementation at ground level. Current policies do not encourage either small holder urban farmers. There must be commitment to create local sustainable economies around small-holder and urban artisanal farmers, with democracy based upon self-governing principles. However, the panellists concluded that legislation alone cannot change until, people's consciousness changes on efficient farming. Efforts should therefore, be made implement large scale changes with new approaches to water security with new and coherent policies in place.

The session was moderated by Dr. Rajendra Singh, Water Conservationist and Founder, Tarun Bharat Singh and the Panellists were Mr. George C. Varughese, President, Development Alternatives, Dr. Anupam Saraph, Member, Club of Rome-India, Dr. Ravi Chopra, Director, People's Science Institute, Dehra Doon, Professor Krishnayya, Member, Club of Rome-India and Mr. Sanjay Singh, Water Activist.

SESSION 7: ENVIRONMENT and RESOURCES ISSUES in WATER SECURITY

SUMMARY OF SESSION

Moderator: Dr. Nitin Pandit, CEO, World Resources Institute-India

Change in demand for water, climate change and population are the chief causes of water stress, but what has to be seen is that there should be minimum damage to the environment and little wastage of this precious resource. The Sustainability Development Goals have marked Water Security as one of the critical goals, recognising that the conservation of environment and water security are inextricably interlinked. Targets whose main thrust is to conserve, restore and mainstream biodiversity for sustainable eco-system services should become the norm. This session requested commitment and responsibility towards a healthy environment and respect for social equity in the fair sharing of water resources.

Water is one sector where there have been a series of national policies, which have made little difference to water security prospects, observed the panellists. So far, the focus has been on the supply side with policy pursuing supply augmentation from obliging river basins and aquifers. The limits of these options are visible. Disconnecting rivers from their task of nourishing aquifers and new urban planning fads like river front developments, are converting rivers into canals.

Concerns were expressed on the absence of state water policies, proposals for interlinking of rivers, cooling of deserts that may play havoc with the wind and monsoon development, human activities and industrialisation that are impacting the health of water bodies. The panellists gave examples of how

[1] http://tarunbharatsangh.in/

usage of land by both humans and animals can adversely affect the well-being of other resources like water. Fertiliser subsidy that encourage consumption of chemical fertilisers, require immense water application for uptake by crops. Moreover, free power supply to farmers is a populist measure which leads to groundwater overdraft at an alarming pace.

Policies and actions, which can help conserve environmental conditions, foster eco-system services and nurture hydrological systems such as providing policy protection to the remaining 99% of wetlands and spatial planning in arid areas factoring in water resources were commended. Another policy intervention can be notifications for river regulation zones designed to protect flood plains from urban and industrial encroachment so as to sustain the integrity of their ecological and hydrological functions.

Other recommendations made by the panellists were that minimum flows for each river need to be worked out so as to enable ecological and groundwater recharge functions to be fulfilled adequately. Policy changes must ensure that 2% - 5% of urban areas be devoted to water bodies order to enhance the availability of local water resources. Urban area domestic water consumption norms needed to be revised downwards and groundwater legislation introduced. Further, efficient water devices policy can be adopted at the local body level in urban areas.

The panellists urged that one needs to quickly move towards sustainable agriculture practices and eventually towards natural ways of farming in rural areas. The location of small forests over absorptive groundwater recharge zones could greatly improve resource availability. Similarly, policies for mass greening can enhance rainfall and thereby the resource availability, but it is vital that they are based on the principles of landscape ecology. Greening of arid zones as well as river linking must be planned only after a thorough understanding of the monsoon mechanism.

One of the important suggestions pertained to the integrated water management ideology for the sustainability of eco systems. This, the panellists pointed out, facilitates cross-sectoral planning, development and resource management. Creation of sharable information is essential for sustainable use of water. Technology, such as satellites, can be used to bring information to people on comprehensive, credible and a contextual view of water resources. The Hydrological Modelling Framework for estimating water balance components is another useful methodology.

Applauding the bio-mimicry approach where nature is given a voice, a significant role for women in the management of water was envisaged. Make water a movement in the country, through pilot projects, awareness campaigns and education was another suggestion given by the panellists. While the government is slow in legislative changes, non-legislative actions can build up the momentum for far reaching changes.

The moderator for this session was Dr. Nitin Pandit, CEO, World Resources Institute-India and the panellists included Dr. Leena Srivastava, Vice Chancellor, TERI University, Mr. A. B. Pandya, Chairman, Central Water Commission, New Delhi, Dr Ashok Jain, Scientist and Administrator, Dr. Purnamita Das Gupta, Chair, Institute of Economic Growth, University of Delhi, Mr. Manu Bhatnagar, Principal Director, Natural Heritage Division at INTACH and Mr. Swaminathan Aiyar, Economist and Journalist.

SESSION 8: CREATING POLICY SUCCESSES in RIVER CONSERVATION and WATER SECURITY

SUMMARY OF SESSION

Moderator: Professor Krishnayya, Member, Club of Rome-India

The surmise in this session was that good governance is key to achieving Water Security and requires well designed and empowered institutions with supportive legislative and policy instruments. Today, people are exploiting water bodies and rivers indiscriminately, not realising that rivers are also an

ecosystem. The source of a river is a sacred place and a replication of the Himalayan 'sacred rivers' example might help people understand the rights of nature. In this context, the panellists appealed that water bodies, too, had rights and there was a need to rejuvenate ground water.

The government is the biggest encroacher, the panellists pointed out, the criticism being that no government department has maps of all major and minor rivers or even a list of them. Nor is any government department explicitly charged to list or protect rivers. The resultant: "Is there a water body not encroached, not polluted or not exploited?"

The three big issues identified were: environmental flows, conserving the pristine rivers and water stewardship. The need for policy on river conservation and the lines along on which this can be done was highlighted by the panellists. There is no existing policy for agriculture in rain-fed areas and 60-80% farmers have no access to water. Policy making can forget the fact of the natural water cycle and often water is extracted from very far away areas. Less water can be extracted for irrigation by changing the food and crop patterns. Resource use and productivity are not proportional and the model should be factor in the water-energy-agriculture nexus. Noting the role of the scientists as paramount; the panellists remarked that they ought to educate the kissans. This includes teaching engineers ecology, as the "eco-sensitive zones" concept is missing. Importantly, the river conservation policy should be integrated with the industrial policy, sanitation, water and other policies.

Groundwater monitoring needs to be institutionalised and groundwater management taught. A focus on data collection, interpretation and analysis is required as also water auditing. This must cut across sanitation, water access issues, water quality and mapping of demand and water uses for improved knowledge leading to better decisions. Multi stakeholders need to be engaged for rejuvenating rivers bodies and develop holistic plans.

Many powers will be required for such policy measures to be executed and for this a Framework for a Law for Conservation of Rivers and Water Security was recommended in this session. Detailed suggestions were given on empowering local bodies by the creation of area *sabhas* or river *panchayats* to enable them to protect local parts of rivers. Conservation activities and afforestation with indigenous trees on waterfronts, where required, can be a part of their activities. Another recommendation was for creation of river parliaments empowered to protect entire rivers and have an overview of the biological, ecological or hydrological integrity of water-bodies.

Professor Krishnayya, Member, Club of Rome-India moderated the session and the Panellists included Professor Vijay Paranjpye, Chairman, Gomukh Environmental Trust for SD, Pune, Dr. Anupam Saraph, Member, Club of Rome-India, Mr. Ravi Singh, Secretary General and CEO, World Wildlife Foundation – India, Dr. Konda Reddy, Food and Agriculture Organization of the United Nations (FAO), India, Dr. S. K. Sarkar, Director, Water Resources Division, The Energy and Resources Institute (TERI) and Dr. Kamal Vatta, Director, Center for International Projects Trust (CIPT).

SESSION 9: BEST PRACTICES IN WATER MANAGEMENT FOR A WATER-SECURE FUTURE

SUMMARY OF SESSION

Moderator: Dr. Amitabh Kundu, Professor, Jawaharlal Nehru University, Delhi

Sustainable management of water resources is the goal for resilient Water Security and for achieving this there are many emerging best practices and several successful ones for water management. Moderated by Dr. Amitabh Kundu, Professor, Jawaharlal Nehru University, Delhi, the focus of this session was how to identify and share best practice to encourage knowledge into action through concerted efforts.

A three-pronged approach was recommended - developing solutions for water problems from within the community itself, improving the interface between society, scientists and decision makers and establishing a platform for dynamic adaption through rapid decision making.

The best practice could be adapted by connecting traditional knowledge for safe water, sanitation, farming and livelihoods. People need to be provided with options and given choices. Including people in the building and conservation of water resources and structures by facilitating community institutions could help tip the balance. The panellists believed that such participatory measures will enhance the capacities, and mobilise and empower the people for achieving water security.

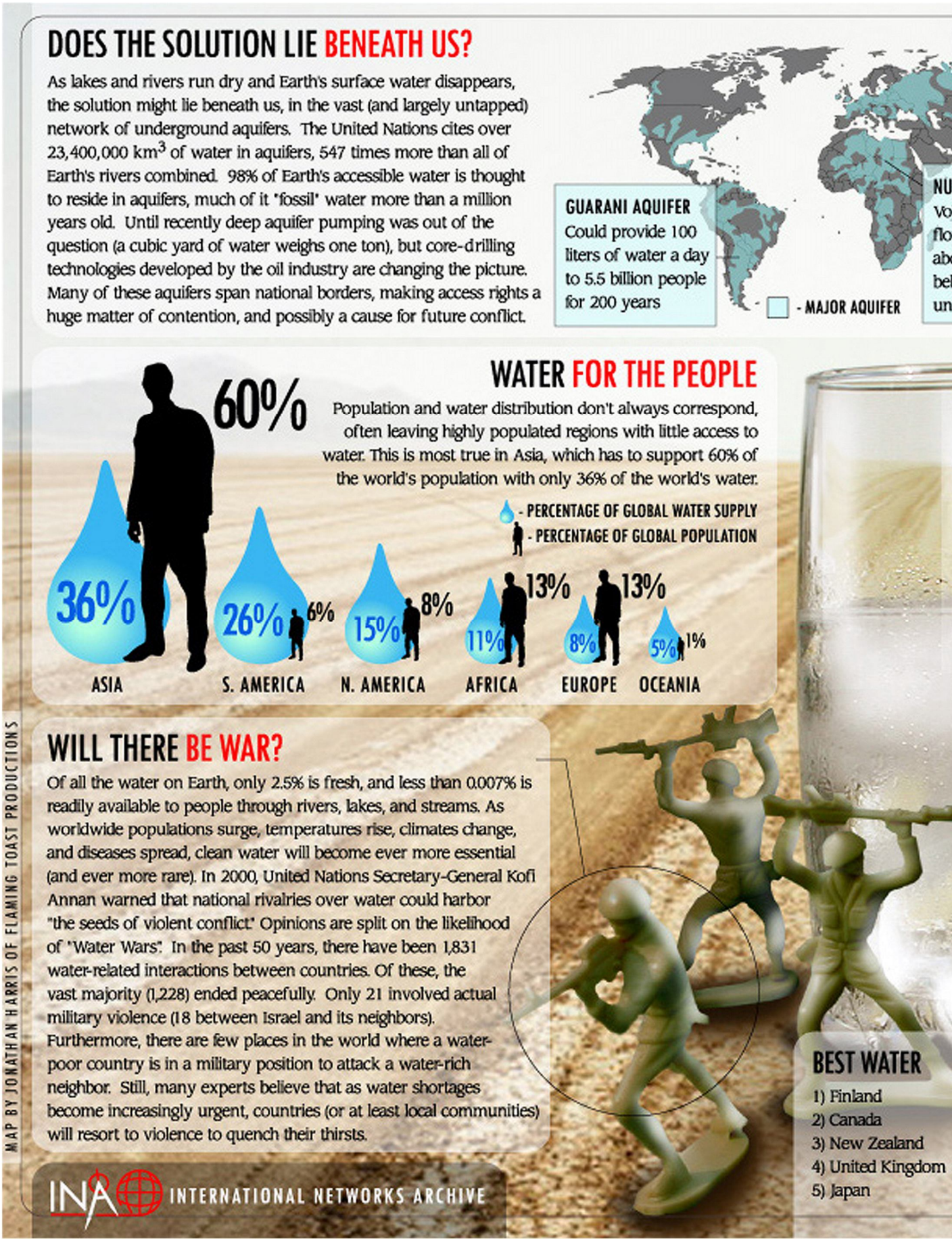
Sustainable water management systems can only be guaranteed if the players and decision makers working together, enable quick decision making so that there is early response to changing climate, droughts and floods and other climatic disasters. The panellists advised that there be focus on water security in global programmes of Climate Change in India, to strengthen capacities of urban local bodies to plan and implement climate change initiatives.

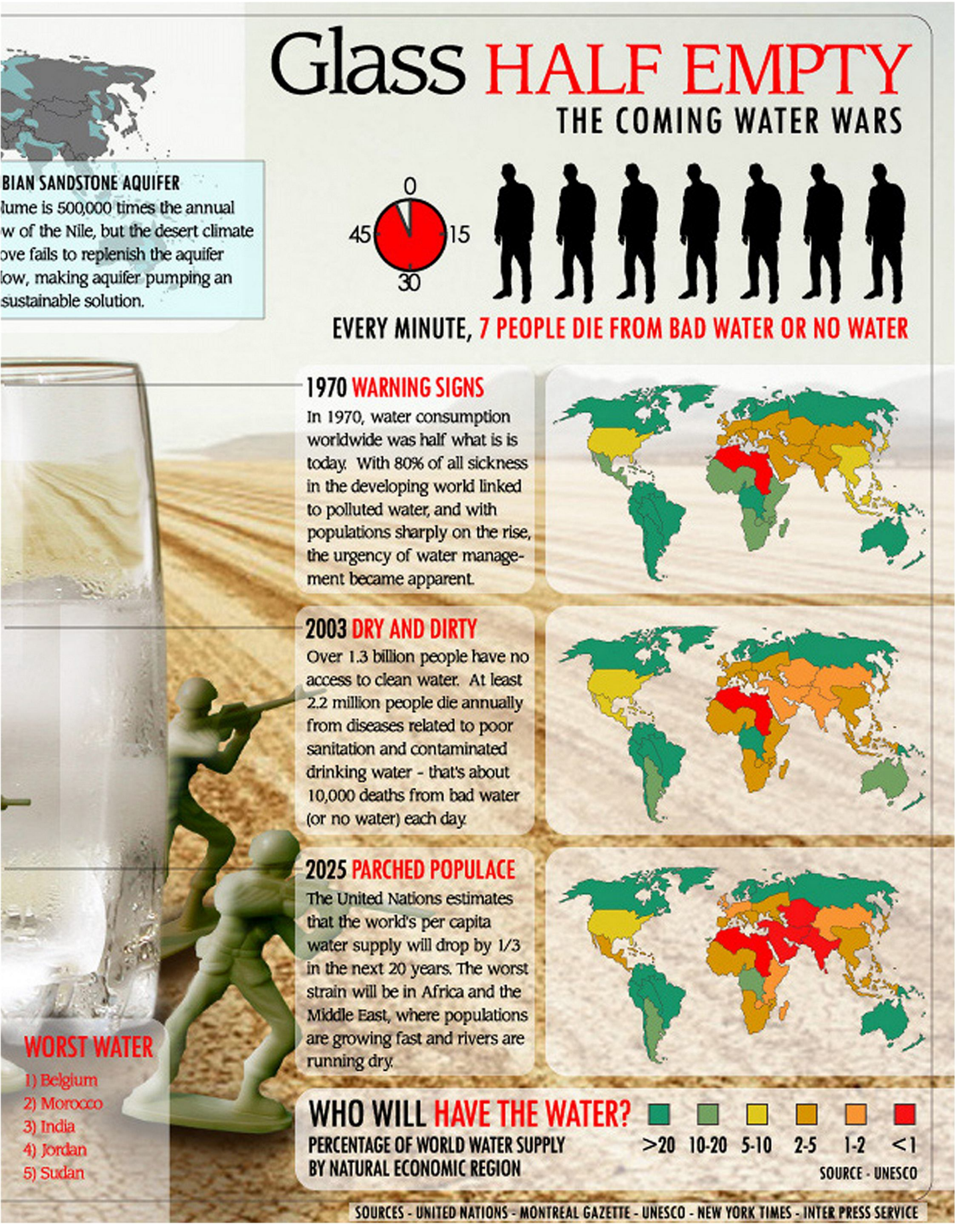
Recommendations on technologies included effective tubes and pipes instead of open canals; reducing rice production as it was too much of a water guzzler and looking at traditional millets; low temperature thermal desalination plants that work uninterruptedly and produce clean water and 'Reverse Osmosis'. Small water enterprises and social entrepreneurship will ensure local solutions and local ownership concluded the panellists.

The moderator for this session was Dr. Amitabh Kundu, Professor, Jawaharlal Nehru University, Delhi and the panellists were Mr. Sanjay Sharma, Chief-Chandrawal Water Treatment Plant, New Delhi, Professor Harsh Gupta, National Geophysical Research Institute, Hyderabad, Ms. Divya Kashyap, Senior Thematic Advisor, Swiss Agency for Development and Cooperation, Embassy of Switzerland, Dr. Chandra Bhushan, Deputy Director General, Centre for Science and Environment and Mr. Perses Bilimoria, Founder President, Biopolymer Society of India.

CLOSING COMMENTS BY DR. ASHOK KHOSLA

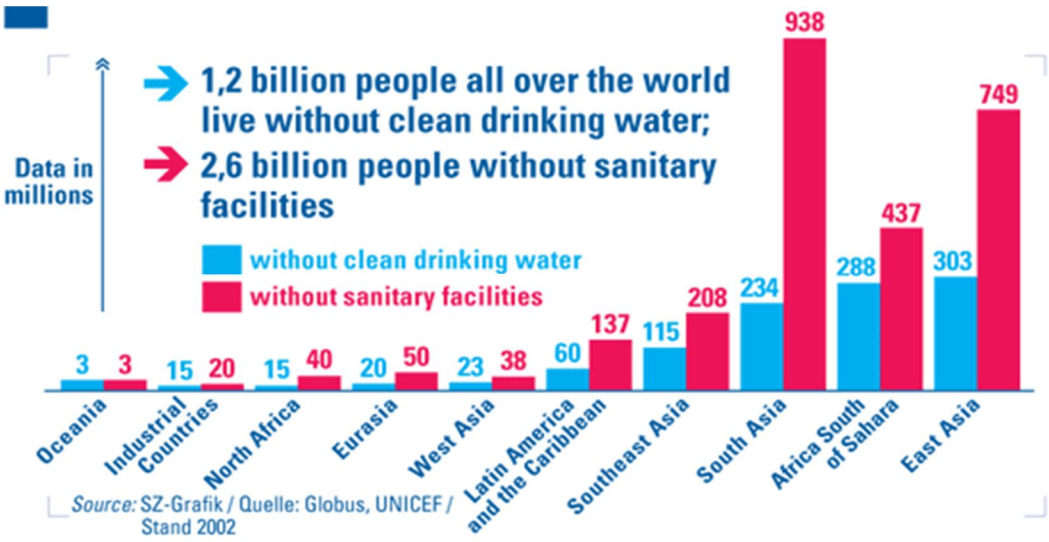
This conference has as its purpose to identify the issues within and outside their domain of responsibility that decision makers must take into account in forming any policy. Stating that this session was about innovations, Dr. Khosla urged that the example of large parts of Rajasthan and Haryana, where new and sustainable technologies have been adopted to conserve water, be taken as models for adapting and adopting in other parts of the country. To multiply best practices, it is critical that the people who make policies and decisions be persuaded of their relevance and value. There is an urgent need to think about the environmental crises facing the country and the world. And one of the biggest issues that is being faced is that unless they take proper account of broader social and environmental implications, economic policies can quite quickly lead to major problems and costs that could outweigh the benefits intended. This is especially important for decisions, such as the design and location of cities, roads and other infrastructure, which have a "lock-in" period of a century or more, making any changes within the reasonable future too costly to contemplate.


DOES THE SOLUTION LIE BENEATH US?
As lakes and rivers run dry and Earth's surface water disappears, the solution might lie beneath us, in the vast (and largely untapped) network of underground aquifers. The United Nations cites over 23,400,000 km3 of water in aquifers, 547 times more than all of Earth's rivers combined. 98% of Earth's accessible water is thought to reside in aquifers, much of it "fossil" water more than a million years old. Until recently deep aquifer pumping was out of the question (a cubic yard of water weighs one ton), but core-drilling technologies developed by the oil industry are changing the picture. Many of these aquifers span national borders, making access rights a huge matter of contention, and possibly a cause for future conflict.
GUARANI AQUIFER
Could provide 100 liters of water a day to 5.5 billion people for 200 years
- MAJOR AQUIFER
WATER FOR THE PEOPLE
Population and water distribution don't always correspond, often leaving highly populated regions with little access to water. This is most true in Asia, which has to support 60% of the world's population with only 36% of the world's water.
- PERCENTAGE OF GLOBAL WATER SUPPLY
- PERCENTAGE OF GLOBAL POPULATION
60%
36%
26%
6%
15%
8%
11%
13%
8%
13%
5%
1%
ASIA
S. AMERICA
N. AMERICA
AFRICA
EUROPE
OCEANIA
WILL THERE BE WAR?
Of all the water on Earth, only 2.5% is fresh, and less than 0.007% is readily available to people through rivers, lakes, and streams. As worldwide populations surge, temperatures rise, climates change, and diseases spread, clean water will become ever more essential (and ever more rare). In 2000, United Nations Secretary-General Kofi Annan warned that national rivalries over water could harbor "the seeds of violent conflict." Opinions are split on the likelihood of "Water Wars". In the past 50 years, there have been 1,831 water-related interactions between countries. Of these, the vast majority (1,228) ended peacefully. Only 21 involved actual military violence (18 between Israel and its neighbors). Furthermore, there are few places in the world where a water-poor country is in a military position to attack a water-rich neighbor. Still, many experts believe that as water shortages become increasingly urgent, countries (or at least local communities) will resort to violence to quench their thirsts.
BEST WATER
1) Finland
2) Canada
3) New Zealand
4) United Kingdom
5) Japan
MAP BY JONATHAN HARRIS OF FLAMING TOAST PRODUCTIONS
INA INTERNATIONAL NETWORKS ARCHIVE


Glass HALF EMPTY
THE COMING WATER WARS
BIAN SANDSTONE AQUIFER
lume is 500,000 times the annual
w of the Nile, but the desert climate
ove fails to replenish the aquifer
low, making aquifer pumping an
sustainable solution.
0
45
15
30
EVERY MINUTE, 7 PEOPLE DIE FROM BAD WATER OR NO WATER
1970 WARNING SIGNS
In 1970, water consumption worldwide was half what is is today. With 80% of all sickness in the developing world linked to polluted water, and with populations sharply on the rise, the urgency of water management became apparent.
2003 DRY AND DIRTY
Over 1.3 billion people have no access to clean water. At least 2.2 million people die annually from diseases related to poor sanitation and contaminated drinking water - that's about 10,000 deaths from bad water (or no water) each day.
2025 PARCHED POPULACE
The United Nations estimates that the world's per capita water supply will drop by 1/3 in the next 20 years. The worst strain will be in Africa and the Middle East, where populations are growing fast and rivers are running dry.
WORST WATER
1) Belgium
2) Morocco
3) India
4) Jordan
5) Sudan
WHO WILL HAVE THE WATER?
PERCENTAGE OF WORLD WATER SUPPLY BY NATURAL ECONOMIC REGION
>20 10-20 5-10 2-5 1-2 <1
SOURCE - UNESCO
SOURCES - UNITED NATIONS - MONTREAL GAZETTE - UNESCO - NEW YORK TIMES - INTER PRESS SERVICE

PART 1: INTRODUCTION to WATER SECURITY

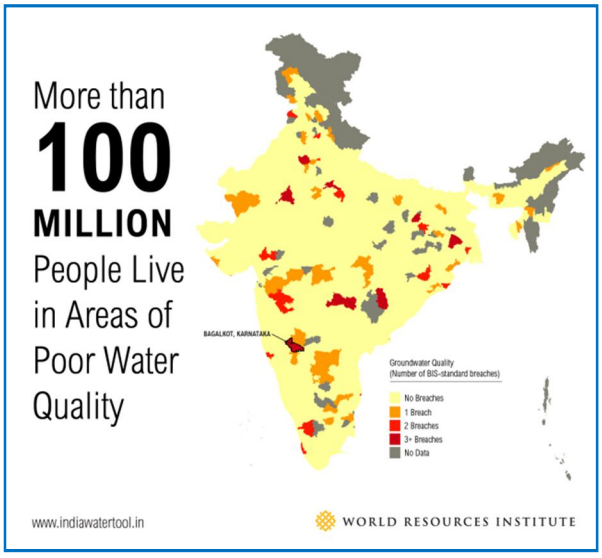
We have taken water for granted, as it has been relatively abundant throughout our existence. However, water scarcities are fast becoming one of the most serious resource issues we face today. Almost 97.5% is salt water and only 2.5% is fresh water, of which 68.9% is locked in glaciers, 30.8% in groundwater, and only 0.3% in our lakes and rivers.

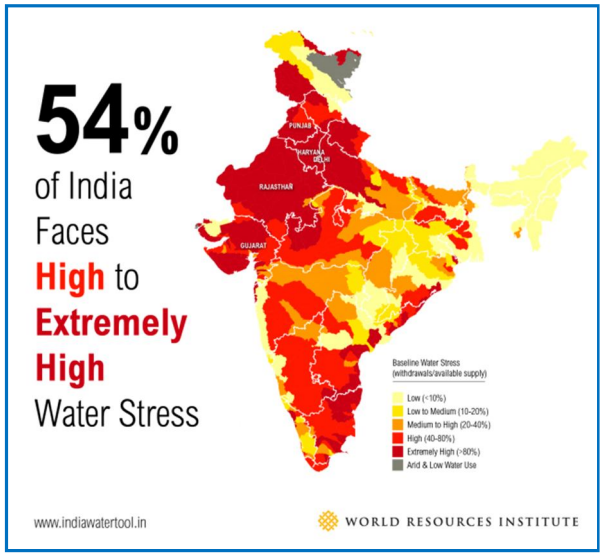


India's annual rainfall, around 1183 mm, is the major source of water in India - of which 75% is received during a short span of four months between June to September.

There are two types of water scarcity:

- **Physical Water Scarcity**: This occurs (in arid regions) when there is not enough water to meet their needs;
- **Economic Water Scarcity**: This occurs when human, institutional and financial capitals limit access to water, even though water in nature is available for human needs.





It is established that poor households in developing countries spend higher portions of their income on water than families in industrialised nations. This increases their vulnerability too.

Understanding the Water Debate

In the last Annual Conference, Dr. Ashok Khosla had drawn attention to the 900lb. gorilla in the room—that by 2050, the population of India is likely to be 1.6 billion people! In concert with climate change impacts, this increase in demand for water, food and energy will require significant expansions of current infrastructure and resource availability. For example: rice, wheat and sugar cane together constitute about 90% of India's crop production and are the most water-consuming crops. In addition, states with the highest production of rice and/or wheat are expected to face groundwater depletion of up to 75% by 2050.

Factoring in climate change, these demands are likely to present a great challenge to India's sustainability. Although the resources required are available to meet this demand, inefficient resource use, mismanagement, unequal governance structures and increased vulnerability to climate change, will severely limit the access required.

In the West, the neoliberalism philosophy promotes a high-consumption, carbon-hungry system and has encouraged mega-mergers, trade agreements hostile to environmental and labour regulations and global hypermobility, enabling a corporation like Exxon to make more money than any company in the history of money. Their outsize power mangles the democratic processes, *even in the East*. Yet the carbon giants continue to reap $600 billion in annual subsidies from Western public coffers, not to speak of a greater subsidy: *the right to treat the global atmosphere as a "waste dump", which destroys natural environments faster than they can be rejuvenated.*

However, the good news is that, in India, we still have time to make the right moves. The Conference delegates mentioned that huge monetary resources have been spent in India on *unproductive, unwanted and largely wasteful projects related to water resources;* projects designed more on greed than outcomes. It was pointed out that around Rs. 3.51 Lakh Crores has been spent *over the last 60 years on "Big is Beautiful" types of projects, such as big dams and canals*, where the cost overruns go into *thousands of percentages*. And now, the Indian water sector has plunged into unsustainability—*in the name of the poor farmer and providing water to improve food security.*

There is perhaps still some hope to redirect the resources—natural and financial—if the right decisions are taken. This is possible if *systemic changes are made that empower women and impact governance (read corruption), politics and grassroots security issue*s. "*Doing the same thing over and over again and expecting different results*" is not an option. Getting organised across issues, such as Climate Change, for example or replicating successful approaches articulated by Mr. Anupam Mishra, Dr. Rajendra Singh, Dr. Ravi Chopra, Professor Vijay Paranjpye, Professor Krishnayya and Dr. Anupam Saraph and a host of speakers who spoke strongly about the way forward, will be the first step.

The best way of being willing to act is to act!

Water and Food Security

During the second half of the 20th Century, the world population increased two-fold. As food production doubled and developing countries increased per capita food consumption by 30%, **Agriculture** confirmed its position as the biggest user of water on the globe, while also producing a diverse range of non-food crops such as cotton, rubber and industrial oils in an increasingly productive way. Irrigation now claims close to 92% in India, and about 70% of all freshwater appropriated for human use, globally.

Within the context of demographic growth, increased competition for water and improved attention to environmental issues, water for food is a core issue that can no longer be tackled through a narrow sectoral approach. New forms of water management in agriculture, including rain-fed and irrigated agriculture, watershed management, Inland fisheries and aquaculture, and livestock and rangeland management need to be explored and implemented in a comprehensive way.

Farmers are at the centre of any process of change and it is crucial that they are encouraged and guided, through appropriate incentives and governance practices. Their goal should be to, conserve natural ecosystems and biodiversity and to minimise the negative impact of their actions, a goal that will only be achieved if the appropriate policies are in place. Irrigation institutions must respond to the needs of farmers, ensuring more and reliable delivery of water, increasing transparency in its management and balancing efficiency and equity in access to water. This will require changes in attitudes, but also well targeted investments in infrastructure modernisation, institutional restructuring, and upgrading of the technical capacities of farmers and water managers.

Evolution of Water Security Concepts

There is considerable scope to improve water resource utilisation, as the amount of food produced per unit of water input is generally low, and access to water is often distributed in a manner that serves neither socio-economic nor environmental objectives in a satisfactory manner.

The gathering water crisis is a challenge that ranges beyond policy-makers and formal agencies. A strategy must be evolved that actively involves the grassroots water suppliers, users and various categories of stakeholders, including:

- **The consequences of water withdrawal from natural sources**: An inevitable result is that the quantity and quality of water flowing in rivers, lakes and underground are modified
- **The relationships between land use and water resources**: Recent findings show that land use has significant impacts on flow parameters, apart from water quality
- **The trade-offs between various kinds of water and land use**, with the needed assessments of alternative use patterns and choices made
- **The social or institutional arrangements that are necessary for the view of the impending water crisis**: The institutions must be capable of balancing socio-economic demands and environmental sustainability.

So What Exactly is Water Security

Water Security is defined as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against waterborne pollution and water-related disasters and preserving ecosystems in a climate of peace and political stability.

In economics, **shock therapy** refers to the sudden release of price and currency controls, withdrawal of state subsidies, and immediate trade liberalisation within a country, usually also including large-scale privatisation of previously public-owned assets.

Greed is not good when it comes to matters of the commons. It would appear that what we need in order to **secure Water for All is NOT entirely the opposite of shock therapy**, but more in tune with:

(a) Liberalising governance structures that will reduce corruption and government control, with adequate laws, institutions, infrastructure and capacity;

(b) Empowering women, who can control their bodies and systemically reduce birth rates;

(c) States in trans-boundary cooperation discuss and coordinate actions for mutual benefit;

(d) Decentralising systems, so that people have control over the decisions on water;

(e) Innovative financing from PPP sources of funds and micro-financing schemes;

(f) Bringing science and technology into the debates, so that enlightened decisions can be made;

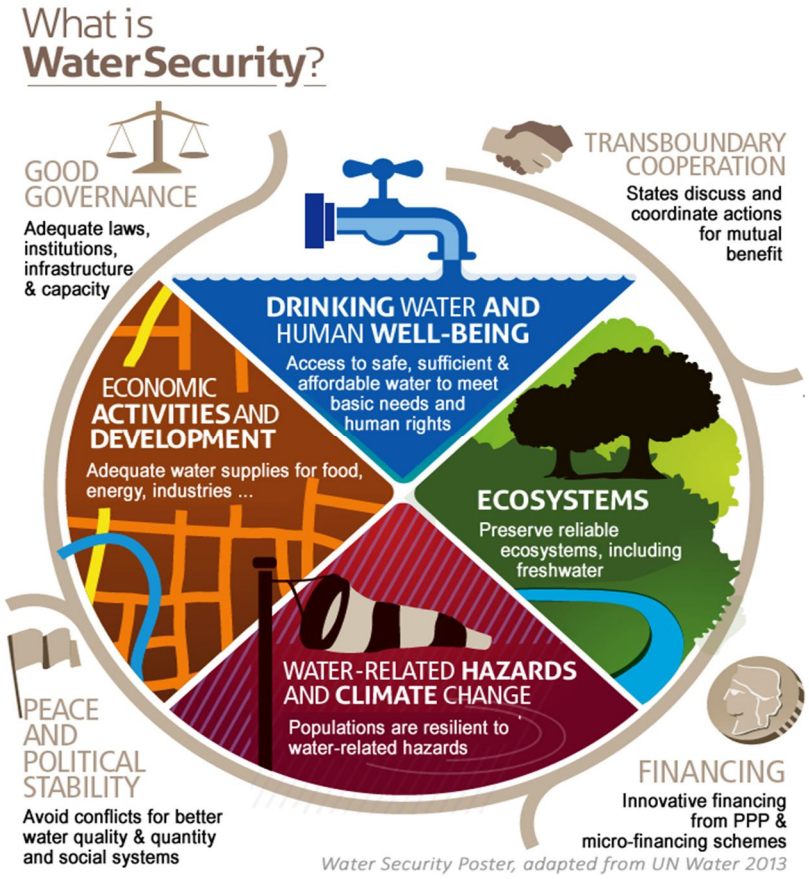
(g) Avoiding conflicts for better social systems, water quality and quantity;

(h) Pumping money into natural & low cost/energy systems for water treatment and purification; and

(i) Implementing the participatory approach of bottom-up processes and scientific systems.

The causes of concern to the future sustainability of access to water supplies, and food, in India, are that:

- The population of India is still growing fast;
- Water for irrigation is lacking in increasingly more places;
- Climate change is leading to increased temperatures with more variable rainfalls;
- The diet is shifting to the urban consumption of higher value food products;
- The yield in food production has levelled off; and
- We have already reached the limits to the availability of land suitable for food production



To put these issues in perspective, there are five major global transitions that make historically-based thinking
obsolete:

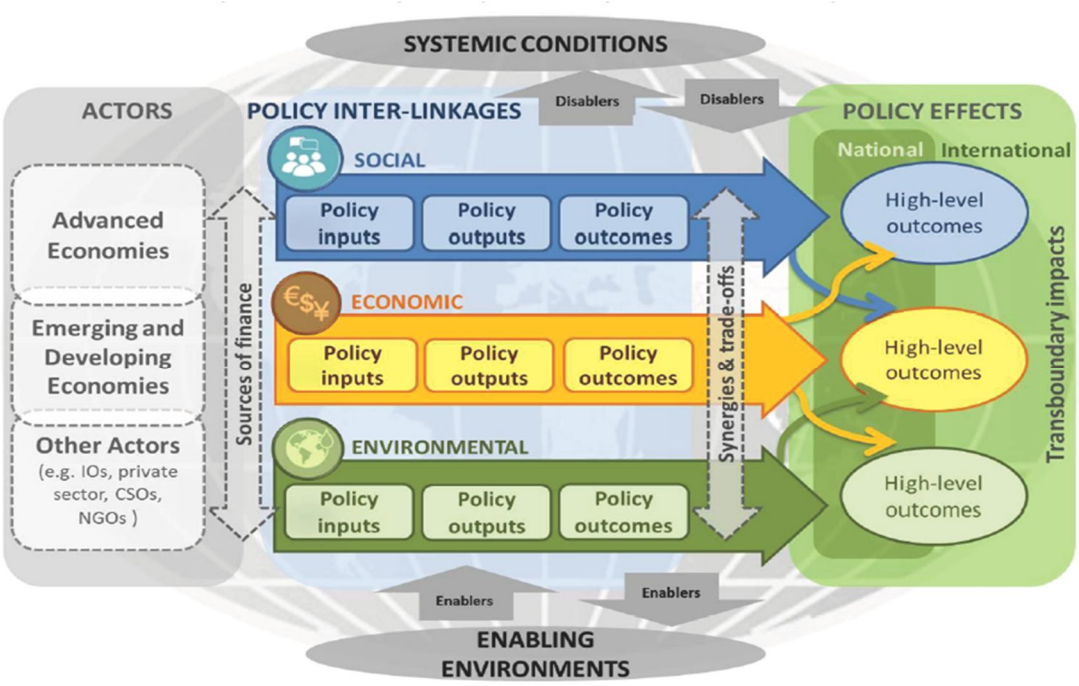
1. **Urban population transition**: By 2050, it is expected that 50-70% of the nation will be living in cities; these people will have increased purchasing power;
2. **Nutrition transition**: Urban people demand and consume higher quantities of foodstuffs that have increased quantities of animal and other high-value foods;
3. **Climate transition**: increasing temperatures and variability in water supplies will lead to variability in food production, prices and access to food
4. **Energy transition**: From cheap fuels—both fossil and renewable energy resources;
5. **Agricultural transition**: From small-scale and fragmented farming to large-scale commercial operations, or organized and sophisticated small holdings.

What is Policy Coherence

India has an abundance of water within its borders, with 13 major and 46 minor basins. The Ganges-Brahmaputra Basin is the largest, covering 34 per cent of India and contributing approximately 59 per cent of the country's water resources. The major sources of water in India are rainfall and glacial snowmelt, contributing to river flows from the Himalayan region.

And yet, there is an acute shortage of appropriate water supplies to the people of India. We can attribute this largely to policy incoherence, which leads to this imbalance in water access.

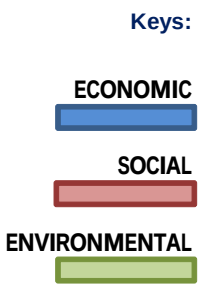
Analytical Framework for Policy Coherence for Water Security Development



Source: OECD PCD Unit, inspired by the work of UNECE/OECD/Eurostat Task Force on measuring sustainable development.

'**Policy Coherence Analysis**' attempts to integrate the economic, social, environmental and governance dimensions of sustainable development at all stages of domestic and international policy, as in the following tabulation:

TARGETS	GOAL Securing sustainable water for all
Universal access to safe drinking water, sanitation and hygiene	
Sustainable use and development of water resources	
Equitable, participatory and accountable water governance	
Reduce untreated wastewater, nutrient pollution & increase wastewater reuse	
Reduce mortality and economic loss from water-related disasters	



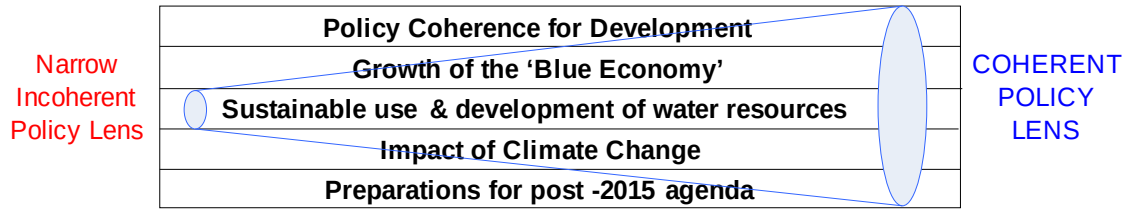
Note: This visualisation of the subjective estimates, rather than any attempt at numerical precision for the intensity of each pillar of sustainability, is indicated in the diagram above.

A coherent policy on water focuses on the most salient problems arising from national transitions that can be ameliorated by specific policy instruments, in the short term. Some problems, like climate change for example, although important, are not likely dealt with by short-term measures. However, a pragmatic approach to getting coherent policies requires a range of policy changes and transitions that could be implemented in the short term.

Now, the transitions are happening so fast that the capacity and mind-set of planners are most likely overtaken by these equilibrium shifts. The past solutions to the food-water-energy-land (soils) nexus are not only unviable, the long-term commitments of land, water and mineral resources make these transitions irreversible.

It has been already noted that *greed is not good when it comes to matters of the commons*, such as water. The application of science and technology to address water security issues is needed. However, once again doing *"the same thing over and over again and expect different results"* is not an option. *We need all kinds of leadership to bridge this gap.*

A View of Water Security through a Policy Coherent Lens



The coherent policy lens described above, where five areas are highlighted for consideration and implementation, expands the '**Policy Coherence**' debate by considering all areas that are essential to ensure water security and outlining how to implement every component that is vital to ensure the right to adequate water for all.

Viewing 'Water Security' through a policy coherent lens provides a tool to prioritise areas for implementation and so improve its cost-effectiveness. Some of the essential components of a coherent water security policy include:

- **Policy Coherence for Development** including population growth, sexual and reproductive health and rights: policy coherence means looking for synergies and complementarities and filling gaps among different policy areas so as to meet common and shared objectives. More coherence ensures economic and social development while also protecting human health, the environment and ecological integration around food and nutrition, water, energy and land (soils). This approach offers the best hope to improve economic development.
- **Growth of the 'Blue Economy'**, plus capacity building and wealth creation: The Blue Economy supports Bio-mimicry approaches to innovations that seek sustainable solutions to water challenges, by emulating nature's time-tested patterns and strategies. The Blue Economy engages regeneration while it addresses the issues of sustainability, which go beyond mere preservation. It is about ensuring that eco-systems can maintain their evolutionary path so that all can benefit from nature's endless flow of creativity, adaptation and abundance.
- **Sustainable Use and Development** of water resources, recognising the intimate links between human well-being, economic prosperity and a healthy environment: A coherent policy that ensures a sustainable use and development of water must focus on the three dimensions of sustainability: social equity, a healthy environment and a viable economy. This would let us get a handle on the sensitivity of water treatment approaches to various changes in the economic, social or bio-spheric environments, and provide sensible information for decision and policy makers.
- **Climate Change** impacts, which arise through more variable rainfall, lower water availability for irrigation and higher crop water demands, affects water resources through its impact on the quantity, variability, timing, form, and intensity of precipitation.
- **Preparations for post-2015 agenda**, including infrastructure development, present a renewed opportunity to provide (a) universal access to safe drinking water, sanitation and hygiene; (b) reduce untreated wastewater, eutrophication and increase wastewater reuse; and (c) reduce mortality and economic loss from water-related disasters.

A Conventional Approach to Water Security

The three main dimensions of water scarcity are:

- A physical lack of water availability to satisfy demand;
- The level of infrastructure development that controls storage, distribution and access; and
- The institutional capacity to provide the necessary water services.

Water scarcity occurs when the demand for freshwater exceeds supply in a specified domain. It arises as a consequence of a high rate of aggregate demand from all water-using sectors compared with available supply, under the prevailing institutional arrangements and infrastructural conditions, manifested by:

- Partial or no satisfaction of expressed demand;
- Economic competition for water quantity and/or quality;
- Usage disputes between users;
- Irreversible depletion of groundwater, and
- Negative impacts on the environment.

Water scarcity is both a relative and dynamic concept, and can occur at any level of supply or demand. It is also a social issue, which is related to human interference with the water cycle. Its impact varies over time, partly as a result of natural hydrological variability, but more a function of prevailing economic policy, planning and management approaches.

Scarcity can be expected to intensify with most forms of economic development, but, if correctly identified, many of its causes can be predicted, avoided or mitigated.

Evolution of Water Security Concepts

Water is at the core of sustainable development. The question of water security—along with food and energy security—is the primary goal of any civilised society. Only 33% of the people of India have access to traditional sanitation, and over 21% of the country's diseases are water-related. There is considerable scope to improve water resource utilisation, as the amount of food produced per unit of water input is relatively low, and access to water serves neither socio-economic nor environmental objectives. Water scarcity occurs when the demand for freshwater exceeds supply in a specified domain. It arises as the consequence of a high rate of aggregate demand from all water-using sectors compared with available supply, under the prevailing institutional arrangements and infrastructural conditions.

Water resources and services support poverty reduction, economic growth and environmental sustainability, while contributing to improvements in social well-being and inclusive growth, affecting the livelihoods of billions.

The Conventional Approach Revisited

Human efforts to develop and supply water have focused on (a) the amounts and the flows that are available in streams and lakes; and (b) the groundwater, which is a significant source for exploitation. The dominant water paradigm: '*develop – supply – use*' has led to the excessive and uncontrolled withdrawal of water from natural sources. Comparatively less water remains in the natural streams, lakes and groundwater aquifers.

Improved accessibility to water has not only deteriorated availability, but also degraded water quality. '*Blue water*' flows are largely determined through land use and land management. Intensified agriculture points to increased consumption of '*green water*', and to less water to recharge the rivers, lakes and groundwater aquifers. Similarly, land use patterns, in terms of tilling practices, cropping patterns and the removal of biomass, are some of the important determinants for rain water partitioning and the speed of water flows above and below ground.

The effort required managing water development and utilisation is becoming increasingly complex and demanding. Costs to build and maintain structures are skyrocketing. While tensions and conflicts between users tend to grow, the difficulties of coping with water quality degradation and vulnerability are increasing.

Water Resource Management

A constant reminder from the Conference was that immense amounts of water are wasted due to poor management. Developing countries often have poor or non-existent government regulation of water. However, a political window exists through which new solutions and new regulations—such as the ideology of Integrated Water Management (IWM) can be implemented.

IWM is a resource management theory that attempts to promote the "coordinated development and management of water, land, and related resources in order to maximise the resultant economic and social welfare in an equitable manner, without compromising the sustainability of vital eco-systems". It has four principles that it adheres to:

- Consider water an economic resource,
- Recognise that water is a finite resource,
- Encourage democratic participation in the development of water, and
- Require that women play a fundamental role in the management of water.

IWM is much more of a goal than something that can be implemented. It is not a policy; It is a set of ideas and beliefs for techniques of water management.

One of the main pillars of IWM, for example, is a stress on the importance of women having a role in the management of water. Many cultures do not hold women to equal status, and may be averse to giving them more rights than men in this area. In a traditionally patriarchal society, it will most likely be very difficult to convince many people in these cultures to give women a significantly more powerful role in the management of water. As a response, independent social reform groups can work with the people by implementing policies that promote the participation of women in the politics of water. This also proves challenging for many countries as governments are wary of the influences of outside groups involving themselves in public affairs. However, this is necessary because many governments will have the same cultural beliefs as the people they govern.

Poor Water Productivity in the Agricultural Sectors

Much of the unnecessary water waste in developing countries is due to inefficient use in both the agricultural and industrial sectors of their economies. Currently, the agricultural sector uses up to 92% of the water supply available in India. There are many ways in which this quantity of water can be greatly reduced, as shown in the discussions of this Conference and the papers included in this Report.

Why a Systems Approach?

Society – with its myriad human activities – is intimately interlinked with processes in the landscape. If water management concentrates on single functions in a compartmentalised fashion – to cater for specific requirements in society – ample experience has demonstrated that various types of undesirable side effects are likely to occur. Arrangements for water management in society typically focus on blue water, i.e., the water that is available in streams, lakes and ground-water aquifers, so these arrangements tend to be designed for the purpose of regulating withdrawals and use of blue water for the production of preferred goods in society. Current arrangements, therefore, neglect the significance of green water and the multifunctional role of water in the landscape. Green water plays a vital role in food self-sufficiency and food security. Both the green and blue water flows are fundamental to the

continuing functioning of terrestrial and aquatic ecosystems, which, in turn, are the very basis for production of food, timber and other tangible goods.

Water resources management must have a double orientation:

- It must be focused enough to deal with specific sectoral issues and stakeholder interests. To achieve desirable results in the irrigation sector, for instance, a management system is required where competent irrigation professionals, together with water users and other stakeholders, can implement necessary functions. In principle, the same arguments apply for various sectors and interests of a society.
- The different departments must also be part of a management system that integrates and coordinates various stakeholder interests. Sectoral interests need to be evaluated against a broader set of local, regional and national – or even international – development objectives. Stewardship for the maintenance of ecosystem productivity and diversity must be part of an institutional framework that aims to facilitate improved basic welfare and development.

Institutional Framework for Strengthening Social Resources

Proper institutional arrangements for water resources management, in terms of organisations, laws and regulations, are often lacking or do not function as stipulated. Equally important, those people who through their activities are beneficiaries or victims of water policy are often excluded from water management.

With growing water stress, a review of institutional arrangements needs to be made, with due reference to the various dimensions of adaptation. On the basis of the discussion here, it is possible to identify at least three major challenges that have to be tackled through a strengthening of the institutional framework:

- Proper handling of the technology: Technical solutions will continue to be of paramount importance in water resources management. Technology, however, must not be considered as isolated from society. Its use must be regulated, respecting the various interests involved. It is, for instance, increasingly important to monitor downstream impacts from technical interventions in upstream locations. Institutional arrangements, in terms of financial arrangements and ownership responsibilities, are also of growing importance in order to introduce new techniques that could reduce pollution.
- With growing competition between various water users and with increasing tensions between stakeholders with incompatible claims on water, institutional arrangements are needed to define different objectives and to handle the resolution of water-related conflicts.

While some of the institutional arrangements must deal with acute and recurrent issues, it is also necessary to build a pro-active capacity in society. Norms and awareness among people are of basic importance in this regard. If the content of education is not conducive to the requirements of society and for its relationship with its life-support system, it is futile to expect that proper institutions and proper management will develop. To prepare for active and constructive engagement with various stakeholders in water resources management, the content and orientation of the information and educational systems need to be assessed.

Impact of Climate Change on Water Security

Climate change will have far-reaching effects on water management in agriculture. In developing countries, the impacts will vary considerably from location to location, but will arise through a combination of less favourable conditions for plant growth, such as more variable rainfall, lower water availability for irrigation and higher crop water demands. These stresses will be additional to the pressures to produce more food, with less water and less land degradation in the face of rising global population and changing food preferences.

Background

Water security is under severe pressure from many sources: *population explosion, rapid shifts of people from rural to urban areas, the impact of dietary change as countries develop, increasing pollution of water resources, the over-abstraction of groundwater and the significant issues created by climate change*.

Climate change affects water resources through its impact on the quantity, variability, timing, form, and intensity of precipitation. Additional effects of climate change that impact water resources include increased evaporation rates, a higher proportion of precipitation received as rain, earlier and shorter runoff seasons, increased water temperatures, and decreased water quality, in both inland and coastal areas.

Increased evaporation rates are expected to reduce water supplies in many regions. More frequent and severe droughts arising from climate change will have serious management implications for water resource users. Water users will eventually adapt to more frequent and severe droughts, in part by shifting limited water supplies towards higher-value uses. Rising surface temperatures are expected to increase the proportion of winter precipitation received as rain, while rising sea levels could also directly reduce water quality and availability in coastal areas, and indirectly cause water tables in groundwater aquifers to salinise.

Climate Change Adaptation for Water Security

Adaptation takes place on farm level and at system/catchment and basin levels, and is therefore more applicable in richer countries. They refer to adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

Adaptation to climate change for Water Security is mainly about appropriate adaptation measures built upon known land and water management practices to foster resilience to future climate change, thereby enhancing water security. Any adaptation measure, however, needs to be assessed for inadvertent adverse effects, in particular on the environment and on human health. It is transformative and requires a collaborative, problem-solving approach, especially in a resource-constrained environment. An active approach is to understand vulnerability, reduce risk, and prepare for consequences while incorporating new science and lessons learnt.

Adapting to increasing climate variability and change through better water management requires policy shifts and significant investments that should be guided by the following principles:

- Mainstreaming adaptation within the broader development context;
- Strengthening governance of water resources management and improving integration of land and water management;
- Capacity-building on climate, water and adaptation measures, and investing in comprehensive and sustainable data collection and monitoring systems;

- Building long-term resilience through stronger institutions and water infrastructure, including well-functioning ecosystems;
- Investing in cost-effective water management and technology transfer; and
- Increased national budgetary allocations and innovative funding mechanisms for adaptation through improved water management.

Some adaptations, such as biological and market adjustments, will be incremental, autonomous and 'unnoticed'. Adjusted cropping patterns, changing crop types, land use and even adjusting diets are examples of autonomous change. Many such adaptations can be implemented quickly and easily with good communications and social marketing campaigns.

Other changes, such as designing water control structures to cope with a higher frequency of extreme events, will involve proactive planning timely investments, on the basis of economic appraisals, that can lead to reduced uncertainty in the long term and improved benefits in the short term. However, such macro-planning requires broad inter-sectoral coordination, with implications for dams, levees, and flood detention areas arising from increased frequency and severity of floods, which in turn impact human settlement, including farming.

Given the trends in agricultural demand for water – as driven by population, income growth and changing diets – a recurring challenge for agricultural water management is the question of how to do more with less. Competition for bulk water is already driving this autonomous adaptation, but climate change is expected to sharpen the points of competition and give added impetus to water management adaptation, to reduce demand and to rearrange supply or extend it through recycling.

Climate Change Mitigation for Water Security

Mitigation refers to human interventions to reduce the anthropogenic forcing of the climate system. Mitigation actions revolve around measures to reduce green-house gas (GHG) emissions and enhance carbon sinks. For example, growing trees and harnessing renewable energy from solar panels, hydropower and wind turbines can create less GHG emissions than traditional coal plants or local wood burning.

Energy consumption for groundwater irrigation is important and significant in India, accounting for 16–25 million tonnes of carbon emissions, which is 4–6% of the national total. It would appear that there is good potential to mitigate GHG emissions, both directly and indirectly in irrigated agriculture, but that more work needs to be done to quantify likely benefits and then pilot and test appropriate modifications, to practice and management at field and system scales. The quickest benefits would come from appropriate incentive policies to minimise energy use (in pumping) and to maximise fertiliser efficiency. Longer-term benefits of carbon sequestration in irrigated fields are tied to the longevity of irrigation itself, in addition to continued good stewardship and husbandry.

If India has 18% of world population, and only 4% share of the world's fresh water, water stresses in the future will mainly be due to the impact of climate change. Accordingly, farmers and scientists must jointly view and study rain and crop patterns and come up with rational plans.

Climate change will have its greatest impact on agricultural water management, in further sharpening the trade-offs between conservation and protection of natural ecosystems, which ultimately support agriculture, and the allocation of land and water to sustain productive agriculture. The choices will be tougher in terms of surface and groundwater allocation where selections must be made between productive and environmental needs, as these are the two high-volume but low-value uses. Higher-value, low-volume allocations to cities, industry, rural water supply and sanitation are unlikely to be materially affected by climate change (even if the demanded volume rises slightly), but collectively these demands will reduce the volume of water for allocation to agriculture and environment.

The Nexus of Water, Energy, Land and Climate Change in Food

Background

The overall goal of studying the 'water-energy-land-climate nexus' and integrating the results into a food policy would be to provide ways in which the rural and urban poor may be able to afford nutritious diets that are usually associated with the urban middle class.

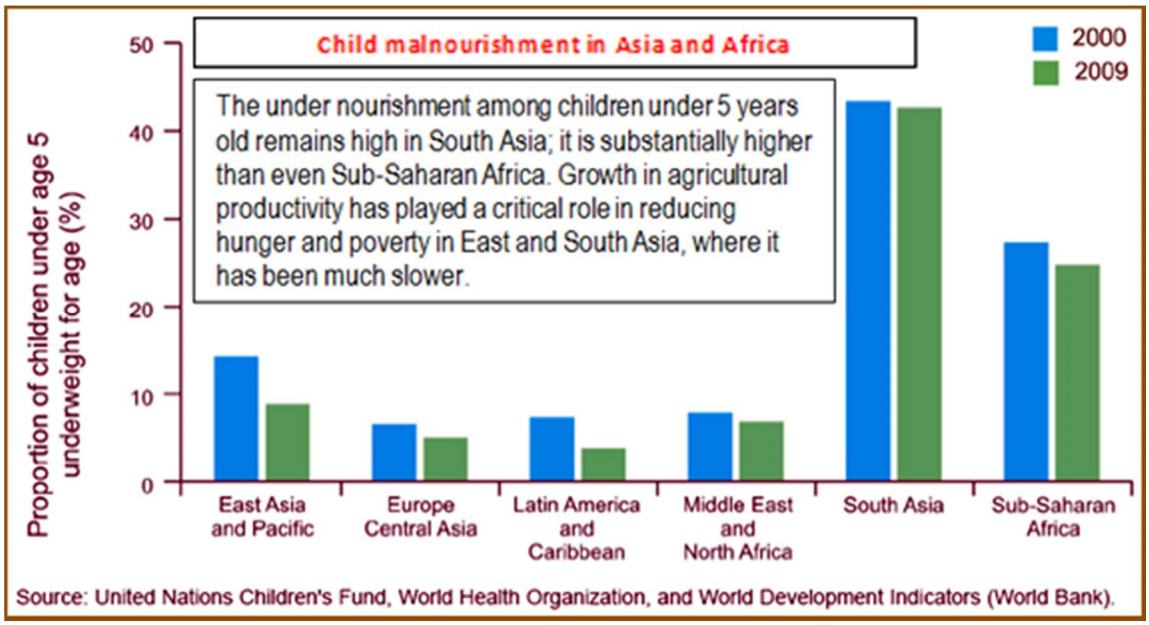
The nexus revolves around the issues of what socio-economic, institutional, cultural reforms and technical innovations on the one hand, and climate change induced environmental concerns, on the other, are equitably addressed to sustain livelihoods and grow more healthy food in local and regional areas. This will ensure that the four pillars of food security—namely availability, access, utilisation and stability—are strengthened, if not maintained.

Agriculture to grow food uses more than 90% of water in India. Hence, the overall goal of understanding the 'food-water-energy-land-climate nexus' is an essential prerequisite for an integrated water policy that would enable the rural and urban poor to access affordable diets that are adequately nutritious.

The Issues

The nexus revolves around socio-economic issues, such as governance, including women's empowerment and environmental and ecological concerns, which includes climate change and biodiversity loss. It centres on the creation of sustainable livelihoods and local food production, to ensure that the four pillars of food security—are maintained, and hopefully strengthened.

Take for example, the issue of nutritional security for children under the age of 5:



The principal reason for this in the South Asian region is **the breakdown of ecosystem services, weak institutions of governance and of infrastructure, and lack of empowerment of women.** Regenerating natural capital, strengthening local institutions and infrastructure and raising the participation of women in planning and implementing development processes are the basis of meeting the needs of food, water, energy and land—even more so in the context of climate-change. Resilient solutions to the problems of food insecurity need integrated approaches to the nexus of water, energy, land, which have highly nonlinear interactions of these elements. There is now extensive evidence worldwide, that, **with good science and a modest investment, degraded lands can be restored, institutions and infrastructure can be enhanced and participation of all can be forged with profound effect on the productivity of local natural resources such as water**.

An assessment of the potential for reducing water needs and increasing production and economic value requires an understanding of basic biological and hydrological crop-water relations. The main potential for conserving water in agriculture lies in the choice of crops that are appropriate for the water resources available in each given region. Another method for saving water in agriculture depends on the choice of technology and of scale of farming. But here, the trade-offs between the different inputs of land, labour, capital and technology can be quite complex and the relative costs and benefits have to be carefully weighed. The impacts of these choices on the relative consumption of energy and water can further complicate the calculations.

Aggregation of small farms—backed by equitable institutional arrangements, mechanisation and modernisation of technologies—can not only maximise efficiency in the use of water, energy and land resources, but also enable them to market their products in urban areas. Strong employment generation from crop diversification into higher value crops is what enables rural economies to adopt the right technologies and achieve an inclusive growth pathway. A misguided choice of technology or policy could create conditions that may be difficult to change, later.

Additional ways to meet these critical needs is to increase the technological efficiencies of water, land and energy use, in agriculture. Increasing water productivity, especially the value produced per unit of water, can be an important pathway for poverty reduction in water productivity. The adoption of techniques to improve water productivity requires an enabling policy and institutional environment that aligns the incentives of producers, resource managers, and society and provides a mechanism for dealing with trade-offs.

Meeting the needs of food, water, energy and land—in conjunction with climate-change—will make humanity more resilient to deal with these issues in a safer space than where it is currently located. It would be inappropriate to treat the nexus of water, energy and land as separate units of the food production process, due to the nonlinear interactions of these elements.

The population size by itself is not the whole problem, as the current levels of food production are capable of providing the people with an adequate low-quality diet. The problem is meeting the growing demands for higher quality diets, which will require modern food chains that rely on more efficient agricultural inputs, storage, transport and marketing.

High-value food-production systems will most likely be based on large-scale commercial farming, unless the movement to grow organic food in the urban areas overtake the rural equation. Strong employment generation from crop diversification into higher value crops can enable rural economies to adopt the right technologies and achieve an inclusive growth pathway. A misguided choice of technology or policy could create conditions that may be difficult to change, later.

BOX 1

The Megacities' shift in food preferences

Urbanisation could double the amount of water required for food production, due to change in the diets of urban people, and new taste for less starchy foods towards more varied diets with more animal and dairy products, fats and oils. These higher quality foods will require producing more animal feed and requirement for processing, storing and refrigerating food products. These processing and storage activities will need more electricity, which has its own large water footprint that is estimated to be an order of magnitude greater than today's conventional municipal water supply.

Without careful planning for Megacities, the shift in food preferences alone could lead to excessive demands on water and energy resources.

For example, relying on small farms that are not sensitised to water and energy saving technologies—to provide for food supplies to large communities—may lead to the exhaustion of water, energy and land resources, due to inefficiencies in the food value chain activities. And reducing the inefficiencies in the food chain cannot be considered independent of energy and agricultural policies.

Appropriate policy mechanisms are needed to establish mechanisms for societies to address the nature of uncertainties faced under current or future conditions, such as drought or flood conditions in rural areas.

PART 2: YESTERDAY'S DEBATE

India has an abundance of water within its borders, with 13 major and 46 minor basins. The Ganges-Brahmaputra Basin is the largest, covering 34 per cent of India and contributing approximately 59 per cent of the country's water resources. The major sources of water in India are rainfall and glacial snowmelt contributing to river flows from the Himalayan region.

And yet, there is an acute shortage of appropriate water supplies in India. We can attribute this to the policy incoherence, which leads to this imbalance in water access.

Source: http://news.nationalgeographic.com/news/energy/2012/04/120406-food-water-energy-nexus/

The purpose of the Club of Rome – India Annual Conference is to garner input from a wide range of expertise and to identify the means by which national, state and local policies in different arenas can be brought into line with each other in the attainment of the most basic goals needed for sustainable national development: secure access to food, water, energy and a healthy, productive environment.

Special Attention to Food Self-sufficiency and Food Security

The impending water crisis has repercussions for various functions in society and the landscape, and it constitutes a significant challenge in a development context. One of the most critical concerns is its effects on food self-sufficiency and food security. In this study, it is emphasised that national food self-sufficiency is increasingly difficult to attain for a growing number of countries. Arrangements must be made at the international level to guarantee access to food items that cannot be produced domestically. At the same time, a high degree of national food self-sufficiency is important for poor countries, where the majority of the population resides in rural areas and where the economy has neither the orientation nor the capacity to generate the export earnings with which food could be purchased. A combination of food self-sufficiency and food security policies is obviously necessary for the foreseeable future.

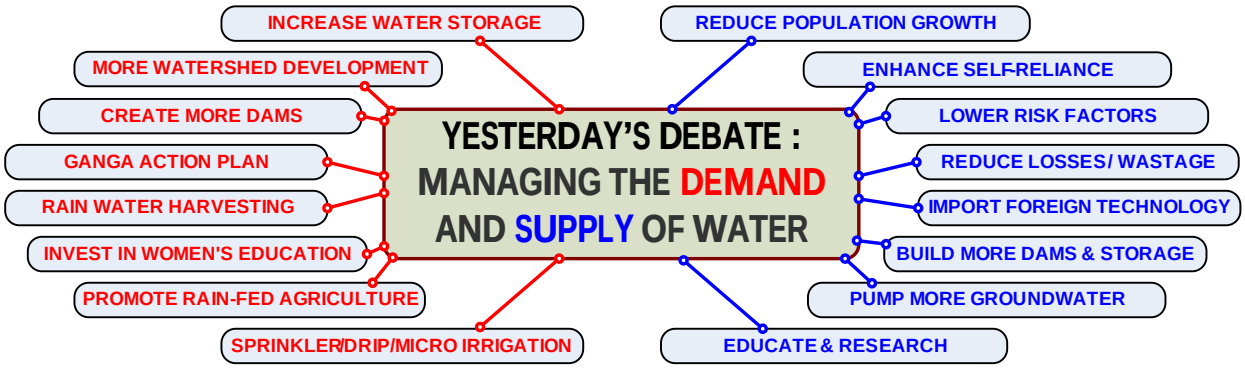
The Critical Role of Water in Achieving Food Security

Today's agriculture sector faces a complex series of challenges: produce more food of better quality while using less water per unit of output; provide rural people with resources and opportunities to live a healthy and productive life; apply clean technologies that ensure environmental sustainability; and contribute in a productive way to the local and national economy. The country's water programme is shaped along the lines dictated by these new challenges, in order to better respond to the needs of its member countries, such as:

- **Improving on-farm water management: producing more with less water**: FAO produces and maintains crop water productivity models for application at field level and for scenario analysis on impact of global warming.
- **Improving the performance of irrigation services:** FAO has developed a multi-language training package for modernisation and rehabilitation of large-scale irrigation schemes and has applied it in 20 countries.
- **Augmenting supply**: the use of non-conventional waters: FAO recognizes importance of reuse of drainage water and use of water resources of marginal quality, such as treated wastewater and brackish water, especially in the arid and semi-arid zones of water-scarce countries and in rapidly growing peri-urban settings.
- **Water Harvesting**: FAO promotes water harvesting as one of the techniques with the highest potential to boost rain-fed agriculture, in particular in semi-arid regions of sub-Saharan Africa.
- **Integrated watershed management**: FAO supports an increasingly important role in new financing mechanisms, including payment for environmental services, based on the results of a watershed management review undertaken by FAO and partners. It also found a need for a more inclusive and participatory approach in watershed management implying multi-stakeholder involvement and a negotiation process among the grassroots, technical and policy concerns.
- **National policies**: **water allocation to agriculture**—FAO warns that agricultural water already is being allocated to other utility uses, such as municipal supplies, environmental reserves and hydropower generation. This indicates a need for a progressive agricultural policy alongside water policy if these allocations are to be optimised in economic and environmental terms.
- **Trade and the potential of virtual water**: FAO supports countries as they confront the prospects of water scarcity and recognises that, if water becomes the scarce factor, it may be more sensible to "import" it embodied in products in general and food in particular, especially if food is available on favourable trade terms. Therefore, efficiency gains in global food trade in terms of water resource utilisation are possible and the consequence of increasing reliance on irrigation for food production in many countries, including food exporting countries, needs to be well understood before such policy commitments are made.

Business as Usual: Managing the Demand and Supply for Water

Measures to ensure our nation's water security clearly need people-friendly and participatory approaches. Many of these are not well understood. Every seminar, roundtable and conference on water-related topics trots out the regular technologies, both on the supply and on the demand side, as shown below:



This approach has only resulted in countless proposals, initiatives and goals that are loosely connected at best, and that are often plagued by internal inconsistencies. The frequent succession of governments—each with different ideologies—has left the state of the Indian Republic's water agenda in tatters.

The "silver bullets" of yesterday's debate—the various activities that can help bring supply of water into some balance with the demand for it—are necessary and extremely important. However, they are not sufficient. Even if all, or most, of these interventions were to be implemented, the water shortage problems would not be fully solved, as there are other political, economic and social barriers, not usually dealt with in the current discourse, that undermine the impacts of such well-intentioned policies and actions.

Water underpins the very fabric of human life – food and drink, the clothes worn, the landscapes enjoyed, the societies lived in and the length and quality of lives. Water supplies and food production are becoming increasingly uncertain due to changes in climate, demographic patterns and economic growth. The current approaches to risk assessment are becoming less reliable. We need a risk-averse strategy to identify the boundaries of a safe space for humanity.

PART 3: TODAY'S DEBATE

The Underlying Premises for Sustainability

The debate needed today encompass ideas such as:

(a) Improvements in the system of **governance**, mainly to tackle the issue of corruption and the absence of a development focus in policy making;

(b) **Reforestation** to naturally recharge the rivers, water bodies and groundwater table and rationalise the food-water-energy-land nexus debates;

(c) **New technologies** for growing food more efficiently, such as fine bubbling technologies, System of Crop Intensifications (SCI), Aquaponics and other water-energy-land-friendly approaches, and

(d) Innovations in **systems**, institutional frameworks and economic instruments, to introduce bio-mimicry approaches and combat trophic downgrading, to ensure that *water for all* may be secured

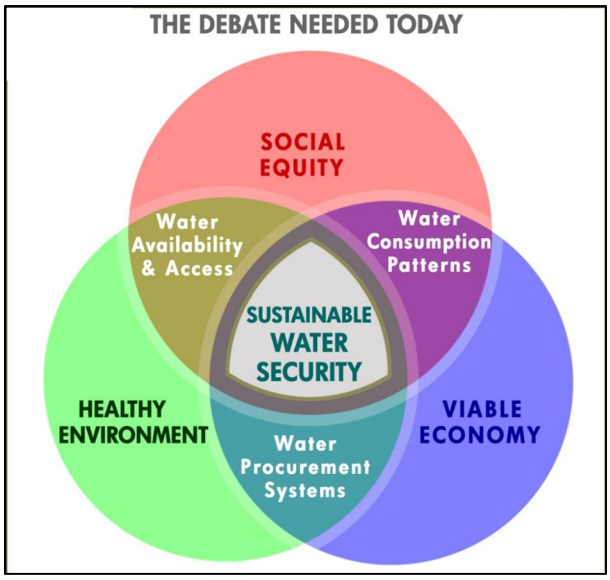
(e) Strengthening the **participation** of all, including particularly women, in the identification, planning and implementation of solutions for their water needs

This means that a new, simple and sustainability-oriented approach is needed, which must now become the central subject of debate in our country. Considering that water security is one of the most important goals for the future health of the nation, the national debate will require several key changes in its general approach and order of business, in order to develop a water security policy framework, which will carry us forward into a truly sustainable future.

The Three Dimensions of Sustainability

No activity that involves the production and consumption of water can be scaled up to reach everywhere or everyone—unless it is economically viable. Hence, reasonable profits and efficient markets are essential for universal water security, as they are for all other basic needs. But profit and markets, though necessary, are not sufficient. They alone, do not guarantee water security for all, either today or in the future. For the poor and the marginalised, additional measures are needed to ensure universal and reliable access to water. And for children and grandchildren tomorrow, the productivity of the environmental resource base has to be protected and enhanced, in order to ensure that they can continue to get the water that they will require.

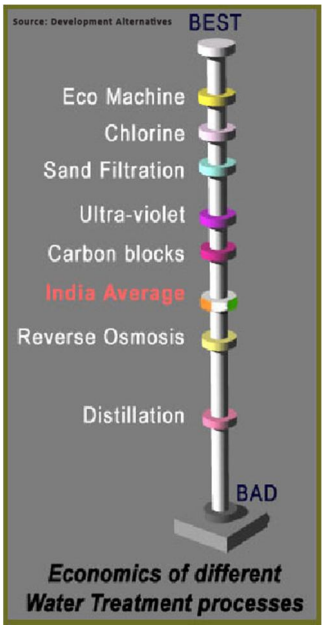
The Venn diagram shown right captures **today's discussion needs and its underlying premises for sustainability**.



Thus, a policy that ensures a sustainable water security for all must focus on the three dimensions of sustainability: **social equity**, a **healthy environment** and a **viable economy**.

The first commitment is to the efficiency, prioritisation and scaling up of water supplies, which means that the mix of the factors of production – land, labour, capital (and others, such as knowledge, technology, infrastructure, market linkages) – have to be optimised for each social, economic, resource and geo-climatic context. Given the changes occurring in the climate, ecosystem productivity, resource prices and transportation costs; the issues of trade and comparative advantage also have to be examined anew.

A. Issue of Economic Viability



It is agreed that the first commitment is to the balance needed for a viable economy. If policies and investments in water security favouring the agricultural sector or the industrial sector—or indeed the services sector or the natural resource sector—get out of economic balance, the performance of the economy can only suffer by becoming sub-optimal and less efficient. A balanced and viable economy clearly is a necessary condition for sustainability.

Apart from concerns such as the nation's strategic imperatives and security of water supplies, which have played a major role in food-related decision-making in India and other countries, there are several emerging factors including climate change, that need to be considered in the choice of water production and treatment strategies.

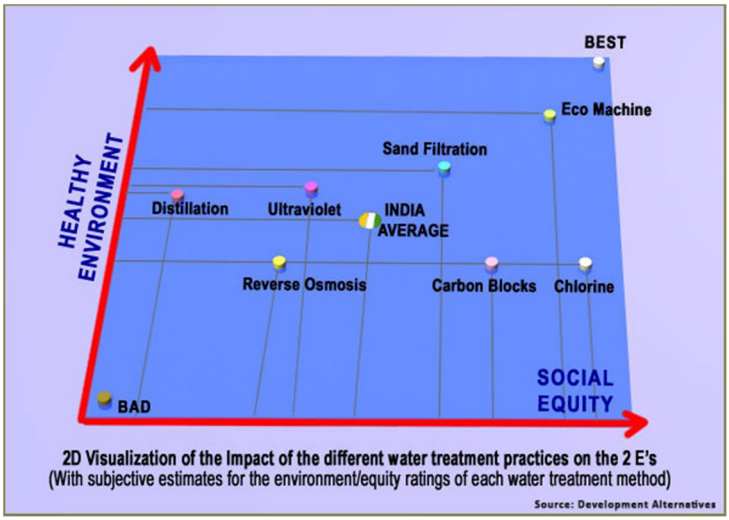
Since few sectors have benefitted as much from research and innovation as agriculture, the investment choices made for the supply of water for agriculture can hugely affect the relative importance of different water-guzzling technologies, to the economy.

Implication*: Water Security depends on the access to water services and the relative prices, and the choice of technology determines not just what is produced, but who gets the income. It is thus clear that the investments made in infrastructure, research and innovation for water supplies have a large impact on the outcomes.*

B. Issue of Social Equity

The second issue is the commitment to social justice in spatial or class terms – in the here and now. It assumes that water, like food and energy, is the right of all, whether urban or rural, rich or poor, powerful or marginalised.

Let us study the impact of different water treatment practices, when plotted against '*social equity*' on the x-axis, and '*healthy environment'*, on the y-axis, as follows:



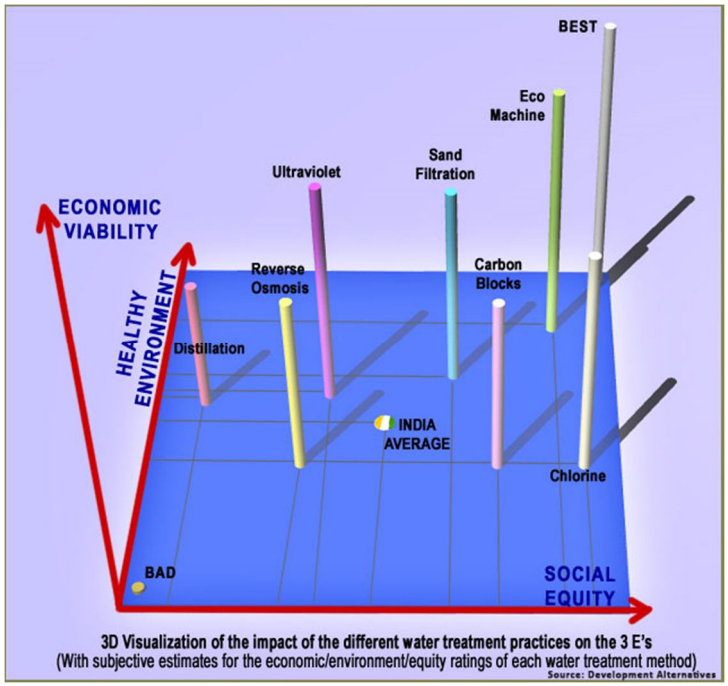
Recent political upheavals demonstrate that equity is a central component not just of liberal, participative democracies but, more importantly, of the very sustainability of these measures. Equity means that the poor, women, tribal people and other marginalised segments of society must have access to adequate water supplies. This issue necessarily focuses on the imperative participatory approach for sustainable policy development, in order to have truly bottom-up decision making processes for designing, developing and implementing coherent policies.

We do not have to worry about policy incoherence, if the people are truly involved in deciding their own water security arrangements.

***Implication**: It is essential to create strong, viable and resilient communities, which can ensure the health and nourishment of their members by enabling them to access and fulfil their basic needs.*

C. Issue of a Healthy Environment

The third is the commitment to inter-generational equity or responsibility for our legacy to the future – embodied in the *Environment* pillar of "sustainable development". Let us study the economic viability, when evaluating the impact of a healthy environment and social equity, of a number of water treatment methods:



This visualisation can help decision and policy makers to decipher the robust and effective policy initiatives needed to achieve the goal of securing water for all. It is instructive to note that the natural processes that promote the bio-mimicry approach is placed at the top right corner, signifying high sustainability credentials.

Based on such representations of the attributes of the '*Water Security*' debate, we may use various modelling approaches, to simulate the trajectory of water security outcomes in terms of time and space variations. This would enable researchers to get a handle on the sensitivity of water treatment approaches to various changes in the economic, social or bio-spheric environments, and provide sensible information for decision and policy makers. These studies relate to differences in the time horizons assumed: some are motivated by the immediacy of today's issues (either for societal concern or for political or personal gain), others worry about what impacts the narrowly-conceived, short-term decisions made today will have on future generations. Recent shortage of water in places such as Marathwada and increases in food-water imports in countries such as China demonstrate that the health of the environment and its resource base is a critical factor in sustainability.

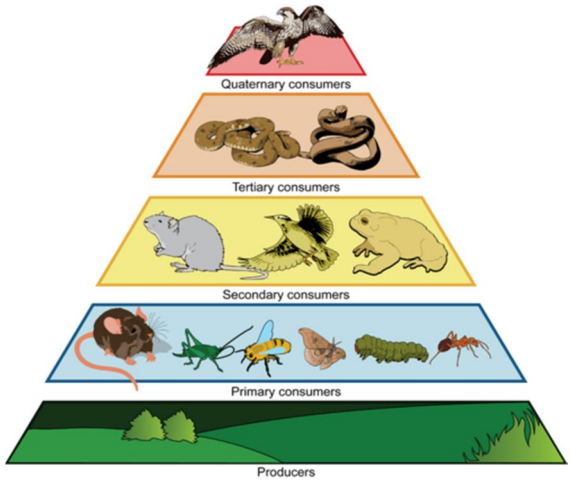
The "*silver bullets*" of yesterday's debate—*the various activities that can help bring supply of water into some balance with the demand for it*—are necessary and extremely important. However, they are not sufficient. Even if all, or most, of these interventions were to be implemented, the water shortage problems would not be fully solved, as there are other political, environmental, economic and social barriers—not usually dealt with in the current discourse—that undermine the impacts of such well-intentioned policies and actions.

Impact of Trophic Downgrading

Trophic downgrading results from human activities that eliminate essential predators at the top of the food chain.

Box 2

The **trophic level** of an organism is the position it occupies in a food chain. A food chain represents a succession of organisms that eat another organism and are, in turn, eaten themselves. The number of steps an organism is from the start of the chain is a measure of its trophic level. Food chains start at trophic **level 1** with primary producers such as plants, move to herbivores at **level 2** and predators at **level 3** and typically finish with carnivores or apex predators at **level 4 or 5**. The path along the chain can form either a one-way flow or a food "web". Ecological communities with higher biodiversity form more complex trophic paths.



Source: http://www.ck12.org/biology/Trophic-Levels/lesson/Trophic-Levels-BIO/

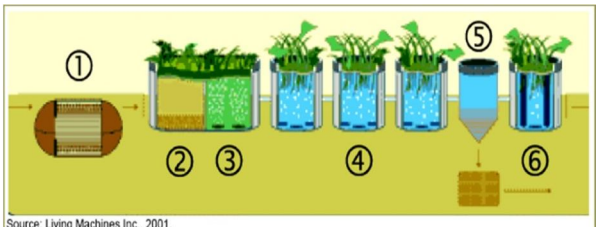
The presence of predators in terrestrial and marine eco-systems controls the secondary consumers and coral-based communities. Wolves, for example, can control and reduce deer populations, smaller numbers of which result in less browsing of shrubby plants. This can result in an explosion of scrubby vegetation on the landscape. Subsequently, grasses decline and along with them many species of herbivores that graze on them.

In India, as in many developing countries, slums are often situated on the edge of streams. The sewage and garbage run down the streets and ends up in the streams, which cannot remain healthy. Soon, all life within dies and it becomes a negative asset.

A remedial action rarely taken would be to introduce ecological technologies that might trigger and facilitate the internal healing of the stream ecosystem. To reverse trophic downgrading in streams and possibly replace it with trophic upgrading and take steps to create habitats that critical species will find hospitable, we should ask the question whether beneficial niche partitioning can be reintroduced into a body of water and then try and figure out how it might be done.

Counterintuitive Policies in Water Security

A counterintuitive proposition is one that does not seem likely to be true when assessed using intuition, common sense, or gut feelings. For instance, **conventional wisdom** promotes the idea that modern and industrialised version solutions for agriculture—a term which is generally used to describe the majority of production practices employed globally by large farmers and corporations—is the most efficient way of farming.



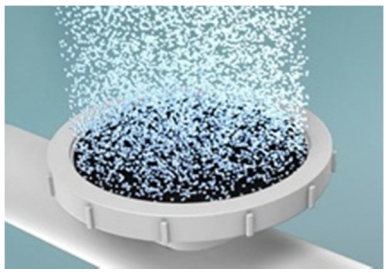
Source: Living Machines Inc., 2001.

FIGURE 1 THE COMPONENTS OF THE LIVING MACHINE®: (1) ANAEROBIC REACTOR, (2) ANOXIC REACTOR, (3) CLOSED AEROBIC REACTOR, (4) OPEN AEROBIC REACTORS, (5) CLARIFIER, AND (6) "ECOLOGICAL FLUID BED"

Policy-makers need to identify existing capacities, as well as gaps, in order to properly address the water security challenge. Capacity development is a long-term process based on incentives, good governance, leadership, and knowledge management and transfer, which need to be continuously adapted according to stakeholders' feedback and needs. The trick is to get to '*The Horse Jump*', ahead of '*Leap Frog Technologies*', such as:

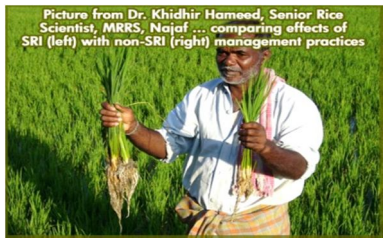
Eco-Machines, which are based on natural, bio-mimicry approaches for the treatment of polluted water, are cost competitive to build and less expensive to operate than conventional waste-water technologies. Living Machine technologies are basically ecologically waste water treatment systems, where waste water comes in, is taken up by the bacteria, converting waste water to high quality reusable water streams.

Fine bubble diffused aeration systems, which are sustainable, energy efficient systems available in the market today. The potential of fine bubbles in the treatment of water and improvement in water quality is enormous, particularly in developing countries suffering from water pollution and shortage. There will be a broad spectrum of business potentials using Oxygen, Nitrogen and a host of other gases that will benefit from fine bubble technology in the coming years, including the food sector, a multitude of cleaning uses, medical applications (such as cleaning of foot sores in diabetic patients) and other areas.



Source:http://www.xylemwatersolutions.com/scs/usa/enus/products/aeration/Pages/default.aspxod

- **System of Crop Intensifications** (**SCI**) and the **System of Rice Intensification** (**SRI**) in particular; the farmers are able to produce more rice using less water, seeds, agrochemical inputs, synthetic fertilisers, pesticides, herbicides, and often with less labour (once the methods are mastered). The net effect is to improve household incomes and food security, while reducing the negative environmental impacts of rice production, thus making water security more resilient. These methods are producing similar effects also with other crops such as wheat, *ragi*, sugarcane, mustard, and various legumes (grams). Hence, a counterintuitive policy for promoting water security would be to **promote SCI/SRI, in place of modern and industrialised solutions for agriculture**.



- **Create local, sustainable economies** around small-holder and urban, artisanal Aquaponics-based and organic farmers, to conserve water and land, with democracy based upon self-governing principles. There is no established policy in place that encourages the creation of either smallholder urban farmers, or local sustainable economies. Without a serious effort by government to address the issue of '*food deserts*' in urban and peri-urban areas, we could slide into chronic imbalances in social and environmental problems. Failures could be the first to lead humanity into sudden catastrophic outcomes, as water scarcity, food riots, climate change, and other social and environmental imbalances lead to societal collapse.

- **Forest Restoration** will recharge streams, rivers, water bodies and most importantly, the groundwater of the region. 'Blue Economy' approaches that involve the generation of multiple revenue streams, will ensure economic balance. Social equity and a healthy environment are natural outcomes of reforestation. Hence, forest restoration is a 'silver bullet' to solving the problems of water insecurity, in both rural and urban environments, as every urban area should have its associated 'forest'.

- **Low Temperature Thermal Desalination Plant** works uninterrupted for several years, to convert sea water to potable water. The prototype plant produced 100,000+ Litres of water/day. Hospital sickness cases dropped to 40%. Yet, many still believe in 'Reverse Osmosis', at far higher implementation and operational costs.

Legislation alone cannot change until the peoples' consciousness change. Unless that shift occurs, the government is not going to implement anything until the cause of the people is answered through new legislation.

When the consciousness of the people shifts to a higher level and the government reflects that change with new and coherent policies, we can start implementing the large scale changes with these new approaches to water treatment.

Creating Policy Successes in River Conservation

Well-functioning coordination at different levels – from national to river basin and sub-basin – and joint planning involving different interests are important for the sustainable management of water resources.

Good water governance is essential to achieving water security, and requires well-designed and empowered institutions with supporting legislative and policy instruments.

A human rights-based approach to water security addresses critical gaps and bottlenecks, and emphasises the establishment of regulatory functions and mechanisms for efficiency, participation and accountability. However, reaching effective and balanced inter-sectoral governance is complex, and solutions have a high degree of context specificity.

Some of the ways to protect river water sources are:

- Prevent deforestation and destruction of grasslands – nature's water filters;
- Restore forests and grasslands that have already been lost or damaged, to prevent sending erosion into our waters;
- Equip farmers with practical ways to keep harmful run-off out of our waters
- Restore floodplains that act as sponges and send water down into groundwater supplies and filter pollution out of rivers; and
- Create new science that helps pinpoint the greatest threats to our waters and the most effective ways to combat them, *sustainably*.

Trans-boundary waters pose enormous challenges for achieving water security in systems, such as river or lake basins and aquifers, which are shared across political boundaries. In such cases, water-related challenges are compounded by the need to ensure coordination and dialogue between sovereign states, each with its own set of varied and sometimes competing interests.

Impact of Governance Issues on Water Security

Water governance refers to the political, social, economic and administrative systems in place that influence water use and management. It is a critical area to improve the sustainable development of water resources and services. Access to water is a matter of survival and can break the vicious circle of poverty. Improving water governance is therefore essential to alleviate poverty. The **four fundamental dimensions** of water governance are:

1. **Social**: The equitable distribution of water resources and services among various social and economic groups, and its effects on society.
2. **Economic**: Efficiency in water allocation, its use and the role of water in overall economic growth;
3. **Political**: Equal rights and opportunities for water stakeholders to take part in decision-making processes. Participation facilitates more informed decision making, more effective implementation and enhances conflict resolution.
4. **Environmental**: The sufficient flow of water of appropriate quality is critical to maintaining ecosystem functions and services that build upon them.

Reforms typically include components linked to the following:

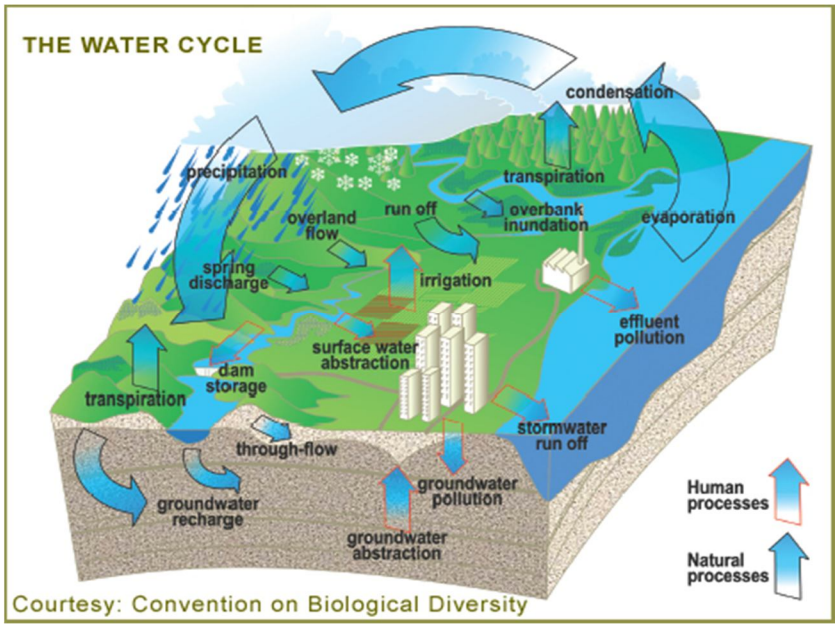
- **Decision-making**: Moving away from a top-down approach, towards bottom-up approaches that combine the experience and knowledge of various local groups and people, to ensure transparency and participatory approaches with local communities;
- **Integrity & accountability**: Corruption is a challenge that is detrimental to sustainable water use and service provision, by diverting financial resources and skewing decisions away from addressing collective concerns.
- **Collaboration**: Various private enterprises, CBOs, water users and NGOs play important roles in the management of water and delivery of water services. Effective government regulations are needed to enable private sector engagement;
- **Roles & responsibilities**: Establishing well-defined, coherent roles and responsibilities can lead to a number of social, economic and environmental benefits. Insecurity of water rights, discrepancies between formal legislation and informal customary water rights, and unequal distribution of water rights, are also frequent sources of conflict.

The Challenge: As local demand for water rises above supply in many regions, the effective governance of available water resources will be key to achieving water security, fairly allocating water resources and settling related disputes.

Impact of Forest Restoration on Water Security

Access to drinking water and sanitation are already enshrined in the MDGs. But, both the supply and quality of water are becoming increasingly insecure for all uses.

Ecosystems function as a "natural water infrastructure". Forests protect water supplies, wetlands regulate floods, healthy soils increase water and nutrient availability for crops and help reduce off-



farm impacts, and natural and man-made wetlands and buffer strips can be effective in managing nutrient run-off and pollution, as shown in the image below of "The Water Cycle": Degradation of natural infrastructure is often the root cause of disasters and contributes to the scale of impacts. Conservation often provides cheaper and more sustainable solutions, and delivers substantial co-benefits such as tourism, recreation and biodiversity. Natural infrastructure can replace or increase the sustainability and efficiency of built infrastructure.

Forest Restoration allows for multiple benefits: We aim to generate a suite of ecosystem goods and services by intelligently and appropriately increasing tree cover across the landscape. In some places, trees may be added to agricultural lands in order to enhance food production, reduce erosion, provide shade and produce firewood. In other places, trees may be added to create a closed canopy forest capable of sequestering large amounts of carbon, protecting downstream water supplies, enhancing groundwater and providing rich wildlife habitat.

Core Forest Restoration Principles

- Enhance the ecological integrity by restoring natural processes and resiliency;
- Develop the use of economic incentives that protect or restore ecological integrity;
- Use and train a highly skilled, well-compensated work force to conduct restoration;
- Document all restoration projects in the context of a restoration assessment and appropriate restoration approaches that restore ecological integrity;
- Conduct a restoration assessment prior to restoration activities;
- Determine the appropriate use of protection, and passive and active restoration based on restoration assessments
- Identify and secure areas of high ecological integrity;
- Cease activities that have been determined by a restoration assessment to impede natural recovery processes;
- Reintroduce natural processes or species through direct intervention;
- Distinguish between fuel-reduction treatments that restore ecological integrity and those that serve primarily to protect property and human life;
- Monitoring and evaluation must be assured before restoration proceeds and should be incorporated into the cost of the project;
- Develop and employ positive incentives to encourage ecologically sound restoration;
- Effective restoration depends on strong, healthy and diverse communities and a skilled, committed workforce; and
- Encourage involvement of a diversity of communities, interest groups, agencies, and other stakeholders at all levels

Security in General with Minimum Environmental Impact

From a holistic viewpoint, the three "silver bullets" for achieving sustainable growth and security are:

1. FOOD = Water + Energy + Land (Soil)

These are things that people need most. If they are plentiful, then green growth and energy security is guaranteed. These are also automatically obtained, if reforestation and governance are pre-existent.

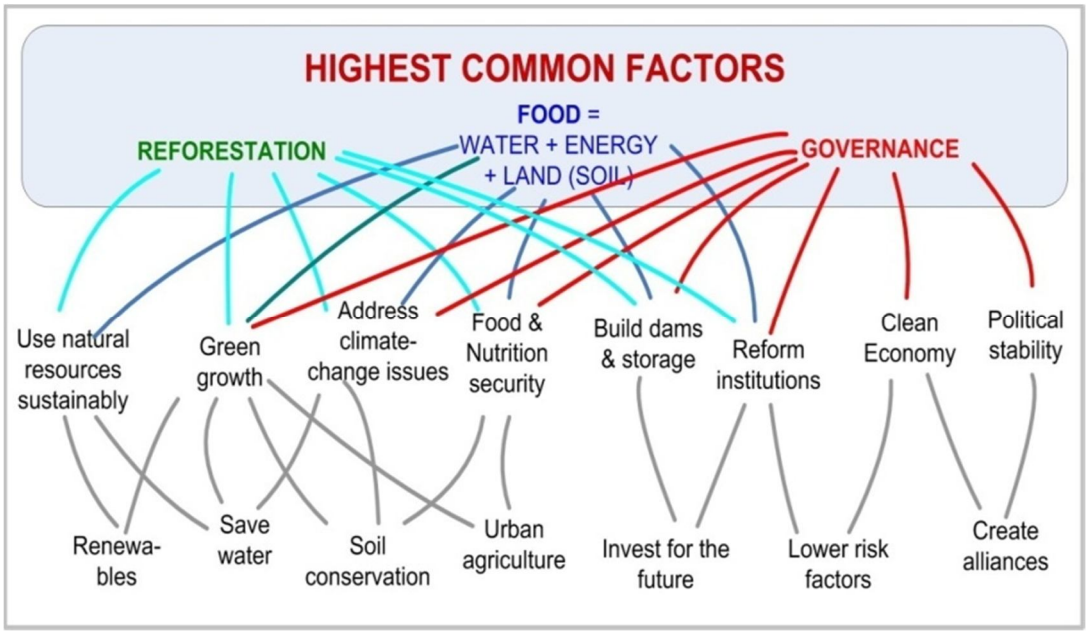
2. REFORESTATION

This means the natural or intentional restocking of existing forests and woodlands that have been depleted. While its main benefits: recharging the water table, combating climate change, reducing carbon emissions and soil erosion, creating biodiversity and such are well known, its long-term impact (say, in 15 – 30 years) on society is not.

3. GOVERNANCE

This means the process of decision-making and the process by which decisions are implemented (or not implemented). We now have enough laws and rules, which are ignored. Mismanagement and non-compliance are the big issues within mis-governance. So! A new and participatory Constitution will help to empower the masses and ensure that the checks and balances are put in place, respected and are effective. We will also need to promote primary education, health and knowledge services, as key social services, to promote good governance, in a repetitious cycle of desired actions.

These derivations are shown in the figure below, which highlights the **highest common factors**—*food, reforestation and governance*—as "*silver bullets*", for solving *all* our security-related problems.



CONCLUSION

Indian society should reduce its ecological footprint per unit of consumption, and start doing so in time to avoid global overshoot.

The task would be greatly simplified if **human society moved away from its fascination with growth**, both in population and economic value.

The concepts defined here will be meaningless unless they are implemented and lead to results on the ground. Most of these concepts are well known to government officials, businesses and civil society – but the formulation of policies does not seem to be influenced much by this knowledge. Clearly, there exist considerable barriers to rational policy making.

One of these is the turf or territorial issue. The silos within which ministries work and the bureaucratic instinct to protect that turf from all newcomers is probably the biggest barrier to rational policy making.

Other barriers include ignorance of the issues, lack of data and attention to research findings, inadequate support for research, lack of respect for the views of others (the "*Not Invented Here*" syndrome), fear of the unfamiliar, narrowly-defined professional or personal self-interest and the other well-known societal or individual frictional processes such as corruption, inefficiency and lack of concern for the national good.

But such barriers have been overcome in various places and at various times, and given the magnitude of the water security problem in our nation, India has little choice but to make this the place and time when it happens.

Integrated planning is essential for managing water as also the governance of this vital resource. Currently, there are more than ten different ministries and departments of the Government of India, implementing guidelines and policies for groundwater, irrigation, reservoirs, river conservation and planning, glaciers and snow covers. Moreover rampant industrial usage and mining activities need strict monitoring.

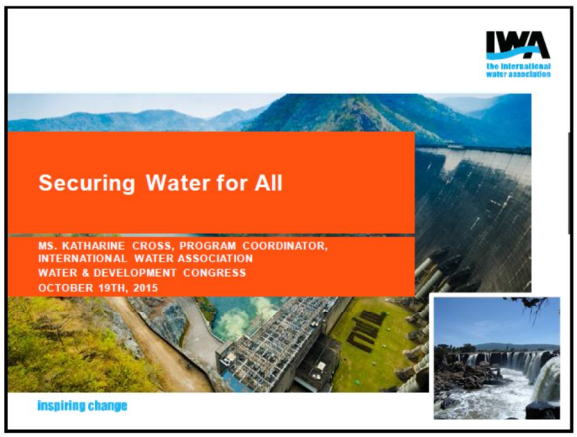
There has to be therefore, a broad national water policy to ensure harmonisation of the activities of these agencies. It is understood that two draft laws and the report of an expert committee headed by Mr. Mihir Shah, Member, Planning Commission, will be framing the core principles on India's future management policy, for institutional reforms in the water sector.

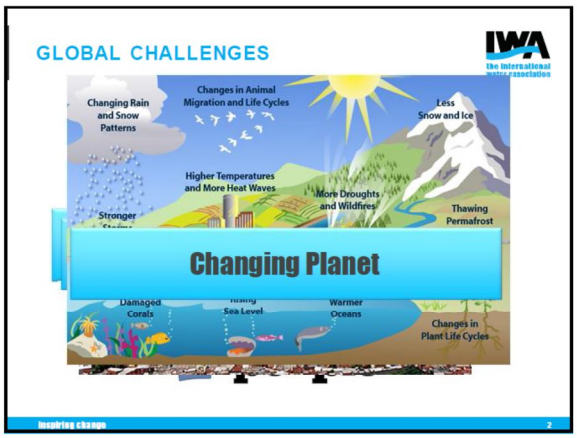
Many conferences take place every year on the subject of "*Water Security*". This one convened by the Club of Rome - India offers a valuable opportunity to probe the fundamental, root causes across disciplines and sectors, and find solutions that can be translated into policies in officialdom and action on the ground, in order to enable the country to eliminate thirst and the need for clean water, within a very short time.

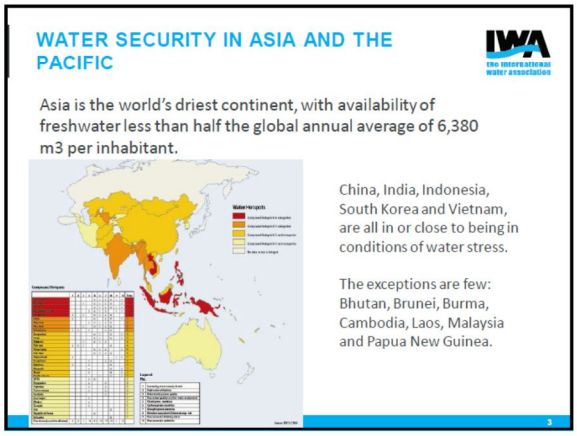
APPENDIX

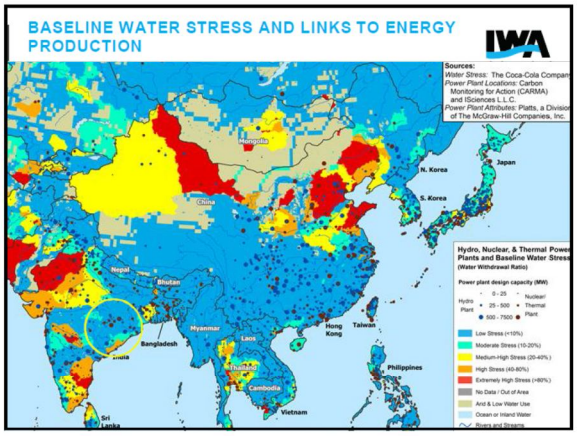
1. Ms. Katharine Cross, Program Coordinator, International Water Association
2. Dr. John Todd, John Todd Ecological Design Systems
3. Dr. Anupam Saraph, Professor, Systems and Decision Sciences, Lally School of Management and Technology
4. Dr. S.P. Sharma, Ministry of Water Resources
5. Mr. A. Ravindra, Director, Watershed Support Services and Activities Network (WASSAN), Hyderabad
6. Mr. A.R. Shivakumar, Scientist, Senior Fellow, Indian Institute of Science (IISc), Bangalore

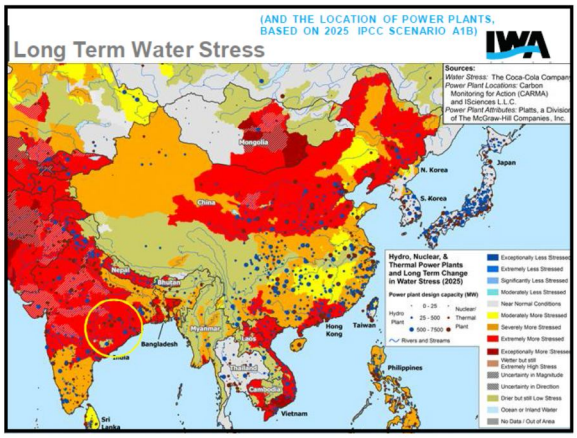
APPENDIX I

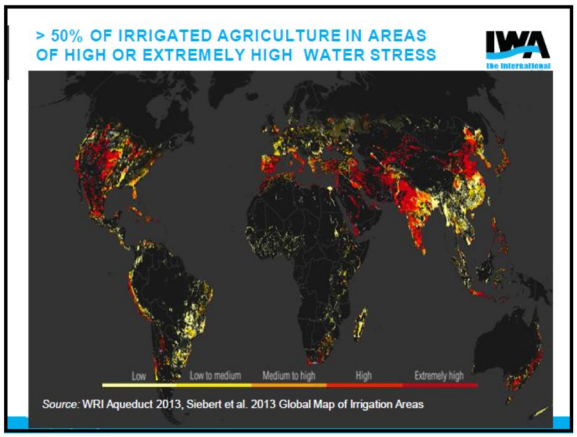

IWA
the international water association
Securing Water for All
MS. KATHARINE CROSS, PROGRAM COORDINATOR,
INTERNATIONAL WATER ASSOCIATION
WATER & DEVELOPMENT CONGRESS
OCTOBER 19TH, 2015
inspiring change

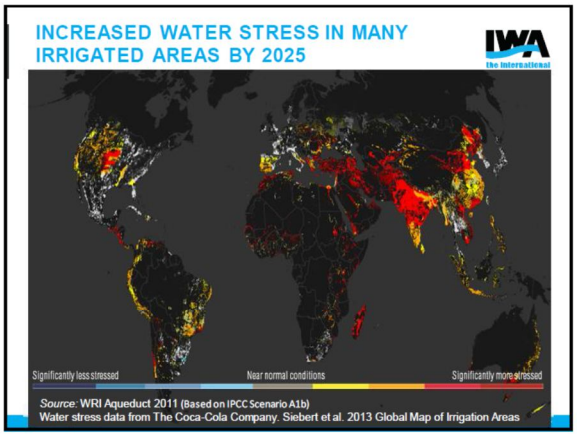

GLOBAL CHALLENGES
IWA
the international water association
Changing Rain and Snow Patterns
Changes in Animal Migration and Life Cycles
Less Snow and Ice
Higher Temperatures and More Heat Waves
More Droughts and Wildfires
Stronger
Thawing Permafrost
Changing Planet
Damaged Corals
Rising Sea Level
Warmer Oceans
Changes in Plant Life Cycles
Inspiring change
2

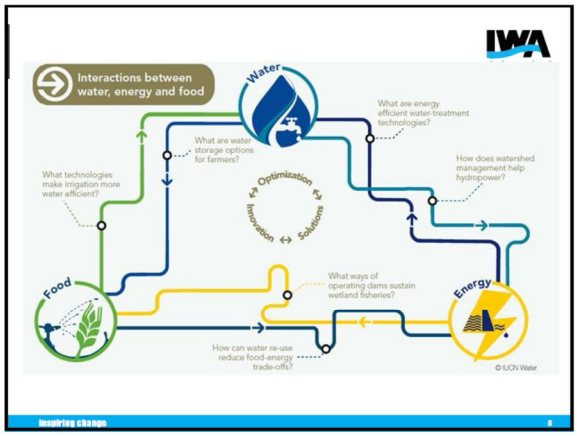

WATER SECURITY IN ASIA AND THE PACIFIC
IWA
the international water association
Asia is the world's driest continent, with availability of freshwater less than half the global annual average of 6,380 m3 per inhabitant.
China, India, Indonesia, South Korea and Vietnam, are all in or close to being in conditions of water stress.
The exceptions are few: Bhutan, Brunei, Burma, Cambodia, Laos, Malaysia and Papua New Guinea.
3

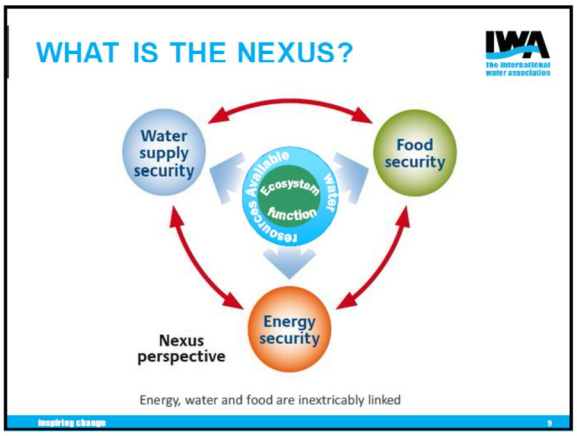

BASELINE WATER STRESS AND LINKS TO ENERGY PRODUCTION
IWA
Sources:
Water Stress: The Coca-Cola Company
Power Plant Locations: Carbon Monitoring for Action (CARMA) and ISciences L.L.C.
Power Plant Attributes: Platts, a Division of The McGraw-Hill Companies, Inc.
Mongolia
China
N. Korea
S. Korea
Japan
Nepal
Bhutan
Bangladesh
Myanmar
Laos
Thailand
Cambodia
Vietnam
Hong Kong
Taiwan
Philippines
Sri Lanka
Hydro, Nuclear, & Thermal Power Plants and Baseline Water Stress (Water Withdrawal Ratio)
Power plant design capacity (MW)
Hydro Plant
Nuclear Plant
Thermal Plant
Low Stress (<10%)
Moderate Stress (10-20%)
Medium-High Stress (20-40%)
High Stress (40-80%)
Extremely High Stress (>80%)
No Data / Out of Area
Arid & Low Water Use
Ocean or Inland Water
Rivers and Streams


(AND THE LOCATION OF POWER PLANTS, BASED ON 2025 IPCC SCENARIO A1B)
Long Term Water Stress
IWA
Sources:
Water Stress: The Coca-Cola Company
Power Plant Locations: Carbon Monitoring for Action (CARMA) and ISciences L.L.C.
Power Plant Attributes: Platts, a Division of The McGraw-Hill Companies, Inc.
Mongolia
China
N. Korea
S. Korea
Japan
Nepal
Bhutan
Bangladesh
Myanmar
Laos
Thailand
Cambodia
Vietnam
Hong Kong
Taiwan
Philippines
Sri Lanka
Hydro, Nuclear, & Thermal Power Plants and Long Term Change in Water Stress (2025)
Power plant design capacity (MW)
Hydro Plant
Nuclear Plant
Thermal Plant
Rivers and Streams
Exceptionally Less Stressed
Extremely Less Stressed
Significantly Less Stressed
Moderately Less Stressed
Near Normal Conditions
Moderately More Stressed
Severely More Stressed
Extremely More Stressed
Exceptionally More Stressed
Water but still Extremely High Stress
Uncertainty in Magnitude
Uncertainty in Direction
Drier but still Low Stress
Ocean or Inland Water
No Data / Out of Area

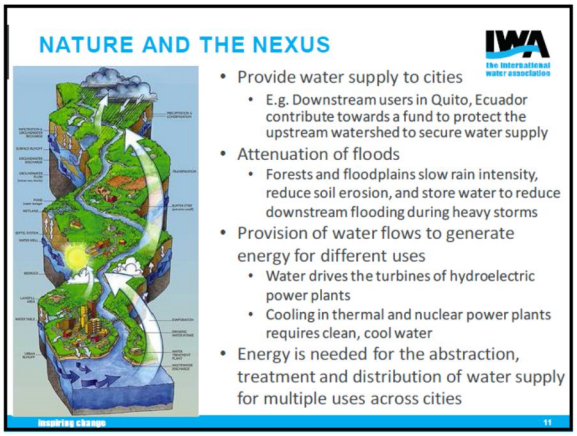

> 50% OF IRRIGATED AGRICULTURE IN AREAS OF HIGH OR EXTREMELY HIGH WATER STRESS
IWA
the international
Low
Low to medium
Medium to high
High
Extremely high
Source: WRI Aqueduct 2013, Siebert et al. 2013 Global Map of Irrigation Areas

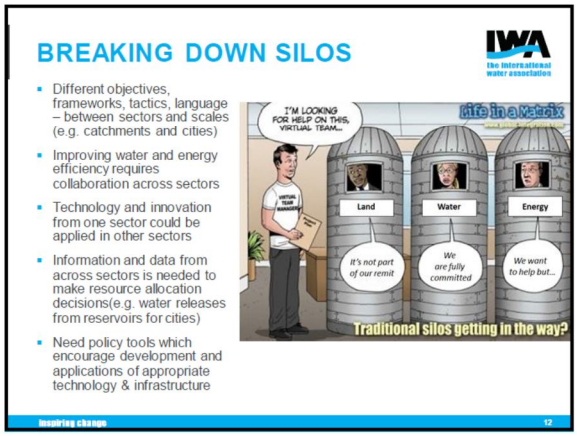

INCREASED WATER STRESS IN MANY IRRIGATED AREAS BY 2025
Significantly less stressed
Near normal conditions
Significantly more stressed
Source: WRI Aqueduct 2011 (Based on IPCC Scenario A1b)
Water stress data from The Coca-Cola Company. Siebert et al. 2013 Global Map of Irrigation Areas


Interactions between water, energy and food
Water
Food
Energy
Optimization
Innovation
Solutions
What are energy efficient water-treatment technologies?
What are water storage options for farmers?
How does watershed management help hydropower?
What technologies make irrigation more water efficient?
What ways of operating dams sustain wetland fisheries?
How can water re-use reduce food-energy trade-offs?
© IUCN Water

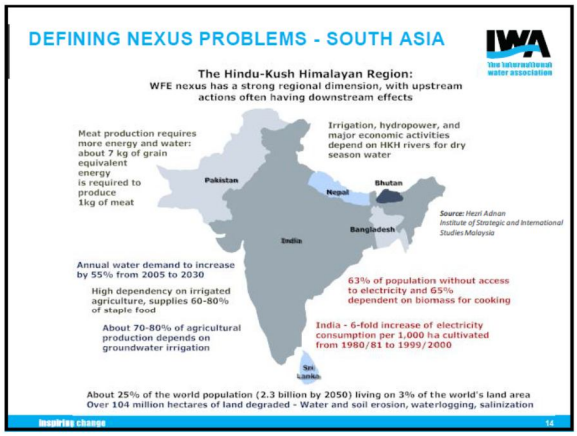

WHAT IS THE NEXUS?
Water supply security
Food security
Energy security
Ecosystem function
Available water
Resources
Nexus perspective
Energy, water and food are inextricably linked

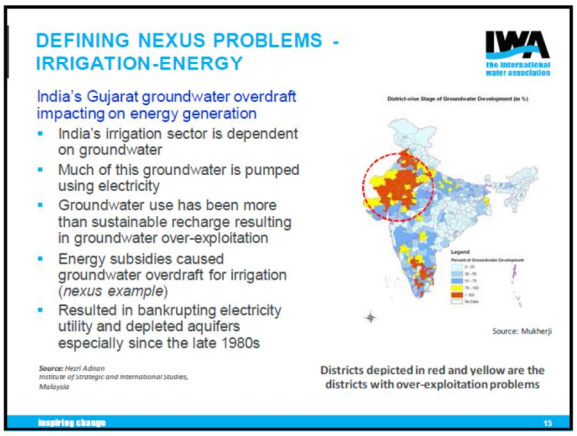

Private Sector
Public Sector
Civil Society
Social Impact
Food
Energy

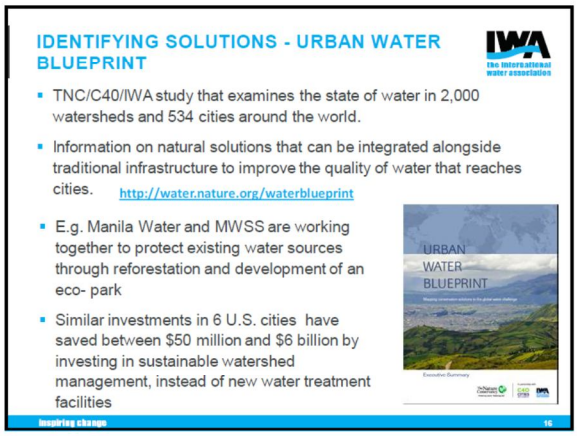

NATURE AND THE NEXUS
Provide water supply to cities
E.g. Downstream users in Quito, Ecuador contribute towards a fund to protect the upstream watershed to secure water supply
Attenuation of floods
Forests and floodplains slow rain intensity, reduce soil erosion, and store water to reduce downstream flooding during heavy storms
Provision of water flows to generate energy for different uses
Water drives the turbines of hydroelectric power plants
Cooling in thermal and nuclear power plants requires clean, cool water
Energy is needed for the abstraction, treatment and distribution of water supply for multiple uses across cities

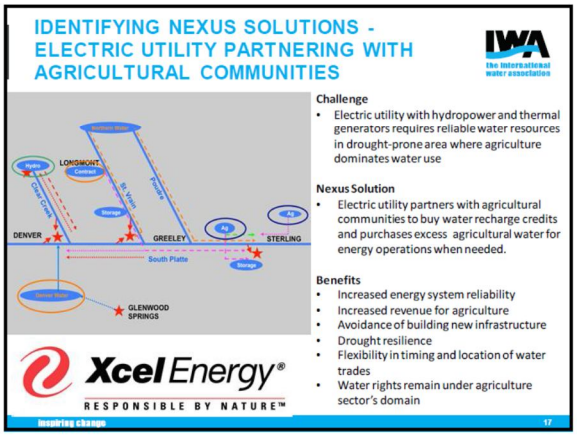

BREAKING DOWN SILOS
Different objectives, frameworks, tactics, language – between sectors and scales (e.g. catchments and cities)
Improving water and energy efficiency requires collaboration across sectors
Technology and innovation from one sector could be applied in other sectors
Information and data from across sectors is needed to make resource allocation decisions(e.g. water releases from reservoirs for cities)
Need policy tools which encourage development and applications of appropriate technology & infrastructure
I'M LOOKING FOR HELP ON THIS, VIRTUAL TEAM...
life in a Matrix
Land
Water
Energy
It's not part of our remit
We are fully committed
We want to help but...
Traditional silos getting in the way?

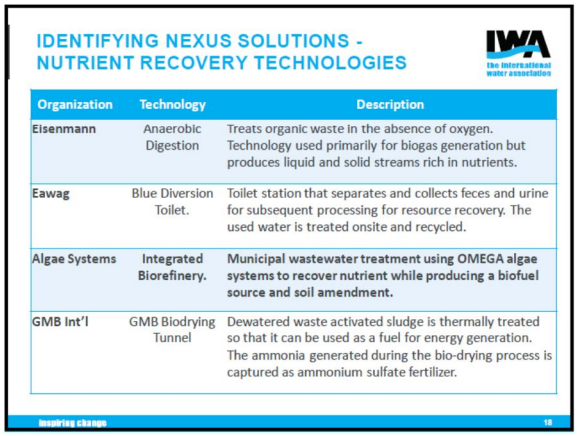

NEXUS @ FOREFRONT OF POLICY & SCIENTIFIC DEBATE
the international water association
WORLD ECONOMIC FORUM
Global Risks 2011
ReSource
Rethink. Reform. Renew.
Water, Food, and Energy Nexus: Why Mountains Matter
Mekong Forum on Water, Food and Energy
SOUTH AFRICAN WATER ENERGY & FOOD FORUM
WATER SECURITY
The Global Resource Nexus
2012 Collaborative Report
THE RACE FOR WHAT'S LEFT
Putting Nature in the Nexus:
13
Inspiring change
13


DEFINING NEXUS PROBLEMS - SOUTH ASIA
the international water association
The Hindu-Kush Himalayan Region:
WFE nexus has a strong regional dimension, with upstream actions often having downstream effects
Meat production requires more energy and water: about 7 kg of grain equivalent energy is required to produce 1kg of meat
Irrigation, hydropower, and major economic activities depend on HKH rivers for dry season water
Pakistan
Nepal
Bhutan
India
Bangladesh
Source: Hezri Adnan Institute of Strategic and International Studies Malaysia
Annual water demand to increase by 55% from 2005 to 2030
High dependency on irrigated agriculture, supplies 60-80% of staple food
About 70-80% of agricultural production depends on groundwater irrigation
63% of population without access to electricity and 65% dependent on biomass for cooking
India - 6-fold increase of electricity consumption per 1,000 ha cultivated from 1980/81 to 1999/2000
Sri Lanka
About 25% of the world population (2.3 billion by 2050) living on 3% of the world's land area
Over 104 million hectares of land degraded - Water and soil erosion, waterlogging, salinization
Inspiring change
14

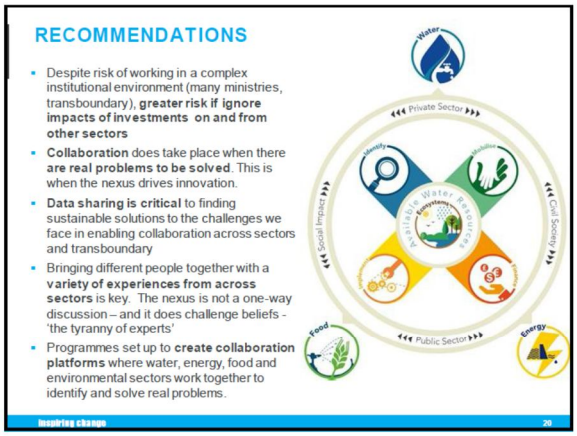

DEFINING NEXUS PROBLEMS - IRRIGATION-ENERGY
the international water association
India's Gujarat groundwater overdraft impacting on energy generation
India's irrigation sector is dependent on groundwater
Much of this groundwater is pumped using electricity
Groundwater use has been more than sustainable recharge resulting in groundwater over-exploitation
Energy subsidies caused groundwater overdraft for irrigation (nexus example)
Resulted in bankrupting electricity utility and depleted aquifers especially since the late 1980s
Source: Hezri Adnan Institute of Strategic and International Studies, Malaysia
Source: Mukherji
Districts depicted in red and yellow are the districts with over-exploitation problems
Inspiring change
15


IDENTIFYING SOLUTIONS - URBAN WATER BLUEPRINT
the international water association
TNC/C40/IWA study that examines the state of water in 2,000 watersheds and 534 cities around the world.
Information on natural solutions that can be integrated alongside traditional infrastructure to improve the quality of water that reaches cities.
http://water.nature.org/waterblueprint
E.g. Manila Water and MWSS are working together to protect existing water sources through reforestation and development of an eco- park
Similar investments in 6 U.S. cities have saved between $50 million and $6 billion by investing in sustainable watershed management, instead of new water treatment facilities
URBAN WATER BLUEPRINT
Inspiring change
16


IDENTIFYING NEXUS SOLUTIONS - ELECTRIC UTILITY PARTNERING WITH AGRICULTURAL COMMUNITIES
the international water association
LONGMONT
DENVER
GREELEY
STERLING
GLENWOOD SPRINGS
South Platte
Challenge
Electric utility with hydropower and thermal generators requires reliable water resources in drought-prone area where agriculture dominates water use
Nexus Solution
Electric utility partners with agricultural communities to buy water recharge credits and purchases excess agricultural water for energy operations when needed.
Benefits
Increased energy system reliability
Increased revenue for agriculture
Avoidance of building new infrastructure
Drought resilience
Flexibility in timing and location of water trades
Water rights remain under agriculture sector's domain
Xcel Energy®
RESPONSIBLE BY NATURE™
Inspiring change
17


IDENTIFYING NEXUS SOLUTIONS - NUTRIENT RECOVERY TECHNOLOGIES
the international water association
Organization | Technology | Description
Eisenmann | Anaerobic Digestion | Treats organic waste in the absence of oxygen. Technology used primarily for biogas generation but produces liquid and solid streams rich in nutrients.
Eawag | Blue Diversion Toilet. | Toilet station that separates and collects feces and urine for subsequent processing for resource recovery. The used water is treated onsite and recycled.
Algae Systems | Integrated Biorefinery. | Municipal wastewater treatment using OMEGA algae systems to recover nutrient while producing a biofuel source and soil amendment.
GMB Int'l | GMB Biodrying Tunnel | Dewatered waste activated sludge is thermally treated so that it can be used as a fuel for energy generation. The ammonia generated during the bio-drying process is captured as ammonium sulfate fertilizer.
Inspiring change
18


DIALOGUE SYNTHESIS PAPERS
IWA
the international water association
Title
Clean technology for nexus infrastructure solutions
Water stewardship and corporate engagement in the nexus
Influencing pathways of investment for the nexus
Natural Infrastructure in the Nexus
Governance of the Nexus
Connecting Water Across the Nexus: Learning from the Global Dialogue
Natural Infrastructure in the Nexus
Inspiring change
19


RECOMMENDATIONS
Despite risk of working in a complex institutional environment (many ministries, transboundary), greater risk if ignore impacts of investments on and from other sectors
Collaboration does take place when there are real problems to be solved. This is when the nexus drives innovation.
Data sharing is critical to finding sustainable solutions to the challenges we face in enabling collaboration across sectors and transboundary
Bringing different people together with a variety of experiences from across sectors is key. The nexus is not a one-way discussion – and it does challenge beliefs - 'the tyranny of experts'
Programmes set up to create collaboration platforms where water, energy, food and environmental sectors work together to identify and solve real problems.
Water
Private Sector
Civil Society
Public Sector
Food
Energy
Inspiring change
20


Thank you!
More information:
www.waternexussolutions.org
Inspiring change

APPENDIX II

The Dream of Healing Polluted Streams and Rivers

By John Todd

As a young boy I walked several miles to and from school. For me the journey was better than the schooling. My route followed one or other of two streams that ran parallel to each other. They both flowed into Hamilton Bay at the very western end of Lake Ontario. One of the streams discharged a quarter mile east of our family's house on the water, while the other entered the bay, equidistance to the west.

The mouth of the eastern branch was a cattail marsh with channels that meandered through the maze of tall plants. Heading inland the stream passed through a culvert under a shore road then climbed slowly into rolling hills. The stream defined the western boundary of a golf course. Trees were sparse. The stream became a brook and diminished as it entered a canyon that led to a bluff from which the stream originated. Up on the bluff the land was flat and there were intensely managed market farms with a number of greenhouses. The fields and service lanes shaped my course as I crossed the fields to the main road that linked the city of Hamilton with Burlington, then a town. My schoolhouse was located on the far side of the road on the edge of a suburban area.

The stream to the west was completely different. Its discharge was measured and steady. It passed through a marsh and bog complex and then meandered in dark shade up a narrow canyon with steep slopes until it reached the base of the bluff. Skunk cabbage, Jack-in-the Pulpits and marsh marigolds were well established along the lower reaches. The slopes were heavily wooded and the stream's origins were a series of springs. Watercress was abundant. On top of the bluff was an agricultural area, mostly orchards including cherries and peaches. Further inland, beyond my school the orchards on the limestone escarpment were mostly apples.

My choice of routes to school was to a large degree determined by whim and time. The eastern or golf course route was a few minutes faster. As I got to know the streams I began to see them as having very different "personalities". In anthropomorphic terms the eastern stream was violent and erratic. It was prone to flooding and drying up. It was dirty and filled with silt. Apart from spawning carp in the lowest reaches there were no fishes and bottom life seemed nonexistent. No snails, frogs or caddis fly larvae resided there. I spent hours looking and waiting for minnows to appear. But they never did.

The western stream, despite being comparably sized and in the same watershed had a polar opposite nature. It flowed steadily through wet years and dry. Its waters were crystal clear and its temperature remained steady. It was characterized by dappled light, deep shadows and organic odors that I still can smell to this day well over half a century later. The big hardwood trees and understory plants imparted in me a sense of jungle like bounty. And best of all, the stream hosted many creatures that I came to know. Most remarkable to my ten and eleven year old self was the spawning of the fish in the spring. Just after the flowering of the marsh marigolds, suckers, a fish with a big somewhat ugly looking sucker mouth entered the stream in large numbers. Suckers are distantly related to the minnow family, although they are classified in their own family Catostomidae. They moved upstream into the darkest reaches and thrashed about in a sexual orgy. They remained oblivious to my wading amongst them.

More than anything it was vitality of the place that attracted me. There was an essential aliveness that in later years I began to understand. The western stream and its valley, despite its modest size, was an intact ecology. What existed there were the remnants of the wild. The place spoke to me. The other stream was neither wild nor a whole ecosystem. The deforested landscape could no longer absorb and hold water from the rains, the soils had washed away and the springs had died. There was an elemental sadness about the stream. Its "moods" were a reflection of exploitation, followed by neglect and then decline. The golf course for me became a symbol of the theft of wildness.

A few years later, my father sensing my deep unhappiness at being surrounded by so much development and biological destruction, found for me a series of books that changed my life. They were Louis Bromfield's Malabar Farm books. It was the story of his return to Ohio from Europe at the outbreak of World War II and his settling on a worn out agricultural landscape. Using ecological methods, combined with farming practices learned from French peasant farmers, he transformed, in just over fifteen years, the hilly landscape into a bountiful Eden. I was mesmerized by his ability to build the equivalent of hundreds of years of top soil within decades. His integration of animals with plants seemed quite revolutionary. What struck me as miraculous were his tales of the return of the springs. These were springs that years before had dried up following the abuse of the woods and the overgrazing of the fields. What Bromfield taught me became my greatest lesson and my most enduring gift. **At thirteen I learned from him the fact that ruined lands can be restored.** I discovered that in the teachings of ecology lie the foundations for healing, not just individual landscapes, but possibly the whole world.

Ecological wisdom is the reading of life connected to life across great spans of evolutionary time. It is about complex relationships between species and their environments, and it is about self-organization, self-design and self-repair. It includes the perpetuation of diverse systems that are constantly co-evolving. It is an elusive dance that one can sense but never fully understand. Nevertheless it is real.

Ecological scientists are chronicling the declining fabric of the earth. The term they use for it is trophic downgrading (J.A. Estes et al; Trophic Downgrading of Planet Earth. SCIENCE VOL 333, 15 July 2011). Trophic downgrading is a fancy term for the elimination of essential species, species that provide the "management" for large and complex ecosystems. Our planet is currently undergoing a mass extinction caused to a large degree by a single species, Homo sapiens, namely ourselves. With our insensitivity to the workings of nature we are pulling apart the earth's fabric through deforestation, extractive farming, industrialization and the wholesale slaughter of the iconic animals of both the land and the sea. Ecologists have discovered that the structures and organization of ecosystems are determined by a top-down control over life within. This is usually accomplished by the feeding of predatory animals that are at the top of the food chain. For example sea otters enhance and protect kelp abundance by feeding on kelp eating herbivorous sea urchins. When the sea otters are killed the kelp is overgrazed by the rising populations of sea urchins and subsequently disappear. Healthy kelp "forests" are a major sink for atmospheric carbon. In other worlds they help maintain an essential climate balance for the whole planet.

In cool region fresh water lakes, when largemouth bass are present, they increase water clarity by consuming smaller fish that feed upon tiny zooplankton that normally reduce algae in the water. When bass are removed from the system the small fish increase, the zoo plankton decrease and algae populations can explode, causing the lakes to seriously decline.

It has been found on coral reefs that the over fishing of sharks and large reef fishes causes a decline in healthy reef building corals and coralline algae. The presence of the alpha predators keeps the coral based community intact. There are many, many examples of trophic downgrading as a result of humans eliminating essential predators at the top of the food chain. The same phenomenon has been observed in terrestrial ecosystems. Wolves, for example, can control and reduce elk populations. Smaller numbers of elk result in less their being less browsing of shrubby plants. This can result in an explosion of scrubby vegetation on the landscape. Subsequently grasses decline and along with them many species of herbivores that graze on them.

Trophic downgrading has widespread ramifications beyond the loss of species and ecosystem structures. Wildfires become more common and there have been a number of links between the increase of diseases and the loss of top predators. Physical and chemical processes within ecosystems can be altered too. For example trophic cascading in lakes can shift them from being net sinks for atmospheric CO_2 to net sources of CO_2.

There are innumerable examples of the breakdown of ecologies around the world. Many have been ruined before they have been studied. The wholesale decline of streams and rivers represent a major case in point. Over the past century the rate of input onto the landscape of nitrogen, as just one example of a pollutant, has more than doubled. This has been mostly caused by fossil fuel combustion and agricultural fertilizers, as well as through the poor treatment of wastewaters.

Oxygen, essential to stream life, disappears within the streams as the result of excess nutrients disrupting the normal food chains. Bacteria and boom-and-bust algae cycles cause the normal biodiversity within the streams and rivers to disappear. Biodiversity and niche diversity are what keep normal streams healthy. By niche I mean the roll an organism plays within a community as well as the specific microhabitat that it inhabits. It has been shown that biodiversity and niche partitioning can improve water quality. It is done in part by a more efficient removal of nutrients and pollutants. (Cardinale, B.J. Biodiversity Improves Water Quality Through Niche Partitioning. NATURE VOL 472, 7 April 2011). This is an extremely important piece of information for restoration biologists. Creating and maintaining biodiversity and distinct niches can become a tool for ecosystem improvement. The question arises, how can this be done? Are there ways to ecologically engineer systems that might restore health to a stream that has been degraded through the loss of species as well as through the loss of habitat.

It has been argued that the only way to restore the stream is to get rid of the toxins, fertilizers and excess silt is through going upstream and stopping the offending practices at source. This is certainly true as far as it goes, but I long ago observed that in most instances around the world the task is close to impossible. In South Africa, a country where we work, the slums are often situated on the edge of streams. In these communities sewage often runs down the streets and along with the garbage ends up in the streams. The streams in this kind of situation do not have much of a chance to remain healthy and life within dies. I work on projects where we are trying to prevent slums from doing this, but the process is slow and there is not enough money for the task in most places.

There is an alternative approach, but it involves a course of action rarely taken. I am referring to the practice of directly intervening into a stream and introducing ecological technologies that might trigger and facilitate the internal healing of the stream ecosystem. In other words might we reverse trophic downgrading in streams and replace it with trophic upgrading and take steps to create habitats that critical species will find hospitable. Going one step further we should ask the question whether beneficial niche partitioning can be reintroduced into a body of water and then try and figure out how it might be done.

I don't have the answers to these questions, but I do have some potential solutions that should be tried based upon my experience designing and operating Eco-Machines. There are no doubts others and I hope these suggestions will lead to a proliferation of ecological intervention techniques for streams.

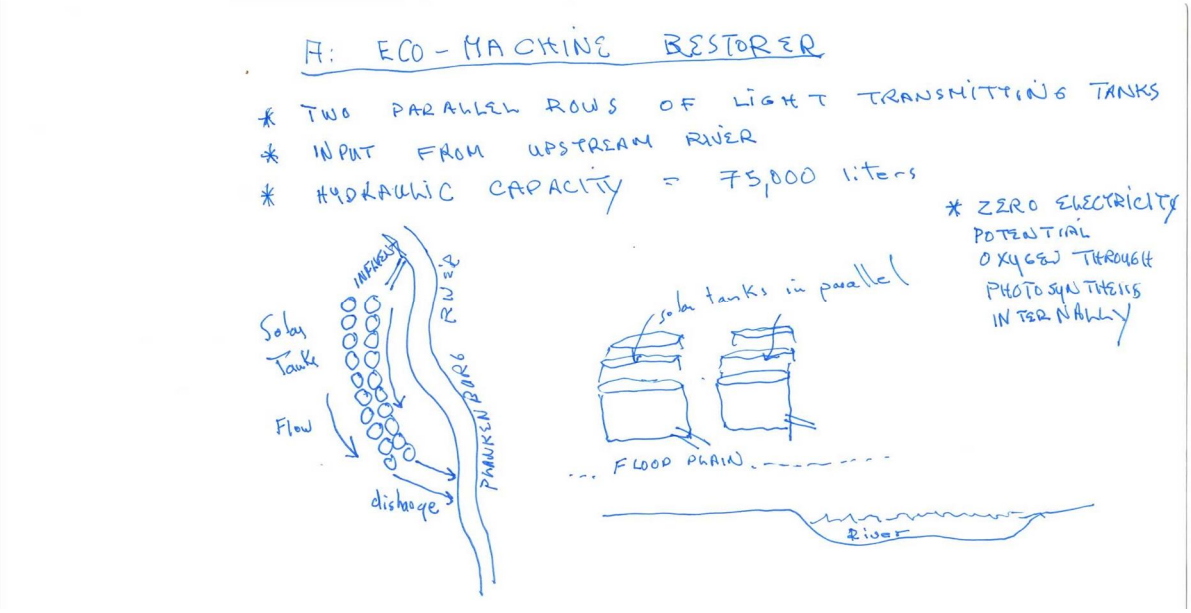
The first idea was: **A Concept 1, ECO-MACHINE SOLAR RESTORER**

Sunshine Powered Ecology for Fish and Algae Culture

Above the floodplain and parallel to the stream would be placed parallel rows of clear-sided tanks like the above. Light is transmitted into the interior and during daylight hours these systems can produce significant amounts of oxygen through photosynthesis by the micro-algae. The tanks are to be connected to each other with piping to form two parallel "streams" separated from the main body of the actual stream except at the input point upstream and the outlet point downstream.

Life within the tanks will constantly clean the water flowing through the system and by the end of the process the stream water will be clear and oxygen rich.

Clear Water at the Outfall



Sketch of the Eco-Machine Restorer Concept

One of the advantages of the system sketched above is that it can operate without electricity. Flow through the system is by gravity. The algae communities within the tanks produce oxygen during daylight hours. A disadvantage of the Eco-Machine Restorer at most locations would be that the facility would need some kind of fencing or protection from vandalism.

The Eco-Machine Restorer would require ecological elements to purify the water and they would tend to be different at various stages along the treatment process. Polluted water at the input end would be exposed to a unique guild of organisms for treatment. The first third of the tanks would house “artificial kelp” substrates, curtain-like structures made from a water absorbing media inoculated with bacteria and algae. These would be the system’s early stage workhouses.

The middle group of tanks would have floating racks where marsh plants and water loving plant species would be grown. Their roots would penetrate down into the water and provide surface areas necessary for diversifying the biological communities, including water filtering animal plankton and freshwater clams and mussels.

The final series of tanks would be seeded with stream species normally found in clean waters. This community would have fishes including a diversity of small species as well as top predators. These tanks would also be planted to raft-based higher plants on the surface, and could include riparian tree and shrub seedlings for subsequent stream bank restoration projects. One of the functions of the surface plantings would be to protect the fishes from bird predators such as kingfishers. I once had the misfortune of losing, within twenty-four hours, fifty young bowfin fish to kingfisher predation because the fish lacked protection from above.

Water leaving the Restorer and entering the stream would be clean and rich with a diverse biota. My hope here is that the there would be a zone of clean water in the stream and that this oxygen rich zone would slowly expand its influence as a result of the continuous seeding into the stream of beneficial organisms.

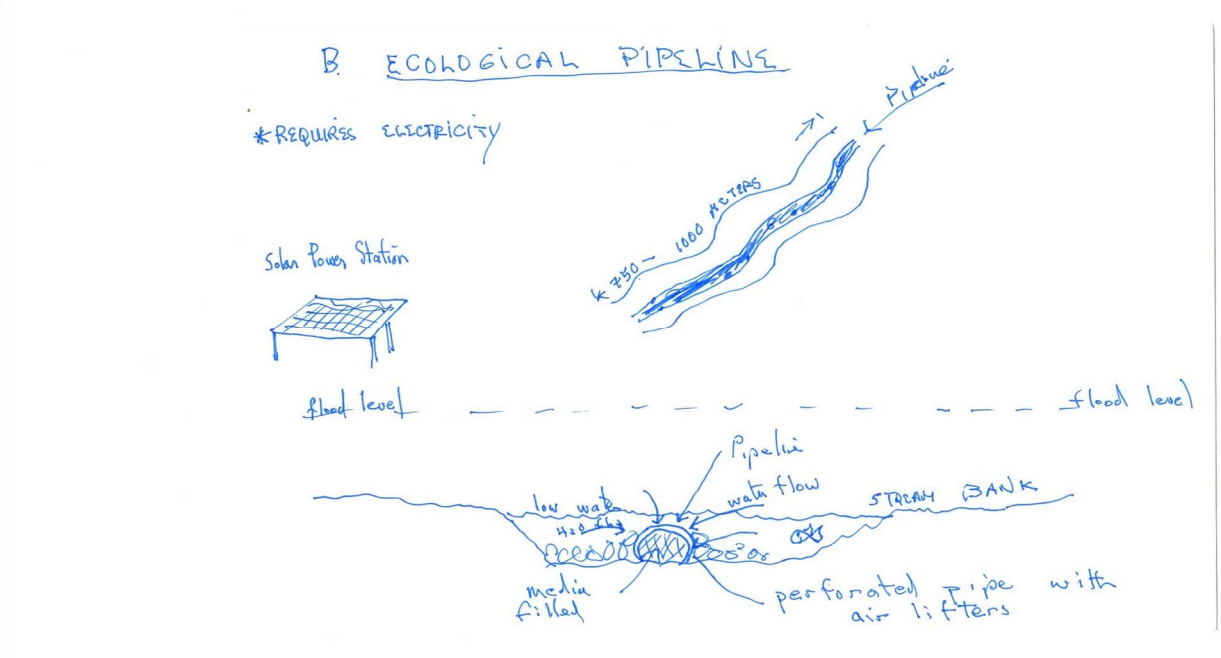
One of the great advantages of the Eco-Machine Restorer is that it would become a destination and a focal point for educational and stream clean up activities. Another advantage would be the visibility of many of the organisms. The public might come to appreciate the contributions of the different kingdoms of life in supporting stream health and healing.

B: Concept 2, an ECOLOGICAL PIPELINE

This concept involves a pipeline running along the bottom of a stream. The pipe would be perforated and filled with a course media. It would also be covered with gravel. Even at low water during the dry season the pipeline would be covered. Stream water would be aerated and circulated through the interior of the pipe and the surrounding gravel. The system would be “invisible” in so far as no physical structure would be obvious from the stream bank. The length of the prototype pipeline should be between one-quarter and one-half mile in length.

This concept has one drawback over the other schemes. It will require electricity to power the air compressor. I am proposingthat solar power should produce the electricity with the solar power station situated above the flood plane.

The function of the pipeline will be to filter the stream water and reduce the levels of pollutants in the water. The processes will be microbial with bacteria and possibly fungi playing dominant roles. However if water clarity is improved, as we hope, it will allow more light to penetrate the water thereby enhancing photosynthesis by attached algae, or algal-turf, communities. Should this take place the stream will experience a jump in biodiversity and support aquatic insects, snails and fishes.



A major technological challenge of this concept will revolve around water circulation through the media along the length of the pipe using airlift technologies. We have used a number of approaches over the years, but never quite in the way proposed here. A short segment model will have to be built and tested, initially in a tank or a shallow pool. One of the benefits of the Ecological Pipeline approach is the technology will be relatively immune to high water and even flooding conditions.

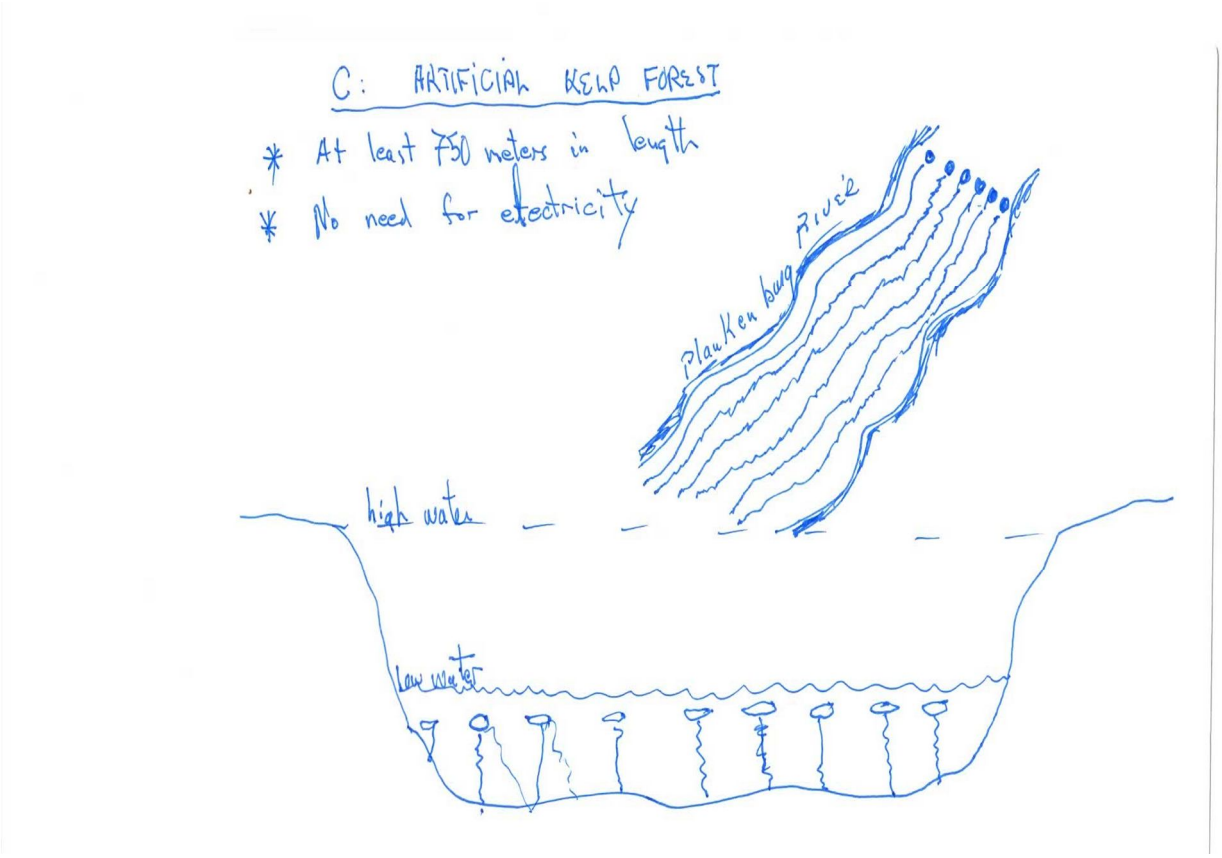
C: Concept 3, An ARTIFICIAL AQUA-FOREST

For years we have used artificial fabrics in water to provide surfaces for beneficial organisms that aid in the purification of waters. Incredible numbers of life forms can occupy somewhat restricted spaces with media present.

Attached Growth Media in Seawater

Close Up of Attached Community

The primary purpose of the Aqua- Forest concept is to insert into the stream environment biologically friendly surface areas on a large scale. This concept involves ribbon-like structures that are anchored on the bottom at the upstream end of the treatment area. They are no deeper than the shallowest zone of the stream during the dry season. The sketch below shows the general scheme.



This is the simplest of the schemes. It requires no electricity and apart from the anchors, no infrastructure beyond the media. In the past we have used non-woven fabrics of the sort often seen in car wash facilities. Some of the fabrics are quite “sticky” and optimal for the attachment of microbial and algae dominated communities. Another benefit of the Aqua-Forest approach is that it is easily scaled up and flexible enough to allow for a series of distinct sections along a river course with each section adjusted to the varying shapes and depths of the stream.

With the attached communities in place, the first benefit will be an increase in water clarity and a decrease in the pollution load, leading to an increase in life-giving oxygen levels. Although to my knowledge the concept has never been tried in a stream, an Aqua-Forest has the potential to develop a lot of water purification “horsepower” and be the foundation for expanding niche and species diversity appropriate to each stage.

All of these ideas need to be tried out ion a variety of streams with a variety of pollution problems. They can all best tested throughout the world. In countries like Mexico and India most streams are to all intents and purposes are conduits for waste streams and no longer live streams. Maybe these ecological engineering ideas can become viable by making streams healthy, bountiful and beautiful again.

APPENDIX III

Saving India's Rivers

Dr. Anupam Saraph, Ph.D.
Professor, Systems and Decision Sciences,
Lally School of Management and Technology

The Science

- Most small streams contribute to preserving the flows in a river
- Small streams flow when saturated sub-surface flows release excess water
- Draughts prevented when sub-surface flows are protected
- Sub-surface flows are protected when sand preserved and vegetation in streams is not removed
- Draughts happen when small streams are destroyed
- Floods happen when small streams disappear and cannot buffer release of water into rivers
- Floods are prevented when trees and vegetation in small streams buffers streams discharge rate
- Pollutants in small streams pollute groundwater and rivers

The Actions Needed

- Declare all small streams as protected and reserved
- Allow natural vegetation to grow along small streams
- Undertake afforestation along stream banks to protect strems
- Ensure encroachment from small streams is removed
- Ensure small streams are not "cleaned" of sand and vegetation
- Map small streams and list them
- Ensure no discharge of any effluents into small streams
- Build small bunds to allow the flow in small streams slow and recharge the sub-surface and ground

The Mission

To protect every small stream

The Goals

- List and map all small streams
- Declare all small streams as protected and reserved
- Remove all encroachments
- Remove effluent pipes and discharges from small streams
- Afforest small stream banks
- Publish state of the small streams report
- Pass the Right to Water Security Act in each State and Right to River Conservation Act in the Centre

Framework for a Law for Conservation of Rivers and Water Security

Dr. Anupam Saraph, Ph.D.
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state of our rivers

- 6 decades of self-rule, 676 districts
- almost all pristine waterbodies destroyed
- not one district with waterbodies that are not encroached, polluted or exploited
- government itself has projects to build roads in rivers, lay sewers in rivers, even buildings in rivers
- rivers have become sewers

database of rivers

- no government department has maps of all major and minor rivers or even a list of them
- no government department explicitly charged to list or protect rivers
- no account of perennial streams going seasonal
- no record of draughts or floods associated with loss of streams

why save our rivers?

- droughts and floods
- climate change
- water security
- food security
- biodiversity

do our rivers matter?

- Article 51A(g) of the Constitution: "it is the fundamental duty of every Indian to to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures"

do our rivers matter?

- Article 262(1) of the Constitution: "the Parliament to make law to adjudicate dispute or complaint with respect to the use, distribution or control of the waters of, or in, any inter-State river or river valley in accordance with entry 56 on Union List in the Seventh Schedule allowing for the regulation and development of inter-State rivers and river valleys"

do our rivers matter?

- Article 257 of the Constitution: merely treats rivers as waterways and permits the Union Government to use them as a means of communication as part of its functions with respect to naval, military and air force works in accordance with entry 24 on the Union List in the Seventh Schedule allowing shipping and navigation on inland waterways, declared by Parliament by law to be national waterways, as regards mechanically propelled vessels

do our rivers matter?

- Entry 13 in the State List in the Seventh Schedule allows state governments to legislate on communications, that is to say, roads, bridges, ferries, and other means of communication not specified in List I subject to the provisions in the Union and Concurrent List.

do our rivers matter?

- Entry 17 in the State List in the Seventh Schedule permits State governments to deal with water supplies, irrigation and canals, drainage and embankments, water storage and water power subject to the provisions of entry 56 of List I

do our rivers matter?

- Entry 3 in the Eleventh Schedule provides power and responsibility to panchayats to undertake minor irrigation, water management and watershed development.

do our rivers matter?

- Entry 5 in the Twelfth Schedule provides the power and responsibility to Municipalities to ensure water supply for domestic, industrial and commercial purposes

do our rivers matter?

- Article 243ZD (3) (a) (i) of the Constitution requires a District Planning Committee to consolidate the plans prepared by panchayats and Municipalities in the district and prepare a development plan for the district as a whole and have regard to matters of common interest between the Panchayats and the Municipalities including spatial planning, sharing of water and other physical and natural resources, the integrated development of infrastructure and environmental conservation

do our rivers matter?

- Madras River Conservancy Act 1884 provides powers to a Conservator of Rivers to survey and prohibit certain activities like cultivation

purpose of a new act

- purpose to protect and conserve rivers

powers required to accomplish the purpose

- empower local bodies as implied in the 11th and 12th schedule of the constitution to enable area sabhas or river panchayats
- empower area-sabhas or river panchayats to protect local parts of river
- empower river parliaments to protect entire river

empowering local bodies

- list and publish maps of all water bodies
- reserve and protect all water bodies
- prohibit the growth of the water block beyond its water carrying capacity, and its natural capacity to absorb pollution free effluents from treatment processes or plants
- undertake and publish an social audit of all water bodies
- report on all action taken to free water bodies from violations, aggression, pollution or exploitation within each water block

empowering river panchayat

- powers to ensure the biological, ecological and hydrological integrity of the waterbody
- resolutions of the Panchayat on ensuring the integrity of the waterbody must be binding on the Local Authority
- ensure that no person is deprived of water access or permitted any privilege beyond that permissible
- maintain a record of the users with access to the waterbody and any complaints received about access or other violations
- maintain a record of the water withdrawal rate by the block
- audit that documents the aggression on the waterbody and waterfront, the pollution through any discharge into the waterbody and restrictions, if any, on drawing water, flora or fauna from the waterbody

empowering the parliament

- represent each Water Block of the waterbody and exercise all such powers to maintain the biological, ecological and hydrological integrity of the watercourse
- prohibit all activity that alters the natural flow or poses any threat to the biological, ecological or hydrological integrity of any waterbody or be an aquifer interference activity
- ensure water bodies are able to flow naturally, unconstrained and without pollution, building walls, fences, barricades, channels, buildings, sheds of temporary or permanent nature within any water body or waterfront must be prohibited
- laying pipes, cables, or any other construction in any water body or waterfront, undertaking industrial activities, intensive farming, mining, dumping, or roads must be prohibited; as must the release any substances, sewage, sullage, and effluents that contaminate any waterbody.

safe activities

- rainwater release into water bodies or waterfronts provided it is released through open streams
- conservation activities and afforestation with indigenous trees on waterfronts where no trees exist
- seasonal fishing and organic farming
- sustainable withdrawal for each water block

unsafe activities

- construction, laying pipes or cables
- dumping, storage, mining
- industrial activities
- release of effluents
- activities that threaten the biological, ecological or hydrological integrity

draft acts to enable purpose

- union framework act for conservation of rivers
- state act for water security

APPENDIX IV

Climate Change Adaptation for food and Water Security

Dr. S.P. Sharma,
Ministry of Water Resources

Present Scenario

- Successive droughts, sudden heavy rainfall resulting in floods in Uttarakhand and in Srinagar, J &K, cyclones in Odisha in last two years;
- Unprecedented heavy unseasonal rains during winter last year;
- Regional Imbalance in water supply-demand;
- Greater regional imbalance in rainfall pattern in last decade vis-à-vis demand;
- Worsening economic conditions of farmers.

Likely future situation

- Possibility of floods due to sudden very heavy rains, more ice melt on hills and unseasonal rains;
- Presently maintained high level of food grain stocks may not continue for long due to Food Security Act;
- Serious imbalance in supply-demand in pulses, oilseeds, onion, and sugar;
- Uncertain position of production of cotton, Onion, pulses, oilseeds and sugarcane due to uncertainty about monsoon.

Demographic situation

- Likely to be higher rate of urbanisation, migration in future due to high rate of unemployment;
- More congestion in metro cities and shortage of water, affordable housing and increasing pollution due to growing number of cars, transportation bottlenecks;
- Crime situation may worsen due to likely high rate of unemployment in urban areas and condition of farmers becoming more sensitive;
- Pressure on land, water may be more with high migration rate across states, regions.

Socio-economic Situation

- Rising consumer inflation of food products in spite of decline in whole sale prices index;
- Growing unemployment in view of less employment elasticity of large industry and modern service sectors;
- In-effective Agri.-insurance due to inadequate Agri.– Statistics with less focus by state machinery;
- Pitiable condition of small, marginal and tenant farmers due to lack of access to institutional credit improved seeds, and other inputs to tenant and smaller, marginal farmers;
- Uncertain climate, less public investment in Agriculture;
- Receding ground water level due to overexploitation and poor water quality in some regions.

Present consumption scenario

- Growing regional, inter-group in-equality in income and consumption;
- Large variety of consumption items in the market;
- Growing wastage of food, clothing, footwear, plastic and increased packaging , transportation due to high concentration of manufacturing;
- Generation of large amount of garbage leading to pollution, degradation of land, water and air;
- High sugar and oil contents in manufactured processed food and snacks leading to health hazard.

Suggestions for policy change

Water management:

1. Banning flood irrigation gradually and replace it with surface piped irrigation and by promoting micro-irrigation with investment, subsidy on drip and sprinklers systems;
2. Effectively promoting co-operative, integrated irrigation and higher public investment in minor irrigation;
3. Change in Crop rotation in North-western India, especially in Punjab, Haryana;
4. Promoting organic farming and farming of pulses and oilseeds with special incentives in central India having less area under irrigation at present;
5. Improving Water use efficiency and optimum pricing of water and electricity used for irrigation.

Suggestions for policy change

Agriculture:

1. Creation of Tractor pools for hire in villages for small and marginal farmers;
2. Installation of Minor Irrigation schemes in Public Sector in co-operative framework in regions with higher share of very small holdings to be operated through Water Users' Associations;
3. Making Agri-insurance more effective with use of small area estimation as suggested by IASRI and making it beneficial to all farmers;
4. Strengthening Agri-Statistics by totally overhauling the system by giving these activities to Statistical personnel taken on contract basis at village panchayat level;
5. Improving Agri. Extension with more emphasis on appropriate crops as per climatic, soil and other conditions in the concerned regions.

Suggestions for policy change

Farmers' Welfare:

1. On the pattern of export credit, the suppliers of desired agri. Products may be given cards with proportionate amounts to be encashed in Rly. travel, purchase of mfd. Products from Khadi, Kendriya Bhandars, departmental stores purchase of medicines, charges of pathological tests etc.
2. Giving implicit incentives like school/college fees reimbursement, cash reimbursement on loans for inputs, subsidy on house construction and grants for marriage of daughters to farmers of essential commodities like food grains including pulses, oilseeds;
3. Establishing Animal Hostels in every Panchayat over a period of time as well as in surrounding areas of towns for effective development of Animal Husbandry and dairying on Gujarat Model;

Suggestions for policy change

Farmers' Welfare-contd.

4. Promotion of micro-financing to small and marginal farmers without any land mortgage through Mudra Bank and Self Help Groups;
5. Development of MSME clusters for every block based on local agri. Production;
6. Setting up of residential Kendriya Vidyalayas especially for children of farmers in every development block in the country (around 7000) in phases;
7. Setting up of Modernised Primary Health Centres with all Pathological facilities in every Block near KVs;
8. Setting up of Vocational Colleges as per the local needs in every district.

Suggestions for policy change

- **Food Management**

1. Regulating wastage of food in hotels, hostels, parties and public functions by appropriate publicity;
2. Introducing protocols for transfer of surplus food to animal shelters, night shelters for homeless, orphanages, gaushalas;
3. Introducing incentives for saving of food and minimising wastages of food and food grains;
4. Taking help of religious preachers and institutions for persuading people to reduce large scale food serving and hosting of lavish parties.

Research & Development

- There is need to develop drought resistant varieties of crops for rain fed regions;
- More emphasis on crop mixing, multi-cropping and crop rotation need to be given in Agriculture;
- There is need of estimation of crop-wise water foot print for advising states to optimise area under different crops as per soil, and water conditions;
- There is also need of region-wise research for increasing water use efficiency by identifying appropriate varieties of crops as per water availability.

Recommendations

- Regular and effective co-ordination among Ministries of Agriculture, Water Resources, Rural Development, and Environment, Forests may be ensured;
- Inter-linking of rivers to be prioritised and sincere efforts for water conservation should be made in mission mode;
- Water shed development with focus on creating more water bodies, reviving those defunct and subsidising, promoting public investment in surface minor irrigation;
- Developing MSME linkage with rural areas with higher priority to Cotton ginning, Oil and Dal milling, co-operative Animal Husbandry, Dairy reserved for SSI sector;

Recommendations

- Effective Implementation of giving MSP for all major crops and supply by PDS for all Food grains, Oils, Pulses, Sugar to the BPL and to the farmers;
- Providing other incentives rather than price to farmers and taking care of their other economic needs, e.g. higher education of children, health, essential travel, and non-food consumption items;
- Increasing R & D in Agriculture for adaptation to climate change;
- Regulating lavish consumption by persuasion and reduction in wastage of food.

APPENDIX V

Rainfed Perspective of Water: A Policy Framework

Ravindra Adusumilli[2]

Abstract:

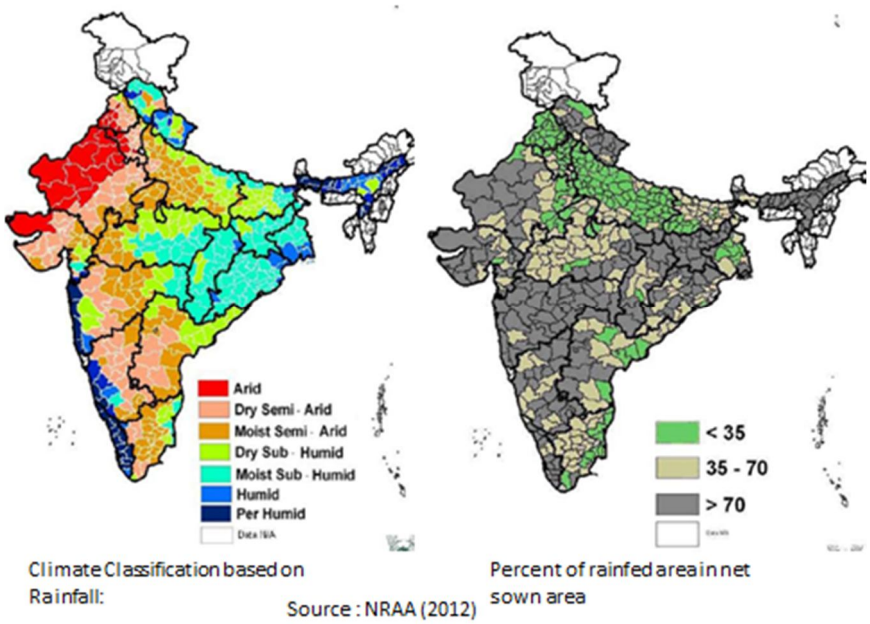
The country is at a stalemate with respect to the water resources management in agriculture. More and more is demanded on a finite resource, either on the surface or in the aquifers. Dealing with symptoms and tinkering here there, will not solve the problem. The present paradigm of water resources management in agriculture is 'irrigation centric'; the promise of policy is to provide 'irrigation' - more and more when the resource is dwindling. This will go no further; that all of us know.

This paper, evolving from the longstanding experiences of WASSAN and the RRA Network, posits a 'Rainfed Perspective of Water' as a useful policy framework to deal with multitude of problems – climate change, inclusive growth of rainfed areas, food security, ecological restoration and such others. The perspective suggests a shift in the policy objective of 'provisioning irrigation' to 'securing rainfed crops' as a basis for investments. It alludes to shifts in the "Billion Cubic Meter' perspective to 'mm of soil moisture' harvested, stored and applied to meet soil moisture deficits. It suggests to make maximising 'Rainfall Use Efficiency' as a metric shifting away from the current 'water use efficiency'. The contours of such a shift in the policy perspective is laid out.

'Har Khet ko Pani' and 'more crop per drop' are the slogans of the proposed Prime Minister's Krishi Sinchai Yojana (PMKSY). The paper lays out a framework to set a new and relevant course for policy-action and public investments in India to benefit the majority of rainfed farmers.

'Rainfed' perspective of water looks incongruous! Such incongruity stems from our so called modern 'BCM' / 'TMC' perspective of water which has been the obsession of irrigation planning in India. Water is seen something that flows, in abundance!

For a rainfed farmer things are different. Water is seen as deficits in soil moisture; once the rain comes, its immediate assessment is to what depth soil is wet? Is it sufficient to sow seed? Is it sufficient to take up weeding or even, is it sufficient to apply fertilisers? This has been the 'water' preoccupation of farmers in rainfed areas.



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These farmers are in majority and as is said quite often, 'even after all the irrigation potential is realised', these will be in majority. These are the areas that are subjected to droughts, at an increasing frequency with the advent of climate change. These are the areas where rural poverty is clustered and distress migration is pervasive.

And, these are also the areas where there is water! Rainfall is not scanty! Perhaps the challenges are different and highly location specific. To aid green revolution, our planners searched for flat areas with good soils and mega-sources from where they can take water to relieve these areas from the dependence on rains so that surplus can be produced and distributed all over India through PDS. A massive state-subsidised irrigation-dependent agriculture edifice is created which has set the dominant aspirations of farmers.

Then came groundwater; farmers saw the opportunity in a governance-vacuum. Several invested their own surplus from agriculture or even wage earnings from migration, borrowed at high interest rates or sold their other assets to access groundwater. So much so, that groundwater surpassed dams/canals as a source irrigation. Diesel engines and then electric ones, the dependency grew and state started subsidising electricity; free-in several states! A water-energy nexus is created.

Rainfed farming prevailed to be the larger part of our Net Sown Area. Even while about only 30 to 40 per cent of farmers accessed groundwater, the aquifers are drying up! 70% are in the queue awaiting some surplus or loan to dig a borehole! The decentralised groundwater based irrigation emulated canal irrigation and went for irrigated-crops.

Then comes the policy focus on 'water use efficiency' measured as crop per drop or 'per-drop-more crop'; whatever is the crop! Drip irrigation in Rice, perhaps epitomizes the philosophy. No one questioned, why rice when one has to invest heavily on plastics to save water? Micro-irrigation subsidies are the policy instruments; the 'mantra' for achieving water use efficiency.

Irrigation, electricity, micro-irrigation – we have created an edifice of 'irrigated agriculture' propped up by massive subsidies; through-in fertilizer subsidy used disproportionately within this system – we have created a mammoth that eats up whatever possibilities that exists in capital investments in agriculture. Besides, we carry billions of litres of 'water' virtually through our stocks of rice and wheat in FCI and PDS across regions; while most part of the country can produce its own food, if there is an appropriate support.

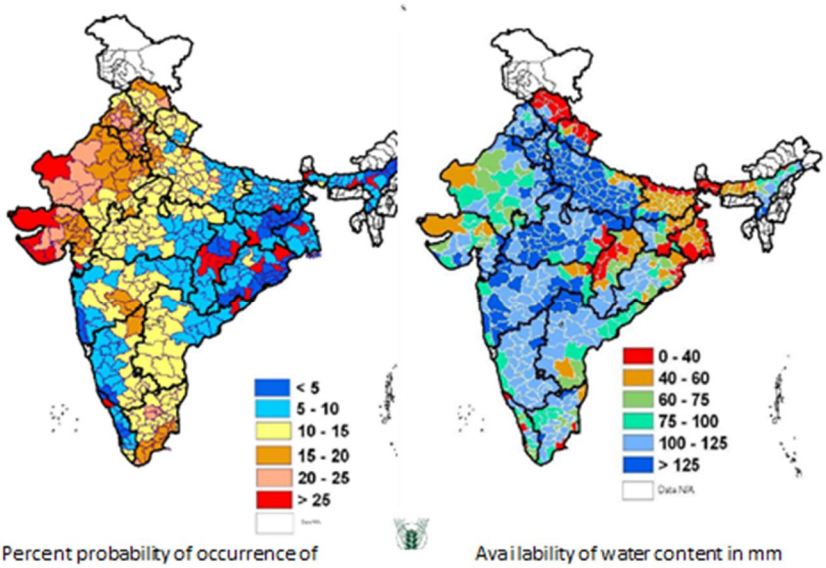
More of the same, is no longer possible!

All this while the rainfed farmer looks at any opportunity to fill in deficits in soil moisture so that her crop is secure. This has never been on the canvas of our planning – how to provide for such deficits of soil moisture? If it rains adequately, and if such rains are distributed well there is no need for additional water for these farmers. In case there is a gap in rains, a spell of short or medium or longer drought, then they need supplemental water to fill in the moisture deficit. About 60% of farmers look for such supplemental water to secure their crops – but their requirement never figures in our planning.

An estimate by Sharma et al., (2006) at International Water Management Institute concludes that harvesting a part of the rainfall surplus (9.97 M ha-m) is adequate to provide a critical irrigation for 18.75 M ha during a drought year and 22.75 M ha during a normal year out of the 25 M Ha of area assessed; groundwater is still not included in the model. And, such provision of critical irrigation had the potential to improve yields by 29 to 114 per cent for different crops during the period of assessment. Marginal value that such supplemental irrigation creates far outweighs that of micro-irrigation. A visual examination of Fig 2 might be convincing in itself.

Why then, securing rainfed crops from drought spells has eluded the planners and Indian Planning – is a larger debate that has roots in the Green Revolution paradigm!

The negative impacts of climate change are more pronounced in rainfed areas. These are the areas where poverty and hunger are endemic, and growth sticky. Crop insurance and new adaptive cultivars cannot meet this massive challenge. But, these are also the areas where rainfall is substantial, the opportunities are many. What we need is a 'majority view' of water rather than the dominant view of the minority that is 'irrigation' as it is perceived now.



Percent probability of occurrence of severe drought

Availability of water content in mm

Source : NRAA (2012)

That a paradigm shift is imminent is unquestionable- there is no way the present levels of extraction of groundwater or demand for surface irrigation can be met; more particularly in a fast changing climate regime.

We need some fundamental corrections in our visioning of water.

First and the foremost, what should be the policy objective for provisioning of water for agriculture? Need a shift from provision of 'irrigation' to 'securing crops'. If securing crops across the country has the first claim on water resources in agriculture, the entire policy paradigm will change- we need different kinds of investments, different geographies, different technologies, different policies, legislative and institutional framework.

At this moment in history, this is a legitimate claim of the majority of farmers who are outside the huge edifice of irrigation propped up by discriminatory public investments on water.

Secondly, the concept of **'**water use efficiency' does not implicitly value the source of water and equity outcomes. 'Rainfall Use Efficiency' is a more appropriate metric in the new paradigm. Rain falls everywhere for kharif crops. What needs to be done to supplement rains so that kharif crops are securely harvested with high productivity? The 12th Five Year Plan alludes to this concept but not enough is done to translate the metric into a measure of action / investments.

Thirdly, TMC or BCM perspective of water needs to change to 'mm' of soil moisture! Harvesting and retaining rainfall in soil profile is the most efficient way of improving water productivity. Preoccupation with 'Irrigation' negated scope for efficient ways of managing soil moisture, local harvesting of runoff and augmenting groundwater resources. The need is to shift from 'irrigation' perspective to 'water resources' perspective that deals with the breadth of water resources i.e. from soil moisture to surface flows / groundwater.

Fourthly, provisioning irrigation dominated the policy and plan investments. The role of state in governance of water is crucial for a paradigm shift. When entitlements are created for all farmers to protect their rainfed crops from drought spells as their legitimate first claim on available water resources, robust governance mechanisms are much needed to deliver such entitlements. Regulation of use of precious external sources of water (surface or ground) in quantity, purpose, time, method and person assumes greater importance in the new paradigm.

Fifth, is a shift towards a more 'biological' way of investments than mere investments in the 'mechanics' of water. Water efficiency and health of soil profile are inseparable. Healthy living soils with numerous microbes in their profile with porous surface harvest rainfall the most and retain moisture for long. Such

biological processes must be considered equally with the mechanical ways of saving water – through drips or sprinklers. Crops that we grow, crops that we consume also have a bearing on 'rainfall use efficiency'. Investment, incentives and support systems need to be built for a comprehensive management of water.

Such a paradigm shift towards a 'Rainfed Perspective' of water achieves the following simultaneously:

1. Growth : as the marginal productivity of water in the new paradigm is much higher
2. Inclusiveness: as it creates entitlements / first claims for farmers who do not have access to the present 'irrigation'
3. Resilience to Climate Change and Better adaptation: as the primary focus is to provision for adversities of rainfall failures – the adaptation would be substantive.
4. Ecological Restoration: as the paradigm sees and work on a continuum of healthy , live soils for efficient moisture management contributes significantly to ecological restoration. As the approach attends to the farmers not having access to groundwater – it can potentially reduce the run on groundwater and helps to keep the aquifers live.
5. Food security and hunger: (at national and local levels). Kharif crops in rainfeds are mostly (rainfed) rice, millets, pulses and oil seeds; these products are in a high inflationary path. Focused attention to rainfeds reduces the risks, improves productivity and may expand area under these crops. Integrated crop systems, leaves diverse and nutritive food at the households. That such programs are taken up across the country in wide-spread geographies, it will have a distributed impact and outreach to the interiors.

The above approach is feasible if there is a political will. There are numerous experiences across the country that corroborates the virtues of the new paradigm. These experiences also provide a framework for structuring public investments, evolving programs and institutions. Revitalising Rainfed Agriculture (RRA) Network and WASSAN has been working in this approach at scale building on a synthesis of various experiences across the country.

More of the same or tinkering at the symptoms will not take us any further in the nation's water resources management. We need a bold new vision and a clear political direction.

Perhaps, this can be a framework for the newly formulated PM Krishi Sinchai Yojana (PMKSY), if the governments at the Centre and in the states want to break away from the past and set a new course of inclusive development in India!

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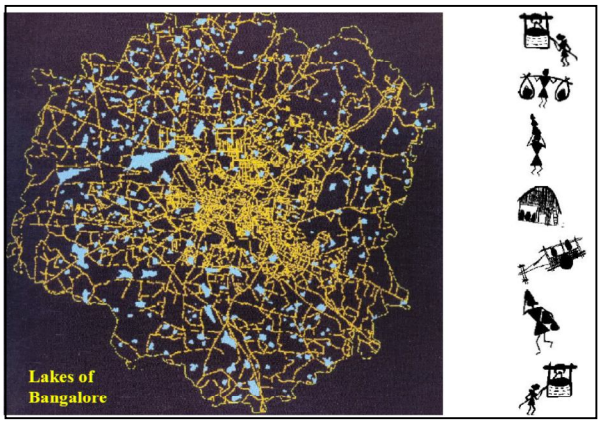
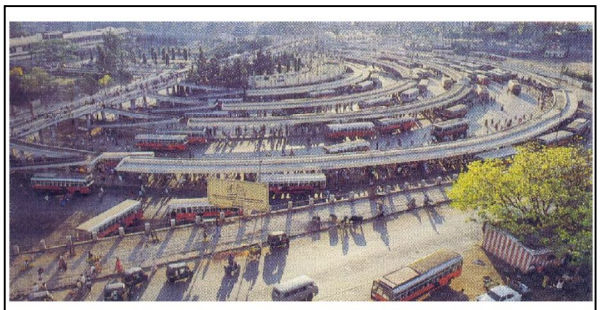
APPENDIX VI

Koramangala Tank is today a Housing "Complex"

KGA Golf Course, Once Challaghatta Tank

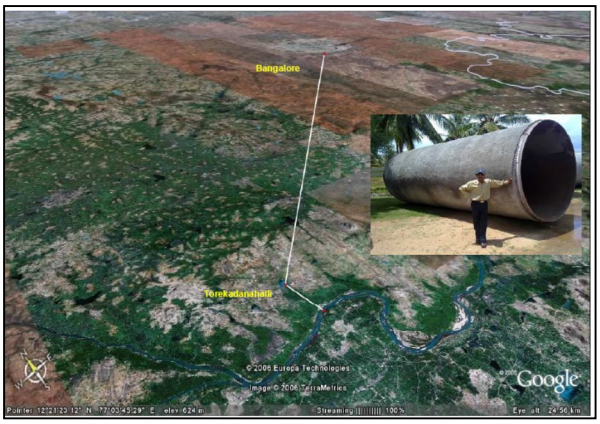




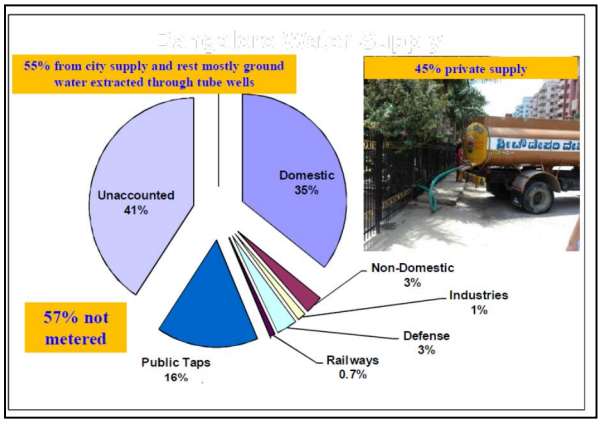
Bangalore City Bus Stand, Once Dharmambudhi Tank

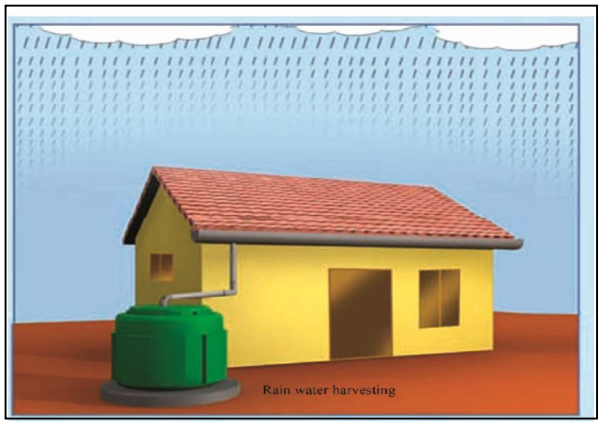
A Sports Stadium today, Sampangi Tank earlier

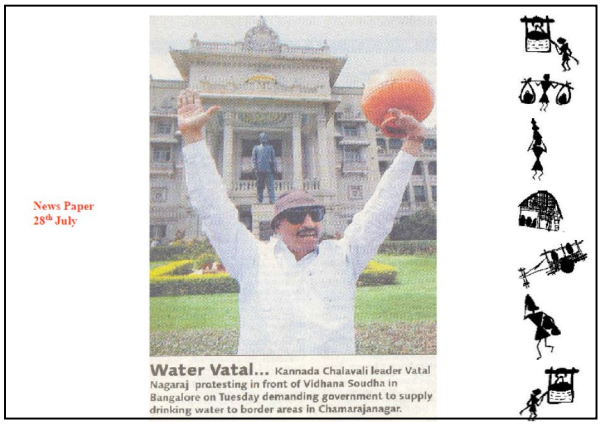

October 5th 2014
Tsunami in Bangalore
Rain story... A tsunami may not have struck Bangalore but it looked like it had. Many cars were seen stuck on Wednesday night following flash floods as rain came down in bucketsful. The Shivananda Circle subway bore testimony to the fury.


Bangalore
Yerekadanahalli
Google

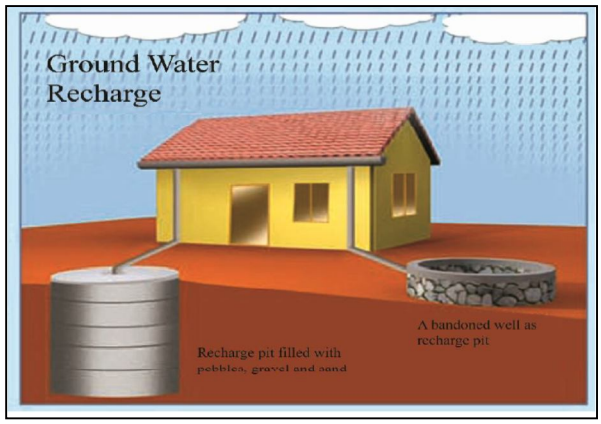

SINKING CITY
Two more die in rain havoc
Hosur Road completely submerged
Water overflowing from seven lakes
Traffic grinds to a halt
As many as 166 low-lying areas flooded
City receives 200 mm off rains in 36 hours
Hapless commuters consider coracles a better option to commute instead of motor vehicles on Hosur Road in Bangalore on Friday.
B'lore City in deep water

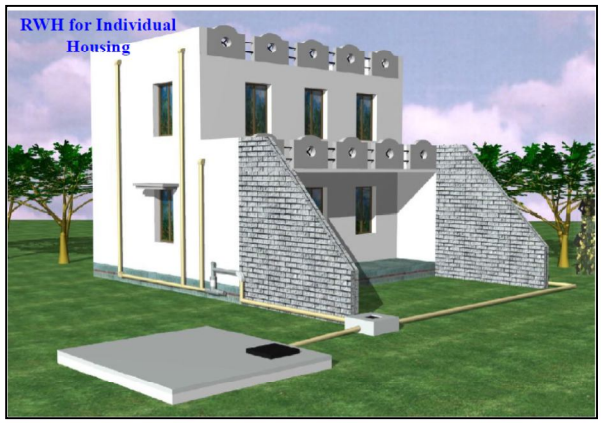

55% from city supply and rest mostly ground water extracted through tube wells
45% private supply
Unaccounted 41%
Domestic 35%
Non-Domestic 3%
Industries 1%
Defense 3%
Railways 0.7%
Public Taps 16%
57% not metered


Rain water harvesting

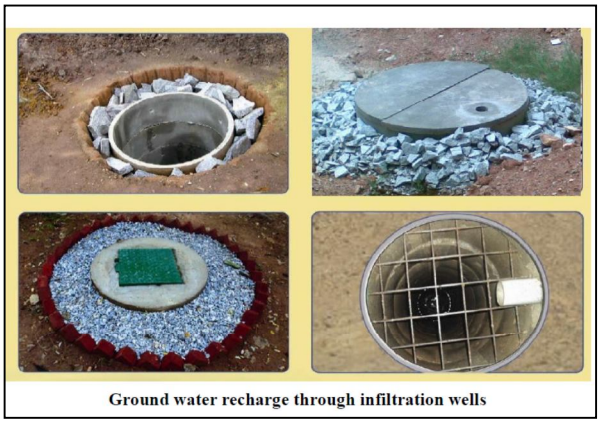

News Paper 28th July
Water Vatal... Kannada Chalavali leader Vatal Nagaraj protesting in front of Vidhana Soudha in Bangalore on Tuesday demanding government to supply drinking water to border areas in Chamarajanagar.

RWH at Kengeri Beedi Workers Housing

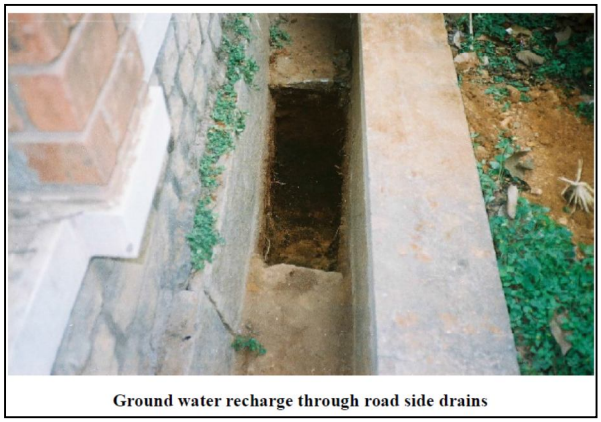




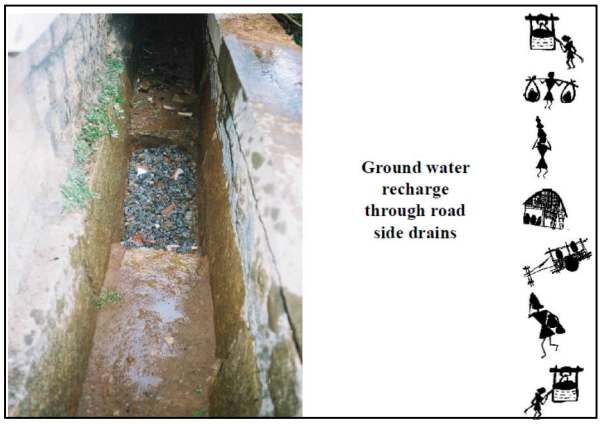

Rainwater Harvesting on Roads and Pavements


Ground water recharge through infiltration wells


Rainwater Harvesting from porous walk paths


Ground water recharge through road side drains


Rainwater Harvesting in Public Parks


Ground water recharge through road side drains

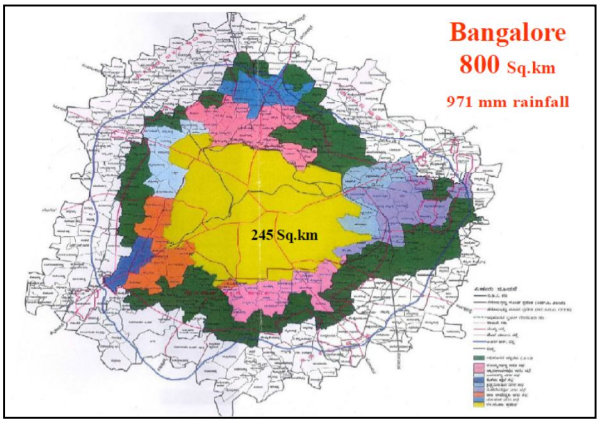
Rainwater Harvesting - Bangalore Story

- Awareness
- Technology
- Policy Guidelines
- Demonstration
- Training
- Help Desk
- Multilevel Information Dissemination

Rainwater Harvesting - Bangalore Story

Policy Support

- Revised Building Byelaws by BBMP
  - Gazetted by Government - Mar 6th, 2003
  - Published – Feb 21, 2004
- Property tax discount announced - August 10th, 2005 Government of Karnataka
  - Cabinet nod to make RWH Mandatory - Feb 4th, 2009
  - BWSSB Regulation came into force - August 27th, 2009
  - Today, nearly 80% target group complies with RWH act in core area of Bangalore (around 100 thousand proprieties)




Times of India, Aug 10, 2005

TIMES CITY

Harvest rainwater, get property tax discount

By Rakesh P/TNN

Bangalore: Collect rainwater and get a 20 per cent discount on the property tax that you pay!

That's the introductory offer from the Karnataka government which is stretching itself to the maximum in popularising the concept of rainwater harvesting in rural habitations across the state.

The government passed an order 10 days ago announcing 20 per discount on property tax for five years to rural folks whose houses have rainwater harvesting facilities. The offer, which starts from September 1 this year will be on till March 31, 2008.

Speaking to The Times of India, rural development and panchayat raj secretary V P Baligar said: "Karnataka will be the first state in the country to offer concessions on property tax with regard to the implementation of rain water harvesting programmes."

Encouraging rainwater harvesting facilities will not only check depletion of the groundwater table but also tackle fluorosis, a water-borne disease. There are 58,682 rural habitations across the state and nearly half of these face drinking water problems.

In July this year, drinking water needs of 227 habitations were met through tankers and the needs of 113 habitations were met by sinking borewells. However about 1,000 habitations in 13 districts recorded excess levels of fluoride in water.

"Rainwater collection and utilisation is one of the best solutions to this crisis. We weighed the pros and cons of making rain water harvesting compulsory like it is in Tamil Nadu. But as several government programmes thrust on the people have not been received well, we decided to motivate people to go in for rainwater harvesting facilities. In this backdrop we decided to provide incentives on property taxes," Baligar said. The offer, for the time being, is only confined to rural areas. A similar proposal for urbanites is pending with the urban development department, which is studying the percentage of discount to be given, sources said.

Tips on sops

How to avail discount on property tax

- Construct a water collection tank of 1,000-litre capacity
- Submit a voluntary application to the gram panchayat (GP) seeking discount
- Submit a tank construction completion report to the GP
- Wait for the GP officials to inspect the house
- After receiving intimation, pay property tax at discounted rates to the GPs

Incentives


Deccan Herald, Jan 15, 2011

Policy Support

State may make rainwater harvesting mandatory

BANGALORE: The state government is contemplating making rainwater harvesting structures mandatory in newly-constructed buildings in all urban pockets across the state. Urban Development Minister Suresh Kumar told the Legislative Council on Friday.

Speaking after piloting the Bangalore Water Supply and Sewerage (Amendment) Bill 2011, Suresh Kumar said the government will make suitable amendments to various legislations to implement the


Plumbers Training


Deccan Herald, Oct 19, 2009

Monday, October 19, 2009

'Rain water harvesting must for new houses from Nov 1'

Rs 10,000 cash prize for citizens who provide a best model

Incentives

BANGALORE: As water woes multiply, the State government has begun an incentive-based scheme, coupled with stringent laws, to encourage rain water harvesting.

From November 1, Bangaloreans will have to ensure that their new homes have a proper rain water harvesting system. According to an announcement made at a public meeting by Minister for IT-BT, Information and BWSSB Katta Subramanaya Naidu, the city will see houses on a 30 x

On the other hand, BWSSB will begin an incentivising scheme by introducing a lottery-based cash prize for Rs 10,000 to five citizens, who would provide best models of rain water harvesting.

The minister also announced that monetary and material support will be provided for community rain water harvesting, if the people evinced interest.

Talking tough, Katta Subramanaya Naidu said that strict action will be initiated against those who do not take steps to prevent sewerage contaminating drinking water. So much so, the erring citizens will have their water and power supply disconnected.

At a public meeting in the City Naidu said," The onus is on everybody to save water. Implementation of rain water harvesting will increase the ground water table level in the city, and thereby help resolve water problems in the City."

Dr Shivshankar, scientist from Karnataka State Science and Technology Department, presented a detailed plan about rain water harvesting to citizens.

He explained the construction of rain water harvesting system at home, with used pipes and buckets. He also informed that they could provide three layers of mesh and collect rain water in their overhead tanks.

This apart, he appealed to the people to use defunct and dried up wells to collect rain water.

DH News Service


Helpdesk to handle queries on rainwater harvesting

K.C. Deepika

BANGALORE: The Bangalore Water Supply and Sewerage Board (BWSSB) is working towards implementing the Rainwater Harvesting Regulations by appealing to people to install rainwater harvesting (RWH) structures in their houses.

The water body has set up a helpdesk where people can call 22340848, 22340849, 23340848 or 23340849 for any queries.

"If people contact us on the helpdesk and seek advice, we send our engineers to the site to set up the structure by charging Rs 500. We have to check pit and type of filter," said Komaramaiah, BWSSB Chief Engineer.

The Bangalore Water Supply and Sewerage (Amendment) Act of 2000, under which RWH rules Rain Water Harvesting Regulations were introduced, has made it mandatory for all houses which are built on 30 x 40 sites between the time period of August 25, 2009 and March 31, 2011, to have rainwater built in or else to have rainwater harvesting structures.

BWSSB meter readers are busy telling uninitiated owners of buildings that fall under the Act. "BWSSB meter readers told us if we have a rainwater harvesting structure. Since we do not have one, we were told that we will not be supplied water after the May 27 deadline," said M.C. Moses, a resident of Mugeshpalya, where he has built on a 50 x 60 site.

54,000 buildings

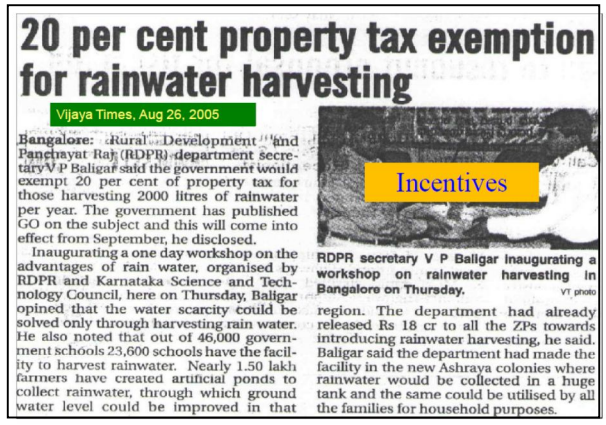
A senior BWSSB official said 54,000 buildings constructed during the nine-month period have been identified to come under the purview of the Act. According to the Act, the immediate mode of action to be taken in case of non-compliance after May 27 will be to cut the water supply and levy a one-time ground drainage fee.

"Since the Act does not apply to older buildings, we are holding awareness campaigns. As for apartment buildings, the rule applies to them as well. We have to see one connection to each apartment building," he added.

Giving information on the costs involved, A.S. Shivakumar, Principal Investigator of the Karnataka State Science and Technology Council, Indian Institute of Science, said: "The total cost (including that of installation for rainwater harvesting) goes towards storage and the rest for the pipes and filters. "It can cost anywhere between Rs. 4,000 to Rs 40,000," he said.

Helpdesk

- May 27 is the deadline for getting the facility installed
- Helpdesk numbers 22340848, 22340849, 23340848, 23340849


20 per cent property tax exemption for rainwater harvesting

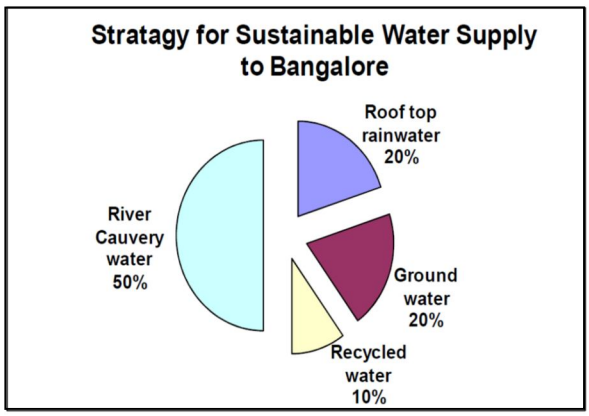
Vijaya Times, Aug 26, 2005

Bangalore: Rural Development and Panchayat Raj (RDPR) department secretary V P Baligar said the government would exempt 20 per cent of property tax for those harvesting 2000 litres of rainwater per year. The government has published GO on the subject and this will come into effect from September, he disclosed.

Inaugurating a one day workshop on the advantages of rain water, organised by RDPR and Karnataka Science and Technology Council, here on Thursday, Baligar opined that the water scarcity could be solved only through harvesting rain water. He also noted that out of 46,000 government schools 23,600 schools have the facility to harvest rainwater. Nearly 1.50 lakh farmers have created artificial ponds to collect rainwater, through which ground water level could be improved in that region. The department had already released Rs 18 cr to all the ZPs towards introducing rainwater harvesting, he said. Baligar said the department had made the facility in the new Ashraya colonies where rainwater would be collected in a huge tank and the same could be utilised by all the families for household purposes.

Incentives

RDPR secretary V P Baligar inaugurating a workshop on rainwater harvesting in Bangalore on Thursday. VT photo



Rainwater Harvesting - Success Stories

- Policy and Technical support to Government of Karnataka through BWSSB and BBMP for Rainwater Harvesting
- RWH in Landmark buildings like Vidhana Soudha, High Court of Karnataka, Housing colonies, Hostels, Hospitals, Public and Pvt. buildings
- Over 250 awareness camps and training programmes organised
- Training of over 1700 personnel in the city
- Information dissemination materials of professional quality
- Two RWH Helpdesks established in Bangalore
- Technical Consultation on RWH for Institutions and Industries - over 300 major projects

Around 100 thousand properties have adopted RWH in Bangalore

10 Point Plan of Recommendation:

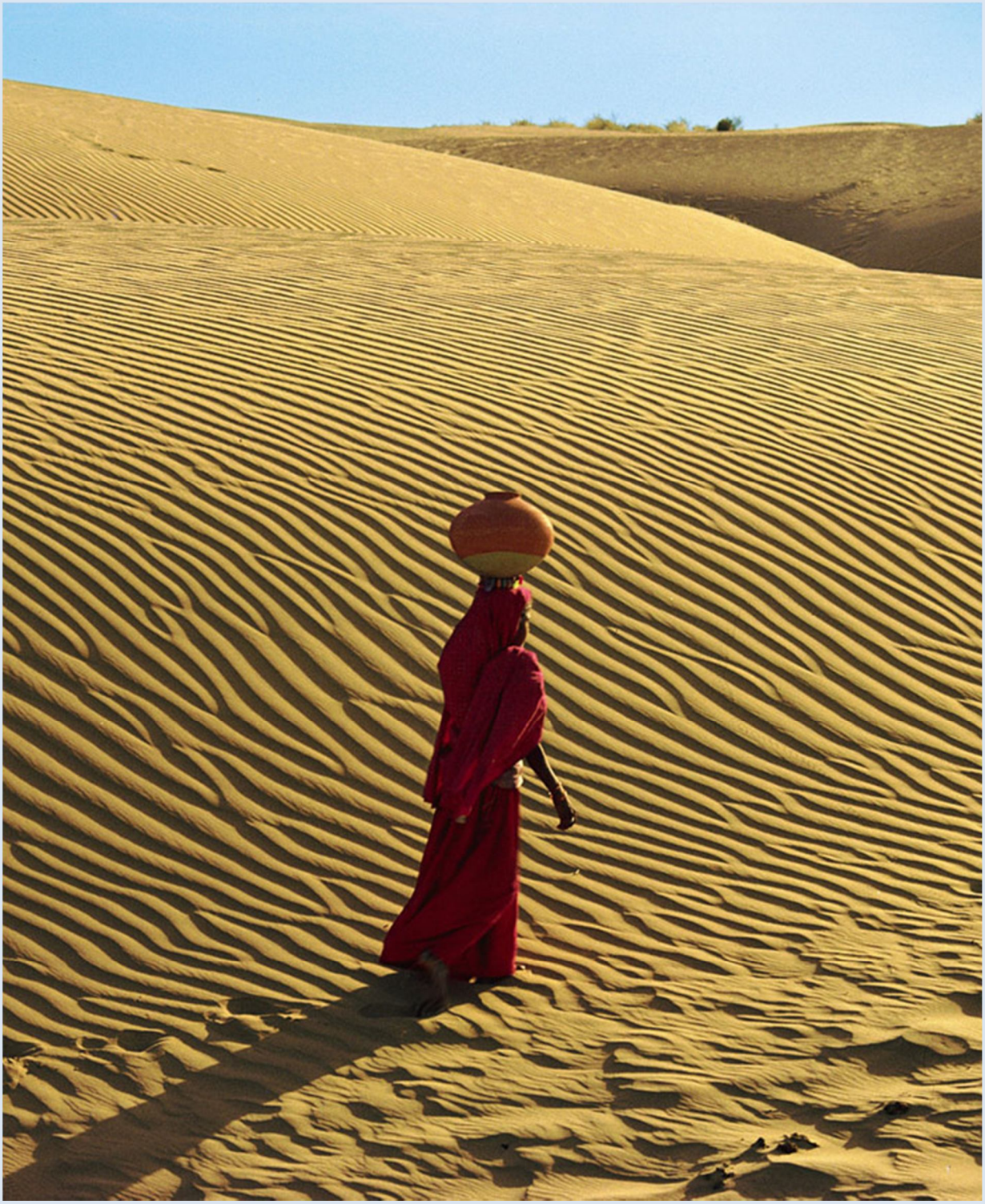
1. RWH made compulsory for all properties in Urban areas
2. Encouragement to have open wells and shallow borewells in each property – overflow of roof top rainwater from tanks to flow in to artificial recharge pits / open wells
3. Enforcement of strict effluent treatment in all commercial and industrial establishments. Encourage eco friendly detergents, soaps and shampoos
4. Ground water recharge through intermittent recharge trenches in storm water drains and strict enforcement to avoid gray water in storm water drains
5. Public parks and open places to have RWH and ground water recharge through open wells . Tree based parks to be developed and phase-out large patches of lawn. All public parks to be maintained by using only organic manure and permitted pesticides
6. Permit ground water withdrawal proportional to ground water recharge in institutions and commercial water users (bottling plants, tanker supply etc.)
7. Establish duel supply system - initially to bulk users and new layouts
8. Meter all category of water users from all sources to have better water auditing
9. Bulk users like defense, railways and industries to generate their own recycled water and reduce dependence on city supply
10. All urban lakes and water bodies to be rejuvenated in phased manner and maintained by city authorities as reservoirs of buffer storage and ground water augmentation facilities

Established in 2011, The Indian National Association for the Club of Rome is a non-profit organisation, which aims "to act as a global catalyst for change through the identification and analysis of the crucial problems facing India and the communication of such problems to the most important public and private decision makers as well as to the general public." The broad goal of the national chapter, CoR-India, is to help design an agenda for governments in India, the business sector as well as all its citizens' organisations that could enable everybody in this country to live a full life in harmony with their surroundings by the centenary of the nation, 2047.

(www.clubofrome.in) Contact: info@clubofrome.in

Development Alternatives (DA), a not-for-profit action research and development organisation, is the primary knowledge partner of CoR - India. DA innovates and disseminates sustainable solutions aimed at reducing poverty and regenerating natural ecosystems and their services. Established in 1982, its eco-solutions deliver basic needs products through the small, local enterprises that generate green jobs and sustainable incomes. Based on its innovative environment-friendly technologies and market principles, these enterprises help build local economies and communities while maintaining a minimum ecological footprint.

(www.devalt.org) Contact: mail@devalt.org



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