WATER SECURITY :

GLOBAL AND INDIAN PERSPECTIVES

A dissertation submitted in partial fulfillment of requirement of the degree of Master of Philosophy in Public Administration from Punjab University, Chandigarh.

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CERTIFICATE

I have the pleasure to certify that M V Bhanumathi pursued her research work and prepared the dissertation titled "Water Security : Global and Indian Perspectives" under my guidance and supervision. The dissertation is the result of her own research and to the best of my knowledge; no part of it has earlier comprised any other monograph, dissertation or book. This is being submitted to the Punjab University, Chandigarh for the degree of Master of Philosophy in Social Sciences in partial fulfilment of the requirement for the Advanced Professional Programme in Public Administration (APPPA) of the Indian Institute of Public Administration (IIPA) New Delhi.

I recommend that the dissertation of M V Bhanumathi is worthy of consideration for the award of M. Phil degree of Punjab University, Chandigarh.

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LIST OF ABBREVIATIONS

Bcm/Bcum	Billion Cubic Meter
CGWB	Central Ground Water Board
DWAF	Department of Water Agriculture and Forest
IFPRI	International Food Policy Research Institute
IPCC	Inter Governmental Panel on Climate Change
MSP	Minimum Support Price
MTA	Mid Term Appraisal
NCIWRDP	National Commission for Integrated Water Resource Development
NGO	Non Governmental Organisation
NSW	New South Wales
UNEP	United Nations Environment Programme
WRC	Water Research Commission
WUA	Water Use Association

WATER SECURITY :

GLOBAL AND INDIAN PERSPECTIVE

CHAPTER - I

INTRODUCTION

"The environment remains largely outside the mainstream of everyday human consciousness, and is still considered an add-on to the fabric of life."

"Pumping groundwater is like making constant withdrawals from a bank account without ever paying anything into it."

Water is the essence of life. It energizes the bio-geochemical cycle through continuous circulation of nutrients in the whole eco system. Indian ethos always revered and venerated water .The Rivers and tanks have always been considered holy and the Hindu mythology revolved around the river systems. Their banks have been witness to flourishing civilizations. The tanks and river confluences have seen many a theertha yatras on their shores.

Water conservation had been a way of life and old wisdom in ancient India But the modern world and the emerging fast food culture have no time to stand and stare. There is great hurry in every part of the world to catch up

with the development vis a vis their rich counter parts. Increased economic activity, including large-scale irrigation, industrialization and urbanization along with increased population pressure has resulted in creating conflicting demands for the water resources. Often this has meant the diversion of "water for life" to "water for development".

The 2006 United Nations Development Report focusing on water has noted that nearly 1.1 billion people in developing countries have inadequate access to water, and 2.6 billion lack basic sanitation.

This challenge was recognized by the Secretary General of UN, Mr. Ban Ki Moon, in his address to World economic Forum on January 24th, 2008, when he highlighted that the challenge of securing safe and plentiful water for all, is one of the most daunting challenges faced by the world today. He has warned that environmental stress, due to lack of water might lead to conflict and would be greater in poor nations. Drought was the factor that triggered the fight in Darfur ten years ago which ultimately led to millions loosing their lives and homes. Same sad story has been repeated in Somalia, Chad, Israel occupied Palestinian territories, Nigeria, Sri Lanka, Haiti, Columbia, Kazakhastan. Too often where water was needed guns were found.[1]

[1] Davos,Switzerland-Secretary General's address at the World Economic Forum on "Time is running out on water"

The world's poor, and especially, the women and children are the worst affected by the water crisis. 400 million children (1 in 5 from the developing world) have no access to safe water. Around 1.8 million child deaths occur each year as a result of diarrhea. Millions of women spend many hours a day collecting water[2]

Water pollution and effect of climate change have added further dimension to the problem of water security. Agriculture and industry the twin engines of economic development have also proved to be the Dr.Jekyll and Mr.Hyde of our civilization. They have been polluting our rivers and atmosphere on the sly all these years, now stand exposed. Alas! We can not do with out them.

A recent report by International Alert identified 46 countries, home to 2.7 billion people, where climate change and water related crises create a high risk of violent conflict. A further 56 countries, representing another 1.2 billion people, are at high risk of political instability. In china the Yangtze river no longer reaches the sea. In Himalayas the melting glaciers endanger the water supply of hundreds of millions of people in the sub continent.

Indian scientist and activist, Vandana Shiva noted in a documentary that the water crisis is a human-created crisis in the last two decades. In other words, it is not so much of a water shortage crisis, but a water

[2] 2006,United Nations Human Development Report

management crisis[3]. The United Nations appears to concur : "We reject this [Malthusian perspective that global water problems are a problem of scarcity and population growth]. The availability of water is a concern for some countries. But the scarcity at the heart of the global water crisis is rooted in power, poverty and inequality, not in physical availability"[4].

The causes include: lack of adequate water institutions, fragmented institutional structures (a sector-by-sector management approach and overlapping and/ or conflicting decision-making structures), upstream and downstream conflicting interests regarding riparian rights and water diversion of public resources for private gain, and unpredictability in the application of laws, regulations and licensing practices, which impede markets[5].

We have to fit the water crisis in an overall scenario of problem solving and conflict resolution. As pointed out by the Commission For Sustainable Development in 2002, "Poverty eradication, changing unsustainable patterns of production and consumption and protecting and managing the natural resource base of economic and social development are over arching objectives of and essential requirements for sustainable development. Yet of all the social and natural resources crises that the

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[3] World Without Water, from True Vision Productions broadcast by Britain's mainstream media channel, *Channel 4* on April 29, 2006.
[4] 2006 United Nations Human Development Report, 2006, p.2
[5] World Water Development Report

humans face today, water crisis is the one that lies at the heart of our survival and that of our planet earth.

India with the second largest population in the world and a fragile resource structure to provide for its population can not afford to look at itself in isolation. In the scenario of increasing globalization, India's shared water bodies with the neighbors and the emerging concept of water as an economic good it is appropriate to study the issues of water security at the global level and follow with the issues faced by our country.

STATEMENT OF THE PROBLEM

While the development of sustainable and safe drinking water supplies is a global challenge, it is particularly acute in India, given its high population density, space and time variability of rainfall, and increasing depletion and contamination of its surface and ground water resources. Urgent reforms2 are needed in water resource management.

OBJECTIVES

The main objectives of the study are:-

(a) To review some of the emerging issues and challenges in the context of the management of water resources in India.

(b) To identify some of the possible options for policy and institutional reforms.

(c) To develop a strategy for the conservation of water and its sustainable and equitable use for domestic, agricultural and industrial purposes.

SCOPE

The present study is basically concerned with implications of water management policies in India, involving amongst others, the Union Government of India, the State Governments, various water bodies and NGO's. It will thus be appropriate to categorize this study paper as `Policy Research'.

METHODOLOGY

The study paper has adopted the Descriptive Research Design, allowing the researcher to present her own analytical observations of the prevailing water scenario within the country and elsewhere in the world. It has relied upon primary sources such as government documents, Annual Reports of the Ministries, as also the Press Statements of the meetings at official levels, statements of national leaders and newspaper reports, recorded interviews with eminent Environmentalists, analysts, academicians, and bureaucrats have been used to give greater credence to the findings of this research. In addition, relevant articles in reputed academic journals also constitute important sources of reference. Statistical

data and tabulation have been used to carry out objective analysis to strengthen the arguments.

SCHEME OF CHAPTERISATION

It is proposed to study the subject in the following manner :-

(a) Introduction

(b) Global water crisis over views.

(c) Water crisis in India.

(d) Water management in India.

(e) Case studies on water management.

CHAPTER II

GLOBAL WATER CRISIS OVERVIEW

The World Bank reports that 80 countries now have water shortages and 2 billion people lack access to clean water[6]. More disturbingly, the World Health Organization has reported that 1 billion people lack enough water to simply meet their basic needs[7].

Population growth and groundwater depletion present the two most significant dangers to global water stability. In the last century, the human population has increased from 1.7 billion people to 6.6 billion people, while the total amount of potable water has slightly decreased.[8] Much of the population growth and economic development experienced in the last fifty years has been supported by groundwater.

THE PRESENT SUPPLY AND USAGE OF WATER

Humanity has approximately 11 trillion cubic meters of freshwater at its disposal.[9] Groundwater aquifers contain over 95% of this water, while rain, rivers, and lakes make up the remaining 5%.[10] Approximately 1,700

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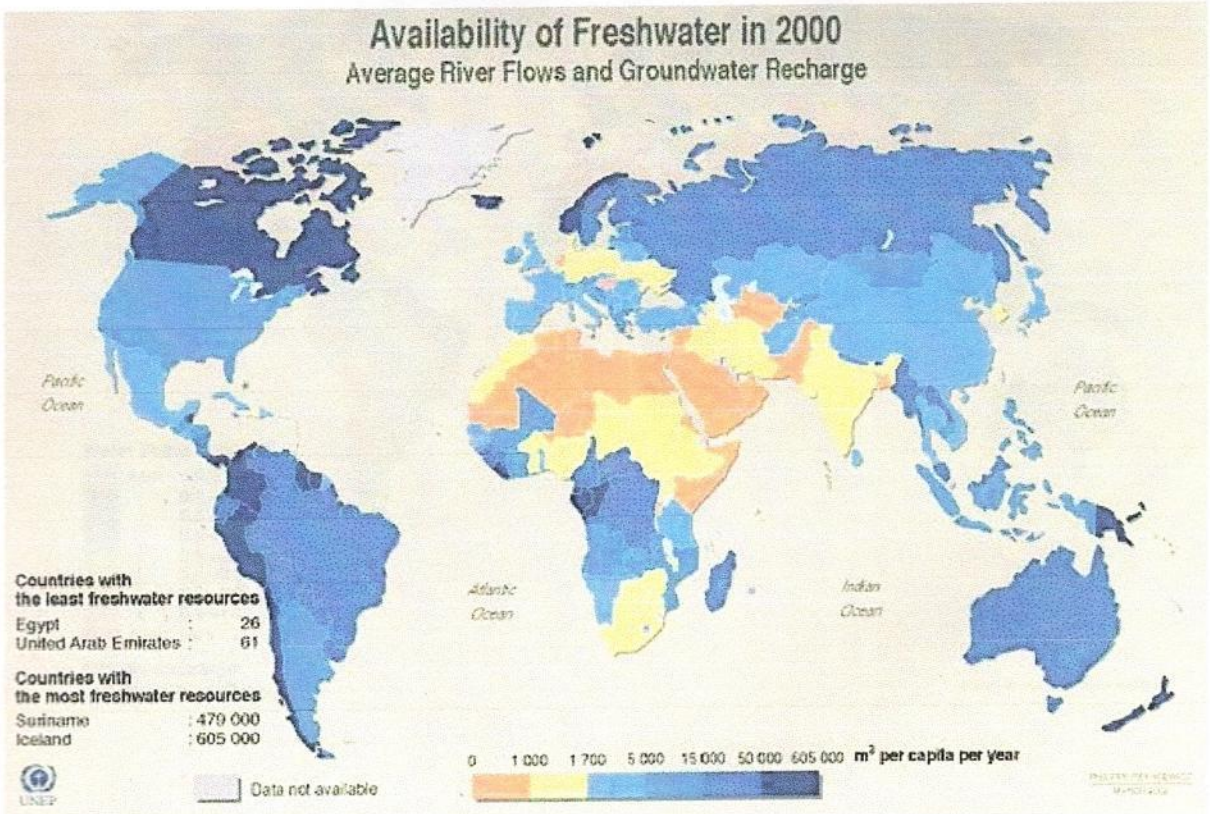
[6] http://ag.arizona.edu/AZWATER/awr/dec99
[7] http://www.who.int/water_sanitation_health/monitoring
[8] http://www.census.gov/ipc
[9] http://ga.water.usgs.gov/edu/watercycleice
[10] http://ga.water.usgs.gov/edu/watercyclefreshstorage

m3 of water exists for every person on the planet, an alarming low number. According to the Water Stress Index, a region with less than 1,700 m3 per capita is considered "water stressed".[11]

The global supply is not distributed evenly around the planet, nor is water equally available at all times throughout the year. Many areas of the world have seriously inadequate access to water, and many places with high annual averages experience alternating seasons of drought and monsoons. (Figure 1 shows water availability per person within a country.)



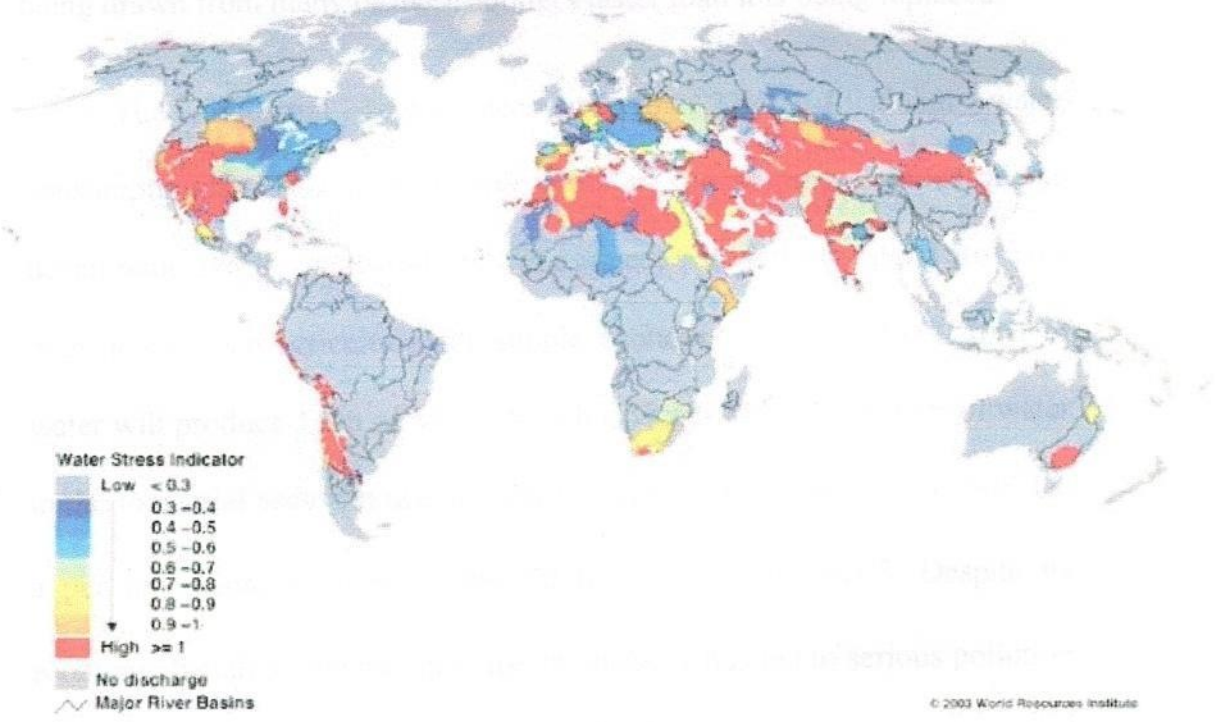
Source: World Resources 2000-2001. People and Ecosystems: The Fraying Web of Life. World Resources Institute (WRI), Washington DC. 2000

Water usage differs highly between developing countries and developed ones. Developing countries use 90% of their water for

[11] http://static.teriin.org/reports/rep02/rep0204

agriculture, 5% for industry, and 5% for urban areas. Developed countries use 45% of their water for agriculture, 45% for industry, and 10% for urban areas.[12]

In the last century water usage per person doubled, even as the total population tripled,[13] creating a situation today where many areas of the world are consuming water at an unsustainable rate. (Graph 2 highlights in red all the areas where water is being consumed at a nonrenewable rate.)



[12] http://www.ifpri.org/2020/visuals/pdfs/slide19
[13] http://www.unep.org/vitalwater/

INCREASING DEMAND

The agricultural sector, by far the largest consumer of freshwater resources, accounts for 70% global consumption.[14] Irrigation consumes most of the water in the agricultural sector, and has become an integral part of modern civilization because of access to groundwater aquifers. Once farmers were freed from relying on rain to water their crops, highly efficient commercial farming became increasingly common. This innovation also underpinned the Green Revolution, which dramatically increased crop production throughout the third world in the 1960s.[15] Unfortunately, water is being drawn from many of these aquifers faster than it is being replaced.

The industrial sector accounts for 22% of global water consumption;[16] This number will grow in the coming decades as the developing world industrializes. The needs of industry tend to take precedence over agriculture for simple economic reasons. 1,000 tons of water will produce 1 ton of wheat, which is worth $200. 1,000 tons of water in the industrial sector, however, will generate $14,000 worth of goods. On a per ton basis, industry creates 70 times more wealth.[12] Despite its economic benefits, intense water use by industry has led to serious pollution that is beginning to create problems worldwide.

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[14] http://www.ozh2o.com/h2use
[15] http://www.af-info.or.jp/eng/honor/bppcl_e/e1994brown
[16] http://www.ozh2o.com/h2use

The residential sector uses the remaining 8% of the total water supply. Although this sector only accounts for a small percentage of overall use, it always takes precedence over industry and agriculture. In the last fifty years the world's urban population has exploded, and by 2010, 50% of the people on the planet will live in cities.[17] In addition to the simple increase in population, per person consumption of water has risen. As more people begin utilizing modern luxuries like flush toilets, showers, and washing machines, the demand created by the residential sector will increase dramatically.

WATER POLLUTION

The companion of modernization has been pollution. In developing countries which are just entering the industrial age, water pollution presents a serious problem. According to United Nations Environmental Program (UNEP), "in developing countries, rivers downstream from major cities are little cleaner than open sewers". The UNEP also reports that 1.2 billion people are being affected by polluted water, and that dirty water contributes to 15 million child deaths every year.[18] In recent years, scientists have become aware of the problems involved with the contamination of groundwater. Aquifers move very slowly, so once they are polluted it takes decades or centuries for them to cleanse themselves.

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[17] http://worldwaterconservation.com/chinawater1
[18] http://news.bbc.co.uk/1/shared/spl/hi/world/06/urbanisation

Food production contributes significantly to water contamination. When nitrogen fertilizer is applied to a field, the water runoff will have a very harmful effect on plant and animal life,[19] can cause miscarriages, and can harm infant development.[20] The industrial livestock business also presents a serious danger to water systems. The disposal of vast amounts of animal feces destroys nearby ecosystems and is very hazardous to humans.[21]

Water pollution is reaching epic proportions. In the U.S. 40% of rivers and lakes are considered too polluted to support normal activities In China 80% of the rivers are so polluted that fish cannot survive in them. In Japan 30% of groundwater has been contaminated by industrial pollution. The Ganges River, which supports around 500 million people, is considered one of the most polluted rivers in the world. And the list goes on...[22]

FOOD SCARCITY

According to the International Food Policy Research Institute (IFPRI), if current water consumption trends continue, by 2025 the agricultural sector will experience serious water shortages. The IFPRI estimates that crop losses due to water scarcity could be as high as 350 million metric tons per year, slightly more than the entire crop yield of the

[19] http://www.tiscali.co.uk/reference/encyclopaedia/hutchinson/m0035393
[20] http://www.nrdc.org/water/pollution/ffarms
[21] http://www.agrifood-forum.net/practices/sector/livestock/22pollution
[22] Paulo Alois, "Global Water Crisis Overview"

U.S.[23] This massive water crisis will be caused by water contamination, diverting water for industrial purposes, and the depletion of aquifers. Climate change may also play a part. The Himalayan glaciers, which feed the rivers that support billions of people, are shrinking in size every year.[24] Their disappearance would cause a major humanitarian disaster.

The greatest danger to global food security comes from aquifer depletion. Aquifers are an essential source of water for food production, and they are being overdrawn in the western U.S., northern Iran, north-central China, India, Mexico, Australia, and numerous other locations. Additionally, many aquifers are contaminated each year by pollution and seawater intrusion.

Despite their importance, data on underground water reservoirs remains imprecise. There is little evidence regarding how many aquifers actually exist, and the depth of known aquifers is often a mystery. However, it is clear that water from these sources takes centuries to replenish, and that they are being consumed at a highly unsustainable rate.

INTERNATIONAL CONFLICT

According to the UNEP, there are 263 rivers in the world that either cross or mark international boundaries. The basins fed by these rivers

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[23] http://www.factmonster.com/ce6/sci/A0861889
[24] http://worldwaterconservation.com/chinawater1

account for 60% of the world's above ground freshwater.[25] Of these 263 rivers, 158 have no international legislation, and many are the source of conflict.

Water has always been a central issue in Arab-Israeli situation. Ariel Sharon once said the Six Days War actually began the day that Israel stopped Syria from diverting the Jordan River in 1964.[26] Decades later, the Egyptian military came close to staging a coup against Egyptian president Anwar Sadat, who had proposed diverting some of the Nile's water to Israel as part of a peace plan.

The Nile River, which runs through Ethiopia, Sudan, and Egypt, exemplifies the potential for future water conflicts. The banks of the Nile River support one of most densely populated areas on the planet. In the next fifty years the number of people dependant on the Nile could double, creating a serious water crisis in the region.[27] The Nile is not governed by any multilateral treaties, and Egypt would not shrink from using military strength to guarantee its future access to water.

The potential for water conflicts are less likely outside the Middle East, but never the less there are many problematic areas. The Mekong River is the lifeblood of South East Asia, but it begins in one of the most

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[25] http://www.unep.org/Documents.Multilingual
[26] http://www.mideastnews.com/WaterWars
[27] http://news.bbc.co.uk/1/hi/world/africa

water poor countries on Earth: China. The Indus River separates Pakistan and India, and aquifer depletion by Indian farmers has one of the highest rates in the world.[28] U.S.-Mexican relations are already strained over water use on their mutual border.[29] The Niger River basin in West-Central Africa runs through five countries. Surging populations coupled with decreasing rainfall in the region seriously threaten water security for millions of people.[30]

Although the specter of international water wars can seem very real, in the last 50 years there have only been 7 conflicts over water outside the Middle East.[31] While a global water crisis has the potential to tear international relations at the seams, it also has the potential to force the global community into a new spirit of cooperation.

BEST PRACTICES BY SOME COUNTRIES- CASE STUDIES

UGANDA

The Wetland Sector Strategic Plan of Uganda was launched in early 2001 to build on the experiences gained during twelve years of the National Wetlands Programme. Wetlands cover 13% of Uganda's territory, and many are of international biodiversity significance. The programme is innovative

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28 http://www.boston.com/yourlife/health/other/articles/2006/09/30/india_digs_deeper_but_wells_are_drying_up_and_a_farming_crisis_looms

29 http://www.irc-online.org/americaspolicy/borderlines

30 http://www.irinnews.org/webspecials/runningdry

31 UNDP, Human Development Report 2006, E-5-1

in that wetlands management and poverty alleviation are integrated into the approach through the funding of local communities to develop sustainable management initiatives that improve their livelihoods and maintain the integrity of the wetlands. These are based on locally developed management plans that identify areas where all exploitation is prohibited and areas where specific types of management (such as cultivation, fishing, livestock and papyrus collection) are allowed.

The experiences of successful local pilots convinced the sometimes sceptical authorities that local communities were interested in and capable of sustainable management within agreed-upon boundaries. These pilots have formed the basis for 'scaling up' the approach to the national level and the integration of the principles of sustainable management into the national policy framework for these critical habitats. The Ugandan Constitution contains a clause stating that 'wetlands should be held on trust by the government for the benefit of all the people'. The introduction of the Wetlands Sector Strategic Plan shows that this constitutional aspiration can be turned into robust policy that includes effective means through which it can be implemented[32].

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[32] Back ground paper of WWAP for the first WWDR

AUSTRALIA

Australia, a thinly populated continental country, covers an area of 7.7 million sq km with a population of just 18 million. The annual average precipitation is 465 mm--the lowest among continents--but varies widely from 200 mm or less in the two-thirds of desert inland to 2400 mm or over in the one-third of the country forming the east and north coast of the continent. The total exploitable water resources potential is estimated at 188 b cum--117.6 b cum of surface water and 70.4 b cum of groundwater. Current use, however, forms only less than 20 percent of the surface and 10 percent of the sub-surface water resource potential. Such a low level of utilization is partly due to water quality constraints and partly due to spatial inconsistency between water availability and water demand. Of the 12 drainage divisions, only five covering just 26 percent of national territory accounts for 88 percent of the total exploitable water resources. Agriculture accounts for about 80 percent of the total water use and irrigates about 1.7 mha. Almost four-fifths of this irrigated area is concentrated in the Murray-Darling basin--the major inter-state river basin covering parts of New South Wales (NSW), Victoria, and Southern Australia. While the water sector in Australia, as in most countries, is oriented towards its irrigation segment, urban as well as recreational and ecological concerns still remain on top the of water sector agenda. The outstanding problems facing the Australian water sector are:

- Maintaining water quality and protecting water-based ecological systems;

- Controlling further stress on the already expropriated rivers and depleted aquifers;

- Fine-tuning the institutional basis for water sharing and market-based allocation;

- Extending the substitution of economic instruments for administrative regulations;

- Reshaping the relationship between government and community on the one hand and the government and private sector on the other hand

- Improving the physical health of water storage and distribution infrastructures; and

- Enhancing the financial and investment self-dependency of the water sector.

All these are challenges facing a maturing water economy that tries to operate increasingly on an economic rather than on an administrative or political realm. Most of these issues are being addressed by the reform initiatives undertaken since 1994 when the agreement are: improving water quality and environment, refining water rights system and water allocation

procedures, pricing water through independent review, and promoting community participation. Since compliance with these principles entails attractive federal money, most states have already come out with time-bound action plans for initiating additional water sector reforms. The NSW government is the first to pricing process and also to have both a comprehensive reform package as well as a framework for its implementation. As part of its reform initiatives, NSW has adopted a three level stress based classification of its rivers and aquifers as the framework for controlling water pollution and water over-exploitation. The state has also constituted the Healthy River Commission with the task of monitoring and maintaining water quality and in-stream flows in all stressed rivers. Community-based Water Advisory Councils have been established both at the state as well as at the level of all stressed river and aquifer areas with the express purpose of involving users in the water sector reform process (see DLWC, 1997a and1997b). Another very unique experiment involving inter-state initiative to control water stress and water quality deterioration is the agreement reached by the Murray-Darling Basin Ministerial Council in 1995 calling for a collective cap on water extraction at the 1993-94 level. It is certainly a difficult challenge to reverse water use to a reduced level observed in the past. But, both the existing system of volumetric water allocation across regions, sectors, and individuals as well as a high level of political commitment prompted mainly by an imminent threat to everyone

within the basin enhance the prospects of achieving the agreed cap. There are also notable developments at sub-sectoral levels. Corporatization, i.e., the conversion of public water utilities into commercially viable autonomous entities, and privatization are also increasing both in the urban (e.g., Hunter Water in 1991 and Sydney Water in 1994) as well as in the irrigation (e.g., Murray Irrigation Area and Coleambally and Murrumbidgee Irrigation Area in 1997) sectors. The ongoing institutional changes in Australia are going to further strengthen the role of economic instruments and market-based water allocation while, at the same time, improve the physical health and sustainability of water sector[33].

SOUTH AFRICA

South Africa, a country building a democratic polity out of an erstwhile apartheid system, covers an area of 1.3 million sqkm and a population of 42 million. Mean annual precipitation is 497 mm. The total utilizable water resource potential is 35.4 bcum--30 bcum from surface and 5.4 bcum from sub-surface sources. Of the total potential, 50 percent of surface water and 37 percent of groundwater are already developed and utilized [Departmentof Water Affairs and Forestry (DWAF), 1985]. As to the inter-sectoral share, agriculture accounts for 55 percent, domestic sector for 8 percent, and mining and industrial sectors for 16 percent with the rest

[33] Based On Water Challenge And Institutional Response:A Cross-Country Perspective by R. Maria Saleth And Ariel Dinar

is being to meet environmental needs. Although the irrigated area of 1.3 mha--1.1 mha by surface water and 0.2 mha by groundwater--represents just10 percent of the cultivable area, irrigation cannot be expanded much beyond due to the limited availability of irrigable lands [see Water Research Commission (WRC), 1996:28].

Of the total irrigated area, 44 percent is under private (mostly groundwater) irrigation, 30percent is under irrigation boards, and the rest is under public irrigation (WRC, 1996:35). The use of irrigation technology is very high in South Africa as indicated by the area shares of sprinklers (54 percent) and micro irrigation (12 percent). Human right and socio-economic issues that become important in the new South African setting have reoriented the focus of water sector from its power, mining, and industrial segments towards its irrigation and domestic segments South Africa has a three-tiered federal system with national, provincial, and local governments. According to the new Constitution, water resource planning and development functions are with the national government whereas agriculture, the major water user, is with the provincial governments. The local municipal governments have the responsibility for domestic and industrial water supply. The water sector in South Africa is undergoing radical changes due to the new water law that forms part of an overall process of post-Apartheid economic and political reconstruction. As a result, the 1956 water law is going to be soon replaced by a new law currently at

the approval stage. The new law that aims to correct existing inequalities in the water sector defines a modern frame work conducive for decentralization, market-based water allocation, full cost recovery, and economically rooted water management. Although the law makes water resource as a public property, it does allow private and tradable use rights obtainable through application from the DWAF. While the law aims to reorient and strengthen existing water administration including research organizations, it also calls for the creation of new structures like basin entities (e.g., the Catchment Management Agencies) within which existing water distribution agencies like irrigation boards and municipalities will participate as stakeholders along with farmer groups. Although WUAs are there at present only in the sugarcane zones and in the public irrigation systems having farmer liaison committees, they are to play an active role in water distribution and management in future. In urban sector, utility-type autonomous organizations are planned. The water courts created under the earlier law are to be replaced by more accessible Natural Resources Courts and any conflicts not solved either by these courts or by the DWAF can go to regular courts for their resolution. Since these reform proposals address most of the traditional water sector concerns, they, if implemented effectively, could vastly improve the capability and performance of the water sector. The key challenges facing the South African water sector at present are, therefore, related essentially to implementation aspects like:

- Building technical and information capacity within the water sector;

- Modernizing existing projects to allow volumetric allocation and improve delivery efficiency necessary for the eventual introduction of the proposed water permit system;

- Enhancing the regulatory and monitoring capabilities of the DWAF for establishing permit-based water allocation system;

- Developing strong WUAs as an organizational basis for water distribution, system maintenance, cost recovery, water transfers, and conflict resolutions;

- Achieving high degree of coordination not only among various layers of water administration--both the existing and the proposed ones--but also among various levels of government;

- Resolving the conflict between the economic goal of full cost recovery with the equity goal of supporting the underprivileged; and

- Integrating water quality and ecological concerns within the system of private and group-centered water allocation and management.

The document titled as the 'Fundamental Principles and Objectives of a New Water Law in South Africa' as approved by the Cabinet in November 1996 provides an agreed framework for a new water law. Similarly, the

'White Paper on a National Water Policy for South Africa' prepared by the DWAF (1997) outlines the contour of a new water policy. Notably, both these documents give top priority for capacity building, information gathering, and human resource development inwater sector. The critical need to link existing research, training, and technical agencies--both in the public and private sectors--with the main line water administration is recognized. As a way of promoting regulatory/monitoring specialization within water administration, there is also a recent proposal for creating a National Public Water Utility for the express purpose of financing, developing, and operating all water infrastructures in the country.

The relative success of water boards, the regional public utilities for bulk water supply, has led to the proposal for the creation of new regional water utilities. Some of these proposals have already been crystallized as in the case of Lesotho Highlands Water Project and Komati Basin Water Authority. Water charges, which are prevalent only in public irrigation at present, will be increased and extended also to private irrigation to cover not only the operation and maintenance and capital costs but also other components like research levy and water conservation/management fees. To preserve equity, water charges will vary by regions and projects with an added scope for subsidizing the poor on the demand rather than on the supply side. One of the major gaps in the reform proposal is related to water use-induced environmental effects including water logging and salinity that

are serious problems in a quarter of the area currently under irrigation. Under the present set-up, it is not clear whether it is the national or provincial governments that will address these problems as both have concurrent responsibility in environment management. This issue, like the general issue of achieving administrative and operational coordination in water management, can, however, be addressed by establishing effective liaison committees. The major reform challenge lies in achieving the equity goal of water redistribution to favor the hitherto neglected groups without creating uncertainty among investors. However, if the reform proposals are operationalized in their original form without much political compromise, South Africa can be in a stronger position than many African and Asian countries to improve its water sector performance[34].

SUMMARY

In the coming decades, water crises will likely become increasingly common. At the present rate of population growth, the mother earth's capacity to support life will be severely strained. Globally there is urgent need to pay attention to reforms in water sector to ensure equitable and balanced distribution to all the competing sectors and the under privileged .There is new awareness to blend in ecological aspects in water conservation. While mature economies like Australia continue to fine tune

[34] Based On Water Challenge And Institutional Response: A Cross-Country Perspective by R. Maria Saleth And Ariel Dinar

their water policies, developing countries like South Africa have recognized importance of defining water rights and institutions to develop water policies. Maintaining ecosystems integrity especially in the era of climatic changes will be the key challenge to the global water security in the coming decades.

CHAPTER III

WATER CRISIS IN INDIA

A common scene in most parts of India is women and children trudging long distances balancing pots of water on their heads for their basic daily needs. In water scarce Western India, irrigation pumps work 24 hours a day, while poor women find their drinking wells run dry"[35]Cases of water exploitation, scarcity and migration have become abundant.:-

Bhanwar Lal Yadav, resident of TEJA KA BAS, Rajasthan was once a cultivator of cucumber and wheat. He has all but given up growing food and has reinvented himself as a vendor of the most precious commodity of the area viz. **the water under his land**. Each year he bores ever deeper. His well has reached 130 feet down. He reaps handsomely, and he plans to continue for as long as it lasts. In another village in Rajasthan- Peeplee Ka Bas, growing water shortage has lead to large scale migration of its men to seek work elsewhere. The women remain to spend the blistering summer mornings digging ponds in the barren earth, under the public works programme, hoping to catch monsoon rains.[36] It had not been the case always. The village had seen better days of farming and prosperity earlier.

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[35] Lyla Mehta,EPW,2003.

[36] Thirsty giant by Somini Gupta published in The New York Times)

But even fertile, rain-drenched pockets of the country are not immune. In the state of Punjab, India's northern bread basket, 79 percent of groundwater blocks are classified as overexploited or critical; in neighboring Haryana, 59 percent; and in southern tropical Tamil Nadu, 46 percent (Annexure I). Displacement of traditional wisdom by the modern technology of tube wells has indeed been responsible for this situation. In hindsight one could wish that both had co existed.

DEMAND AND USAGE OF WATER

The National water commission (NCIWRDP) has estimated that the total water requirement of the country in the year 2050 would be about 973 bcm on the lower side and 1180 bcm on the upper side depending upon the actual population growth. The union ministry of water resources, however, on the basis of other studies has estimated the country's water requirements to be around 1093 bcm for the year 2025 and 1447 bcm for the year 2050. Thus the total water requirement of the country would barely match or even exceed the available utilizable water resources.

COMPETING SECTORS FOR WATER

The present extent and purpose of water utilization for various purposes is as under:

Purpose	Present utilization (bcm)

Irrigation	501
Domestic	30
Industrial	2o
Energy	20
Others	34
Total	605

Agriculture

Despite the recent rapid growth in the services and industrial production, agriculture is still an integral part of our economy and society. The rural economy sustains two-thirds of India's 1.1 billion citizens[37]. Between 1947 and 1967 the country underwent the Green Revolution, which concentrated on expanding farm yields by double-cropping existing farmland and using seeds with improved genetics. The result was a huge increase in agricultural production, making India one of the world's biggest exporters of grain. In addition, we achieved the goal of obtaining food security. The availability of canal water led farmers to adopt highly profitable, but extremely water intensive crops, such as sugar cane.[38]

[37] Giridharadas, Anand. "Water-scarce India, too, Weighs a Return to Ancient Practices." *International Herald Tribune*, 20 Aug 2005
[38] http://www.tribuneindia.com/2005/specials/tribune_125

Unfortunately, this huge surge in agriculture, required significant water resources for irrigation and accelerated the onset of present water shortages.

India's agricultural sector currently uses about more than 80% of total water resources. Irrigated agriculture has been fundamental to economic development, but unfortunately caused groundwater depletion. Due to water pollution in rivers, India draws 80% of its irrigation water from groundwater.[39]

Domestic

India's 1.1 billion people need access to clean drinking water. The demand for drinking water is divided between the urban and rural populations, and comprises about 5% of total water demand. Due to the amenities of typical urban life, such as flush toilets and washing machines, people living in cities tend to lead more water intensive lives. The urban population has doubled over the past 30 years, now representing 30% of India's total population[40] and is expected to reach 50% of the total population by 2025.[41] Population growth is going to accelerate the water crisis in India, especially as more and more people move into the cities and become part of the middle class. Because the rivers are too polluted to drink

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[39] World Bank Report, India's Water Economy: Bracing for a Turbulent Future (2005)
[40] Ibid
[41] "India's Population to Reach 1.5 Billion by 2025" http://www.dnaindia.com/report

and the government is unable to consistently deliver freshwater to the cities, many urban dwellers are turning to groundwater, which is greatly contributing to the depletion of underground aquifers. Rural citizens face a similar crisis. Currently 30% of the rural population lack access to drinking water, and of the 35 states in India, only 7 have full availability of drinking water for rural inhabitants.[42] Most people who live in rural areas demand less water for day-to-day living than people living in cities, and the majority of their water demand comes from agricultural needs.

Industrial

Water is both an important input for many different manufacturing and industrial sectors and used as a coolant for machines, such as textile machines. Cheap water that can be rapidly pumped from underground aquifers has been a major factor in the success of India's economic growth. For example, the garment industry in Tirupur, a city in the southern state of Tamil Nadu, was growing faster than anyone thought possible for several decades. By 1990's, however, the town had run out of water, which is a critical input for dyeing and bleaching.[43] Despite the many benefits from a thriving economy, industrial waste is largely responsible for the high levels of pollutants found in India's rivers and groundwater. Many corporations end up polluting the very water they later need as an input. Industrial water

[42] India: Water Supply and Sanitation – UNICEF Study (2002), 31
[43] "A Water Revoultion Fuels Industry", USAID (2006)

use in India along with energy stands at about 40 billion cubic meters or nearly 7% of total fresh water utilization, this demand is expected to increase dramatically in the next decade, given the enormous forecast of 9% growth for 2007.

WATER SUPPLY OF INDIA

Although the country receives 4500 Billion cubic meter (bcm) of rain fall and snow fall, the average runoff .is about 1869 bcm. The National Commission for Integrated Water Resources Development has estimated that as against a total annual availability of 1953 km3 (inclusive of 432km3) of ground water, approximately 690km3 of surface water and 396km3 from ground water resources, making a total of 1086 km3 can be put to use. However the commission has also acknowledged that pollution problems have been growing posing a serious threat to availability and use of water.

SURFACE WATER RESOURCESWATER SUPPLY OF INDIA

India has an average annual rainfall of 1170mm. Though this can be considered reasonably good, its net value is considerably reduced because of regional and temporal variations. Some areas have harmful abundance resulting in floods and some areas have acute scarcity resulting in drought. The average annual rainfall in western Rajasthan is 100mm and it is 11000 mm in the Northeastern region. More than fifty per cent of precipitation takes place in less than 100 hours during the four months of June to

September. The rainy days may be about five in the desert areas and about 150 in the north–east. Due to this peculiar pattern of rainfall, about forty million hectare (mha) of agricultural area is flood prone, and about 108mha is drought prone. Eighty percent of the run off in the Himalayan Rivers and ninety percent of runoff in the peninsular rivers occur during the months of June to September. The depletion of forests has aggravated the problem. Reduced infiltration results in smaller dry weather flows. Heavy silt concentration has resulted in deposition of silt in the flood plains, as the shrinking river channels cannot transport excessive silt loads. This has reduced valley storage resulting in higher flood peaks. The occupation of flood plains and increased development and cultivation have contributed to increased flood damage. The impact of droughts are even more severe than that of floods and leaves a permanent imprint on the economy and morale of the people. The vulnerability of certain regions to water scarcity is illustrated by the case of Teja Ka.Bas and Peeplee Ka Bas, Rajasthan. Even those who live in areas of high rainfall often face drought because the landscapes have been denuded. The region of Cherapunji in Meghalaya is an example. Because of heavy seasonal rainfall and the nature of topography, much of the run off cannot be retained. The region now suffers from excessive flooding for three to four months and frequent droughts during the rest of the year.

Ground water resource

There was an extraordinary 'quiet revolution', in which, beginning around 1960, ground water irrigation developed at an explosive rate, while tank irrigation almost disappeared and surface water irrigation grew much more slowly.[44]

Over the last two decades, 84% of total addition to net irrigated area came from ground water, and only 16% from canals. At present the net irrigated area by private tube wells is about double the area of the area irrigated by canals[45].

The planning commission of India has admitted that the extent of extraction has increased significantly over the years, as indicated by the growth in the number of tube wells served by ground water. It is estimated that there are currently 19 million tube wells in the country, out of which 16 million are in use and are drawing about 231 bcm of water – 213 BCM for irrigation and 18 BCM for domestic and industrial use out of net annual ground water availability of 399BCM.

According to the report of 3rd census of minor irrigation schemes (2005), in many states, the irrigation potential created has exceeded the

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[44] Somini Sengupta. "In Teeming India, Water Crisis Means Dry Pipes and Foul Sludge." *New York Times*, September 29, 2006

[45] World Bank Report, India's Water Economy: Bracing for a Turbulent Future (2005)

ultimate potential, showing that mining of ground water, that is exploitation beyond the dynamic source is already taking place.

The Mid – term appraisal (MTA) of the Tenth Five Year Plan states that the rising demand for ground water from agriculture is the prime cause of over-exploitation of water. Decisions on cropping pattern and cropping intensity are taken independent of the status of ground water availability. Water intensive crops are grown even in face of scarcity of ground water, if those crops are perceived to be more remunerative. The problem is aggravated by the availability of cheap and subsidized power. The legal or regulatory regime governing ground water is not geared to address scarcity or demand management. As per the current legal position ground water belongs to the owner of the land whether it is a corporate or an individual. The World Bank study on Indian water economy states that user-friendly nature of ground water and inefficient water supply service by the State are a major reason for the popularity of ground water among Indian farmers[46].

As per the joint assessment carried out by the State Ground Water departments and CGWB in the country, 550 units out of 5723 units are semi critical(10%), 226 are critical (4%) and 839 are over exploited (15%). The

[46] World Bank Report, India's Water Economy: Bracing for a Turbulent Future (2005)

percentage of over exploited blocks have increased from 4% to 15% from 1995 to 2004 is a matter of grave concern[47]

The over all stage of ground water development in the country is 58%. But in the water scenario of India the averages are deceptive. There is high degree of variability in availability and development across the country[48]. All water issues are local issues. At local levels many of the most highly productive localities are already under severe ground water stress. (Annexure I)

Over exploitation has led to increase in pumping depths, reduction in yields in wells/tube wells and rise in cost of pumping ground water. The Delhi Jal Board, which is responsible for supplying potable water, estimates that water tables are dipping by an average of 0.4 meters a year.[49] This in turn has caused wide spread scarcity of ground water forcing farmers to dig deeper as in the case of Teja ka Bas and Peeplee Ka Bas. Another major fall out of ground water exploitation has been contamination of ground water, resulting in increasing arsenic, fluoride and iron content. Since 85% of rural

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[47] Ground Water Management And Ownership, Report of the Export group Government of India, Planning Commission,2007

[48] Ground Water Management And Ownership, Report of the Export group Government of India, Planning Commission,2007

[49] Ramachandran, Asha. "Any Hope for India's Water Woes," India/Kerala News, 2006

water supply programme depend upon ground water as a source, its effect on the health of rural population is a matter of grave concern[50].

In addition to human health there are startling changes to the environment that have been observed as the human society continues wider consumption of groundwater ecosystem:

1. Organic loading of the subterranean environment (such as toxic chemicals like pesticides, various salts (potassium chloride, potassium nitrate) and heavy metals) lead, to extinctions of animals. It modifies the surface vegetation, especially leading to the disappearance of many plants. India has a total of 89,451 animal species accounting for 7.31% of the faunal species in the world and the flora accounts for 10.78% of the global total. According to the Red List of Threatened Animals, 44 plant species are critically endangered, 113 endangered and 87 vulnerable. Amongst animals, 18 are critically endangered, 54 endangered and 143 are vulnerable. Ten species are Lower Risk conservation dependent, while 99 are Lower Risk near threatened.

2. Water erosion in many semi-arid and arid regions has lead to decrease of soil fertility and land subsidence.

3. Shallow aquifers loaded with high concentrations of organic matter from anthropogenic activities (i.e. in areas of organic waste disposal) release

[50] Ground Water Management And Ownership, Report of the Export group Government of India, Planning Commission,2007

nitrous oxides by denitrification. The concentration of this gas in contaminated aquifers is up to three orders of magnitude higher than that expected in equilibrium with the atmosphere and is responsible for acid rains and ecosystem damage.

CLIMATE CHANGE

Climate change is certain to exacerbate the depleting supply of water. As the climate warms, glaciers in the Himalayas and the Tibetan Plateau have been melting. According to the IPCC, global temperatures have warmed by 0.76 Celsius over the last 100 years.[51] This will result in increased flooding initially, especially during the monsoon season when rainfall is already at its heaviest. However, in subsequent years, there will be less and less glacial melt water to continuously supply India's rivers. Nearly 70% of discharge to the River Ganges comes from Nepalese snow-fed rivers, which means that if Himalayan glaciers dry up, so could the Ganges.[52] The Ganges has numerous tributary rivers which supply water to hundreds of millions of people across India. Therefore, if the Ganges even partly dried up, it would have drastic consequences for a huge population. The glaciers, which

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[51] Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.pg. 5

[52] Navin Singh Khadka, "Himalayan Melting Risk Surveyed." *BBC News, Kathmandu*, 5 March 2006

regulate the water supply to the Ganges, Indus, Brahmaputra, Mekong, Thanlwin, Yangtze and Yellow Rivers, are believed to be retreating at a rate of about 33-49ft each year.[53]

Climate change also has an effect on rainfall patterns, but how it will affect them is still uncertain. Nonetheless, scientists agree that climate change will ultimately make rainfall more erratic and cause unpredictable weather. Many believe the increased average water temperature in oceans; will increase the probability and intensity of monsoons during the summer.[54]

POLLUTION

A combination of sewage disposal, industrial effluents, chemicals from farm runoffs, arsenic and fluoride has rendered India's rivers unfit for drinking, irrigation, and even industrial purposes.[55]

New Delhi alone produces 3.6 million cubic meters of sewage every day, but less than half is effectively treated. The remaining untreated waste is dumped into the Yamuna River. New Delhi actually cannot get rid of the sewage it produces because 45% of the population is not connected to the public sewage system. Meanwhile, the quantity of sewage is constantly

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[53] "Himalayan Glacier's Melting Fast." *BBC News,* 14 March 2005
[54] World Bank Report, India's Water Economy: Bracing for a Turbulent Future (2005)
[55] Ramachandran, Asha. "Any Hope for India's Water Woes," India/Kerala News, 2006

increasing due to population growth. When the water reaches downstream cities they have to heavily treat it, which subsequently drives up the cost.

Every river in India is polluted to some degree. As brought out before, the water quality in underground wells also violates the desired levels of dissolved oxygen and coliform, the presence of which is one measure of filth, in addition to having high concentrations of toxic metals, fluoride, and nitrates. [56]

[56] India: Water Supply and Sanitation – UNICEF Study (2002), 30

CHAPTER IV

WATER MANAGEMENT IN INDIA

Famine being the way of life in the days of Raj, independent India gave high importance to harnessing its great rivers. The first two or three plans had component of multipurpose river projects like Bhakra that Nehru called temples of modern India. These projects laid the foundation for India's economic growth and the first green revolution. They contributed in a huge way to the economic development of the country and also to feed its burgeoning population. But the aspects of rehabilitation were not handled well, resulting in resentment and mistrust among the displaced peoples especially the tribal. The administrative and political understanding of ecological impacts was also limited. Thus water management was approached more as an engineering solution and as a supply side management.

Still the storage capacity that has been created over years is considered highly inadequate, India has relatively little capacity to store water. For example, whereas there is about 900 days of storage capacity on the Colorado and Murray-Darling Rivers, there is only about 30 days of storage capacity in most of India's river basins.

Accordingly major investments need to be made to increase capacity to store water, in both surface and groundwater reservoirs, in projects small (such as local rainwater harvesting) and big (such as large dams). In so doing, however, there is a need for concomitant adoption of quite different development and management strategies. It must be understood that storage projects should primarily be for improving the reliability of supplying existing demands and for meeting historically deprived environmental uses, and not for creating and serving new demands (which simultaneously inevitably means curtailing existing downstream uses.)

Efficiency of irrigation structures

There is large gap between the irrigation potential created and utilized (14mha)[57]. Lack of field channels, poor condition of canals, silting of reservoirs, changes in the cropping pattern from that envisaged at the time of project formulation are sited as some of the reasons[58]. The water use efficiency in most projects is less than 40%. Besides large number of irrigation projects are incomplete resulting in cost over run.

Low water charges in most of the states has left them with very little fund to invest in maintenance of the existing structures. Another major factor in the issue is that the public agencies which provide these services

[57] A.Sekar,Water resources Management in India- An A introspection. The Indian journal of public Administration, Vol XLIX,no3.
[58] ibid

are hugely over-staffed. Mumbai Municipal Water Corporation, for example, has about 35 workers per thousand connections, whereas well-functioning utilities have about 3 workers per thousand connections. And the UP Irrigation Department employs an astonishing 110,000 people. The politics of these public enterprises is such that salaries have the first call on revenues – in Haryana, for example, 83% of the allocation for irrigation operation and maintenance goes to paying salaries. The maintenance of water infrastructure is woefully short of standards, as a result India is sporting leaking dams and reservoirs[59].

Legislation on ground water extraction is absent resulting in precarious condition in many parts of the country. Under the present regime, which dates back several decades, the land owner is given the right to capture an unlimited amount of ground water from beneath his land with out being liable to injury to adjacent land owners caused by excessive pumping. The approach was adequate when the demand was limited. Now with the crisis looming large there is a need to change the approach.

Cropping pattern and water pricing

Cropping pattern and water pricing are politically decided. Due to lack of legislation this is dictated by power and influence rather than need and prudence. Hence, end less paddy - wheat- paddy –paddy, paddy –

[59] World Bank Report, India's Water Economy: Bracing for a Turbulent Future (2005)

sugarcane are followed in states like Punjab, Haryana, west UP, Peninsular delta and MP and Karnataka resulting in soil depletion and environmental damage. Free electricity and minimum support price packages have made these patterns highly profitable. The result has been mining of water, poor maintenance and reduced efficiency of water storage and distribution systems, water logging and salinity, bankrupt electricity boards. Till recently there have also been occasions where FCI godowns were over flowing with rotting grain due to inadequate off take or export possibilities (without the support of MSP), when millions go starving.

A major constraint in following a holistic uniform water management policy is that water is a state subject, included in entry no: 17 of the list II in the seventh schedule of the constitution. Water has been a politically touchy issue with many unresolved conflicts between the riparian states. Though entry 56 in the List I empowers Centre to legislate on inter state rivers, by and large the centre has followed the 'wait and watch approach'. As a result there has been unviable exploitation and shortsighted management practices by both upper and lower riparian states resulting in permanent ecological damages.

WAY FORWARD

The country must move purposefully towards demand management. This has to include pricing, Cropping patterns, modernization, use of

technologically superior methodologies like sprinkler and drip irrigation, conservation and recycling, pollution control, all methods of water harvesting etc.

Pricing of Water

The water sector in India is under enormous financial stress. There is a huge liability from deferred maintenance. And the stock is such that even once rehabilitated, the annual requirement for maintenance and rehabilitation would be equal to all public funds currently invested[60]. This has been politically most sensitive issue too, as some state governments had unsuccessfully tried to impose electricity charges on the farm use but subsequently had to withdraw the same. Actually this is a vicious circle where the public do not have faith in the service delivery of the State and refuse to pay and the State is consequently unable to deliver. Though the state cannot overnight improve its credibility, innovative methods like water stamps to the needy and community participation can be tried for better governance.

Cropping patterns and water scarcity

As we have seen the largest demand for water comes from agricultural sector. Huge investments were made in the infrastructure of multi purpose dams. Water was the major component in the green revolution

[60]World Bank Report, India's Water Economy: Bracing for a Turbulent Future (2005)

to achieve food security. The expansion of irrigation to ensure the success of green revolution resulted in the increase in food grain production from 50 million tones in 1950-51 to 203 million tones in 1999 -2000. Reference- Annexure II- Shift in cropping pattern in India.

During these fifty odd years not only more area has come under cultivation but the cropping intensity has also increased. Understandably the area under food grains and especially cereals occupies the pride of place though the percentage of area under cereals decreased from 61.1% in 1950-51 to 52.6% in 2003, due to increase in productivity and better technology. Among the cereals the water intensive crops of rice and wheat have increased at the cost of drought resistant coarse cereals like jowar, bajra, ragi and barley. Area under pulses has also been compromised in favor of rice and wheat. Pulses are leguminous crops and fix nitrogen from the atmosphere. They do not respond to irrigation or fertilizers which were the main inputs in green revolution. The tragedy is that pulses cultivation is an important component in sustainable agriculture.

Another important water intensive crop that has contributed to water scarcity after the introduction of tube wells is sugar cane. The area under sugar cane cultivation increased from 1.71 mha in 1950-51 to 4.00 mha in 2003-2004. The production went up from 57.05 million tones to 236.18

tonnes. The yield has also increased along with coverage under irrigation. Presently this crop is almost entirely irrigated.[61]

An interesting study has been done by the Kellogg School of management on the water cost of various crops. Based on the water needs of each crop, the study has arrived at the water cost per hectare for 33 crops ranging from rice to fruit crops (Anexure-III). The highest water cost goes to Sugarcane, a whopping 35,538 rupees per hectare at a water cost of 25paise per 1000 litres. If the water cost is increased to 50 paise per litre and included in the cost, the gross margin on the revenues will fall most dramatically for sugarcane.

The writing on the wall is very clear. There is a need to draw up cropping patterns for various regions with the aim of preserving sustainable recharge of ground water and produce more value per drop of water. Government policy in terms of MSP does not operate for sugarcane and it is supported by a strong industrial lobby which consumes the bye product of sugarcane.

Charging the sugarcane growers for the water used along with provision of replacement crops would be the most viable policy to wean away sugarcane farmers from mindless water mining.

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[61] Agricultural Statistics published in the web site of the Ministry of Agriculture, Govt of India

The government should manipulate the mechanism of MSP to divert cropped areas to drought resistant jowar, bajra and ragi. The modern medical science has discovered the therapeutic and nutritive values of these coarse cereals due to their natural fiber and high glycemic index. Promotional bodies are required to popularize the consumption of these coarse cereals and pulses so that farmers get the right price in the market for these crops. It would be attractive and innovative to create niche markets for these products in India as well as abroad.

Defining water entitlement

Public ownership of both ground and surface water should be recognized. The water entitlements (of individuals and communities, including traditional users) need to be separated from land rights. Moving towards a formal water entitlement system requires clarifying that water is publicly owned and that water entitlement is usufruct— it is a right to use, not a right to own water.

The real question is who has what kind of right to use water, and what corresponding duties attach to it. Once established, such entitlements give rise to a series of fundamental and healthy changes. First, those requiring additional water (such as high-value agriculture and people living in growing cities) will frequently be able to meet their needs by acquiring the entitlements of those who are using water for low-value purposes.

Second, there are strong incentives for low-value water users to voluntarily "forebear" from use, making reallocation both politically attractive and practical.

India has encouraging examples where communities have volunteered to define and use their water entitlements, which are discussed in detail in the succeeding chapter. Thus it involves essentially scaling up of such community initiatives. In the pioneering watershed management project in Sukormajri initial entitlements were distributed to all in the village, giving people a valued new asset. Many of the poor later chose to cash in their entitlements by selling them to landowners who could put the water to better use.

CHAPTER V

CASE STUDIES OF WATER MANAGEMENT BY COMMUNITY PARTICIPATION

There are many cases where communities have taken the initiative to augment and manage this precious resource. They have shown the way of defining water entitlements which the government has always shied from. These exemplify the democratic and enterprising spirit of the Indians

SUKHOMAJRI

Sukhomajri, located near the city of Chandigarh, has the distinction of being the first village in India to be levied income tax on the income it earns from the ecological regeneration of its degraded watershed. In 1979, when the nation was facing a severe drought, the villagers built small tanks to capture the rainwater and agreed to protect their watershed in order to ensure that their tanks did not get silted up. The tanks have helped to increase crop production by nearly three times. The protection of the forest area has greatly increased grass and tree fodder availability. This, in turn, has increased milk production. With growing prosperity, Sukhomajri's economy has undergone a change.

A combination of public, private and community investments and the participatory efforts of the villagers have lead to, a rate of return of the order of 19 per cent. One of the most impressive savings resulting from the project is in the cost of desilting the Sukhna Lake, which supplies water to the downstream city of Chandigarh. The inflow of sediment has come down by over 90 per cent. This saves the government Rs. 76.5 crore each year in dredging and other costs.

In Sukhomajri, the main incentive for the villagers to protect their watershed came from the assurance they got from the forest department that they would have the right to the usufruct of the degraded forest land. The villagers argued that as they were protecting the watershed, they should get the benefits from the increased biomass production. The state forest department agreed to give the grass rights to the village society as long as the villagers paid the forest department a royalty equivalent to the average income earned by the department before the villagers started protecting the watershed. The villagers pay their village society a nominal amount to cut grass in the watershed. A part of this is used to pay the forest department and a part is used to generate community resources for the village.

In Sukhomajri, the effort made was to distribute water equitably by breaking the relationship between land and water .i.e. by implementing usufruct right. In other words, every resident was given the right to water, which could be traded by the landless or the people with land in the areas

not irrigated by the ponds, with others for a share of the crop. This 'right' lead to cooperation in the village to protect the watersheds which in turn lead to increased grass productivity. Once grass availability increased and equally shared, this became the driver for cooperation in the village[62].

RALEGAN SIDDHI

Ralegan Siddhi is a village situated in a drought-prone area of Maharashtra where the annual rainfall ranges from 450 mm to 650mm only and where the villagers were once not even assured one regular crop.

In 1975, the village was stricken by poverty. It had hardly one acre of irrigated land per family. Krishna Bhaurao Hazare - a retired driver from the Indian army - began work in the village by constructing storage ponds, reservoirs and gully plugs. Due to the steady percolation of water, the groundwater table began to rise. Simultaneously, government social forestry schemes were utilised to plant 300,000-400,000 trees in and around the village. Because of the increased availability of irrigation water, land that was lying fallow came under cultivation and the total area under farming increased from 630 hectares to 950 hectares. The average yields of millets, sorghum and onion increased substantially.

Every effort was made in the village to ensure equitable access to the resources generated. Water is distributed equitably by building a system of

[62] Sunita Narain, Community led Alternatives to Water management: India Case Study. Human Development Report Office Occasional Paper

community wells. In other words, all households have equal access to water from these wells, for drinking and irrigation. Furthermore, to build equity in water distribution, only low water-consuming crops were allowed. The treatment of the watershed and the conservation of water have lead to increased availability of groundwater in the community wells. Water from these wells, supplied at a moderate price, has enabled farmers to grow two to three crops a year including fruits and crops, some of which are exported all the way to Dubai.

By the late 1990s, not a single inhabitant of the village depended on drought relief. Incomes have increased substantially. Over a quarter of the households earn over nearly half a million rupees a year. Ralegan Siddhi's income distribution is also much less skewed than that of rural Maharashtra.

Ralegan Siddhi is, in fact, so rich that it has now even got a branch of a major bank in the village itself. The total savings of Ralegan Siddhi villagers alone is reportedly Rs. 3 crore. For a village that was less than two decades ago, a drunkard's den with a badly degraded environment, this is indeed a miracle.

An impressive system of decision-making has been created in the village. Some 14 committees operate to ensure people's participation in all decision making. *Gram Sabha* (village assembly) was created to take community decisions, which acts as the most important forum for collective

decision making in a village. Since villagers are involved in the planning and decision making process, they are more open to any changes taking place in the village. The purpose of the *Gram Sabha* is, therefore, to involve every villager in the development process and exert social pressure wherever required.

It is important to note that water equity concepts differ between the villages of Sukhomajri and Ralegan. In Ralegan, the right is shared equally in all households, which own land and use irrigated water. The increased employment created because of increased productivity of the private land has lead to income generation even in the poorer households, thus engendering cooperation. The treatment of the watershed and the conservation of water has lead to increased availability of groundwater in the community wells. Water from these wells, supplied at a moderate price, has enabled farmers to grow two to three crops a year including fruits and crops, some of which are exported all the way to Dubai[63].

ARVARI RIVER

Rainwater harvesting has brought the river Arvari in dry and drought-prone Rajasthan back to life. The river flows through a drought stricken region – villagers living on the margins of survival are desperately poor and

[63] Sunita Narain, Community led Alternatives to Water management: India Case Study. Human Development Report Office Occasional Paper

find sustenance by migrating for work to cities. According to historical records of the region, the river Arvari, used to provide groundwater recharge to wells in the area. But nobody can remember seeing it flow except during the short monsoon period. Even the very old remember a dead and dry stream. The river – in its 45 km journey to its confluence in the reservoir of a dam on the river Sainthal – flows through 70 odd villages. Its source lies in the degraded hills near the village of Bhaonta-Koylala.

In 1986, working with a local NGO, the Tarun Bharat Sangh (TBS) the villagers of Bhaonta-Koylala built a rainwater harvesting structure locally known as *johad* to trap the rainwater and to use it to recharge the groundwater. Since then more than 200 water harvesting structures have been built in the 70 villages in the catchment of Arvari. These small dams have helped to recharge the river – literally bringing it to life. Villages talk about Arvari's rebirth as if it was the birth of a child. It is a "hydrological miracle" say top geologists in the country.

Arvari's gradual way to a perennial life is similar to that of a child learning to walk. In 1990 it flowed till October. In 1991, till January next year. In 1992, till February next year. In 1993, till March next year. From 1994 it flowed till April and in 1995 the flow did not cease. It has been perennial since.

But with the water came the bureaucracy. In 1996 the villagers of Hamirpura living along the Arvari were told that a contractor had been given a licence by the state government to start fishing in the river. Under law the river is the property of the government and now that it had water, it was ready to take 'control' of its resource. But this time villagers were not going to keep quiet. They said, this was their river – a river to whom they had given birth – and they should be allowed a say in its management. Working with TBS, in January 1999 they formed a River Parliament, locally known as the *Arvari Sansad* – an association of all the villages along the river course. The meeting that declared the formation of the parliament adopted a constitution to manage the river. If it succeeds this "people's river parliament" will show the way ahead to a number of communities.

PANI PANCHAYAT

Fifty km from Pune, is the village of Mahur which, receives on an average 500 mm of rain every year. But high run-off in this hilly region leaves little water for cultivation. Fifteen years ago, the villagers depended on rain fed agriculture. The rate of out-migration used to be high, with one member of every family living in Mumbai.

But now, from an undeveloped, rocky, barren area, Mahur is showing signs of prosperity. The village is now dotted with fields of lilies, tube roses and other flowers, chickpeas, custard apple and maize. In 1971, the state

government had built a minor irrigation dam in the village to store rainwater. "For ten years, we did not know how to make proper use of it," said Srirang Balu Gole. "Then I heard about a scheme which would help people draw water through pumps. I mobilised some villagers to learn more about it."

Funds were raised through Gram Gaurav Pratishthan, government provided subsidy and the remaining amount was raised by the villagers and the Renukamata Upsa Jal Sinchan Prakalp took off in 1981. Three 30 hp pumps were installed to draw water in the fields of 35 members who had 50 acres between them, which was harnessed for irrigation.

The scheme was unique. Water was not distributed randomly nor did the largest landowner get a lion's share. Instead, each landowner was allowed to irrigate only 2 acres of land and water was distributed equally. One trained person ensured that no one was denied his share.

Now, one and a half decades later, Srirang Gole looks back with pride. "Earlier, I used to get only five quintals of Bajri. Now I get 50. From floriculture alone, I make Rs. 10,000 a month." However, not all farmers have been equally successful. Some earn Rs. 2,000 to Rs. 2,500 a month from floriculture alone while others work for daily wages. But overall, the village seems to have risen from its penury. Cropping patterns have changed for the better. Farmers now cultivate short-term seasonal crops which fetch

better returns. Flowers and fruits are the favourites. The farmers also grow pulses and grains for their own sustenance. Hirabai plucks fresh flowers every morning and sends them to Pune for sale. "Even if there is water, we have to work hard to make both ends meet. But it is better than before. Now there are trees to sit under and we do not starve." she says.

The experiment in Mahur is one of 50 such projects in Purandar, Ambegaon, Maval, and Phaltan talukas of Pune where the principles of Pani Panchayat scheme are in force. Mr. Vilas Salunkhe, the brain behind the scheme, is a mechanical engineer by profession. "I had no connection with villages or the problems of the poor as I had an urban background." But in 1972, moved by the devastating drought in the State, Mr. Salunkhe visited Purandar taluka (he calls it a social accident) where he saw nearly 40,000 people engaged in breaking stones as part of employment guarantee schemes.

"I could not fathom the connection between stone-cutting and drought. I asked the authorities about this strange way of tackling drought and nobody was interested in long-term issues," Mr. Salunkhe said. He met people who told him about the need for small schemes which would fulfill their demands for water.

In 1974, he set up the Gram Gaurav Pratisthan at Naigaon village in Purandar taluka, which was affected by the drought. He realised that

providing employment was one thing but making the people self-reliant was the basic issue. Naigaon, Mr. Salunkhe says, is the first example of micro-watershed development programme and land and water management. In Naigaon, annual rainfall fluctuates between 250 and 500 mm but most of it runs off in seasonal streams. To prevent this, a percolation tank was built and the fields were lined with contour bunds. For five years, Mr. Salunkhe experimented in water and soil conservation, designing low-cost community irrigation schemes, water regeneration and various other techniques to improve production.

It was not easy to convince people who were skeptical and reluctant to share water. A number of social hurdles had to be overcome. Besides producing nearly 200 quintals of foodgrains, the farm in Naigaon generated employment for 15 persons. The whole area was covered with hundreds of trees.

However, once water was harvested, the question of its management and distribution cropped up. In 1980, Mr. Salunkhe decided that apart from micro-watershed development, the economic needs of the village also had to be met. Various experiences at the farm in Naigaon proved that half an acre of irrigated land would sustain one person and on this basis, each family could have a maximum of 2.5 acres of irrigated land. Another concept, revolutionary at that time, was Mr. Salunkhe's insistence that the community should contribute 20 percent of the cost.

He evolved a few principles, the first being that water should be distributed to every villager, regardless of his land holding. "Instead of saying land to the tiller, we say water to the tiller. It is water that should be distributed on a per capita basis" he said. Emphasis was placed on cultivating low water requiring, short-term cash crops.

Even the landless must have access to water, so the question of land distribution also comes into the picture. When equal rights are given to water, land will automatically be shared, Mr. Salunkhe feels. Once the scheme in Naigaon showed promise, surrounding villages expressed a desire to adopt it. He feels that if such ideas can be incorporated into planning, their replication will not be a problem.

In 1981, the Centre appointed a committee headed by Mr. K.B. Shivaraman to oversee the development of backward areas. After visiting the area , under the Pani Panchayat scheme, he felt that the scheme could help solve tha problems of drought -hit Maharashtra by making some minor policy changes. Social justice and water distribution were the only ways of ensuring a solution to the people's problems, Mr. Shivaraman said.

Mr. Salunkhe says, "We have successfully conducted an experiment which has proved how the problem can be solved at the village level. We have tackled the issues of agricultural production and employment.

Unfortunately, in the absence of a government policy, it can only remain a model."

Even the planning Commission had recommended the incorporation of the Pani Panchayat scheme in the 20-point programme. But it needs more than a mere recommendation to make a concept operative. It has to be part of a national strategy.

At present, 1600 families in 20 villages benefit from the Pani Panchayat scheme. Over 3,000 acres of land sustain 10,000 people. Most of these villages are in drought-affected and even high rainfall areas where seasonal migration is common. Now, because of the availability of water, reverse migration is taking place though on a small scale. Of the 1,200 big dams in the country, 687 are in Maharashtra. But recurring droughts indicate that these dams have not helped mitigate water scarcity.

The Pani Panchayat Model has attracted interest in some parts of the country. Such as in Bihar's Palamau district, and Karnataka. Mr. Salunkhe said the replicability of the project was tested in the tribal area of Yavatmal by convincing the people, where the governor had been spending crores of rupees under the tribal sub plan. In Yavatmal, after the adoption of the scheme a woman who owned 40 acres now earns Rs. 4000 a month by renting it out to 20 farmers. Water is available but it has to be harvested and managed properly. Though there are schemes where volumetric water

supply is provided, lack of community participation can render them useless. Sharing water not only means using water judiciously but also making sure that everybody has a right to it.

Once the villagers are self- reliant, their energies turn to reforestation. In Muhur, there are plans to plant trees on barren hillsides. This idea has caught on in most of the project areas. In terms of sustainability, the scheme has proved beyond doubt that water management is the basis for economic growth[64].

CONCLUSION

In all these cases, progress has been possible because the communities created local assemblies that deliberate in the open and invite widespread participation. The answer again lies in fostering democracy. The above case studies show that open and participatory village institutions, with clearly defined property rights, are in the best position to balance competing interests in the community. This does not mean that conflict will disappear, or that all decisions will serve the interests of the poor. But participatory democracy does provide an institutional and legal framework that allows the poor to fight for their rights and defend the natural resources on which their livelihoods depend.

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[64] The Hindu Survey of Environment'96

CHAPTER VI

SUMMARY AND CONCLUSION

GLOBAL SCENE

At the beginning of the twenty-first century, the earth, with its diverse and abundant life forms, is facing a serious water crisis. In the last century, the human population has increased from 1.7 billion people to 6.6 billion people, while the total amount of potable water has slightly decreased. The water usage per person doubled, even as the total population tripled, creating a situation today where many areas of the world are consuming water at an unsustainable rate. All the signs suggest that it is getting worse and will continue to do so, unless corrective action is taken. Population growth and groundwater depletion present the two most significant dangers to global water stability.

According to the International Food Policy Research Institute (IFPRI), if current water consumption trends continue, by 2025 the agricultural sector will experience serious water shortages. The greatest danger to global food security comes from aquifer depletion. Aquifers are an essential source of water for food production, and they are being overdrawn in the western U.S., northern Iran, north-central China, India, Mexico,

Australia, and numerous other locations. Additionally, many aquifers are contaminated each year by pollution and seawater intrusion.

This crisis is one of water governance, essentially caused by the ways in which we mismanage water. But the real tragedy is the effect it has on the everyday lives of poor people, who are blighted by the burden of water-related disease and living in degraded and often dangerous environments.

The crisis is experienced also by the natural environment. In developing countries which are just entering the industrial age, water pollution presents a serious problem. According to United Nations Environmental Program (UNEP), "in developing countries, rivers downstream from major cities are little cleaner than open sewers". The UNEP also reports that 1.2 billion people are being affected by polluted water, and that dirty water contributes to 15 million child deaths every year.

Many countries have recognized the need for sustainable exploitation of water resources. Various forms of water policy and development of water institutions are being experimented. Still there is a long way to go for the world community especially in view of the impending climate change

WATER SECURITY IN INDIA

While the development of sustainable and safe water supplies is a global challenge, it is particularly acute in India, given its high population

density, space and time variability of rainfall, and increasing depletion and contamination of its surface and ground water resources

Demand and supply of water in India

Although the country receives 4500 Billion cubic meter(bcm) of rain fall and snow fall, the average runoff is about 1869 bcm. As against a total annual availability of 1953 km3 (inclusive of 432km3) of ground water, approximately 690km3 of surface water and 396km3 from ground water resources, making a total of 1086 km3 can be put to use.

India has an average annual rainfall of 1170mm. Though this can be considered reasonably good, its net value is considerably reduced because of regional and temporal variations. More than fifty per cent of precipitation takes place in less than 100 hours during the four months of June to September.

The depletion of forests has aggravated the problem. Reduced infiltration has resulted in smaller dry weather flows. Heavy silt concentration has resulted in deposition of silt in the flood plains, as the shrinking river channels cannot transport excessive silt loads. This has reduced valley storage resulting in higher flood peaks. The occupations of flood plains and increased development and cultivation have contributed to increased flood damage. The impact of droughts is even more severe than

that of floods and leaves a permanent imprint on the economy and morale of the people.

The National water commission (NCIWRDP) has estimated that the total water requirement of the country in the year 2050 would be about 973 bcm on the lower side and 1180 bcm on the upper side depending upon the actual population growth. The union ministry of water resources, however, on the basis of other studies has estimated the country's water requirements to be around 1093 bcm for the year 2025 and 1447 bcm for the year 2050. Thus the total water requirement of the country would barely match or even exceed the available utilizable water resources.

CHALLENGES TO WATER MANAGEMENT IN INDIA

Over exploitation

The country ushered in the Green Revolution, which concentrated on expanding farm yields by double-cropping existing farmland and using seeds with improved genetics. The result was a huge increase in agricultural production. The availability of canal water led farmers to adopt highly profitable, but extremely water intensive crops, such as sugar cane. Unfortunately, this huge surge in agriculture required significant water resources for irrigation and accelerated the onset of present water shortages.

Irrigated agriculture has been fundamental to economic development, but caused groundwater depletion. The ground water is exploited at an

unsustainable rate leading to water mining in many areas. As per the joint assessment carried out by the State Ground Water departments and CGWB in the country, 550 units out of 5723 units are semi critical(10%), 226 are critical (4%) and 839 are over exploited (15%). The percentage of over exploited blocks have increased from 4% to 15% from 1995 to 2004 is a matter of grave concern

Effects of over exploitation of ground water

Over exploitation has led to increase in pumping depths, reduction in yields in wells/tube wells and rise in cost of pumping ground water. Another major fall out of ground water exploitation has been contamination of ground water, resulting in increasing arsenic, fluoride and iron content. Since 85% of rural water supply programme depend upon ground water as a source, its effect on the health of rural population is a matter of grave concern.

Climate change

Climate change is likely to exacerbate the depleting supply of water. This will result in increased flooding initially, especially during the monsoon season when rainfall is already at its heaviest. In subsequent years, there will be less and less glacial melt water to continuously supply India's rivers. We do not have sufficient or efficient storage structures to hold this

water flow. There is no plan as yet to mitigate the effects of climate change on water security

Pollution

Besides the quantity, quality of water is a major concern area. A combination of sewage disposal, industrial effluents, and chemicals from farm runoffs, arsenic and fluoride has rendered India's rivers unfit for drinking, irrigation, and even industrial purposes. Every river in India is polluted to some degree. The water quality in underground wells also violates the desired levels of dissolved oxygen and coliform, the presence of which is one measure of filth, in addition to having high concentrations of toxic metals, fluoride, and nitrates.

WATER MANAGEMENT IN INDIA

Historically water management was approached more as an engineering solution and as a supply side management. Still the storage capacity that has been created over years is considered highly inadequate; India has only about 30 days of storage capacity in most of India's river basins. vis a vis about 900 days of storage capacity on the Colorado and Murray-Darling Rivers.

Inefficiency of water use structures

The water use efficiency in most projects is less than 40%. Lack of field channels, poor condition of canals, silting of reservoirs, changes in the cropping pattern from that envisaged at the time of project formulation are sited as some of the reasons. Low water charges in many states has left them with very little fund to invest in the maintenance of the existing structures.

Lack of legislation on ground water

Legislation on ground water extraction is absent resulting in precarious condition in many parts of the country. Under the present regime, which dates back several decades, the land owner is given the right to capture an unlimited amount of ground water from beneath his land with out being liable to injury to adjacent land owners caused by excessive pumping. The approach was adequate when the demand was limited. Now with the crisis looming large there is a need to change the approach.

Cropping pattern and water pricing

Cropping pattern and water pricing are politically decided. Due to lack of legislation this is dictated by power and influence rather than need and prudence. Hence, end less paddy - wheat- paddy –paddy, paddy – sugarcane are followed in states like Punjab, Haryana, west UP, Peninsular delta and MP and Karnataka resulting in soil depletion and environmental damage. Free electricity and minimum support price packages have made

these patterns highly profitable. The result has been mining of water, poor maintenance and reduced efficiency of water storage and distribution systems, water logging and salinity, bankrupt electricity boards.

Lack of political will

A major constraint in following a holistic uniform water management policy is that water is a state subject, included in entry no: 17 of the list II in the seventh schedule of the constitution. Though entry 56 in the List I empowers Centre to legislate on inter state rivers, by and large the centre has followed the 'wait and watch approach'. As a result there has been unviable exploitation and shortsighted management

WAY FORWARD

The country must move purposefully towards demand management. This has to include pricing, Cropping patterns, modernization, use of technologically superior methodologies like sprinkler and drip irrigation, conservation and recycling, pollution control, all methods of water harvesting etc.

Pricing of Water

The water sector in India is under enormous financial strain. States have been compromising the maintenance of utilities for the huge water subsidies. As a result, we have leaking dams and canals. The public

unwillingness to pay for water use is also due to lack of credibility for the state.. Though the state cannot overnight improve its credibility, innovative methods like water stamps to the needy and community participation can be tried for better governance.

Cropping patterns and water scarcity

With green revolution, cropping intensity increased and cropping pattern shifted in favor of water intensive cereals, namely rice and wheat. This has been at the cost of drought resistant coarse cereals, soil enriching pulses and oil seeds. An important water intensive crop that has contributed to water scarcity after the introduction of tube wells is sugar cane. As per a study by the Kellog School of Management, Sugarcane has the highest water cost a whopping 35,538 rupees per hectare at the rate of 25paise per 1000 litres. If the water cost is increased to 50 paise per litre and included in the cost, the gross margin on the revenues will fall most dramatically for sugarcane. The writing on the wall is very clear. Charging the sugarcane growers for the water used along with provision of replacement crops would be a viable policy to wean away sugarcane farmers from mindless water mining.

The government should manipulate the mechanism of MSP to divert cropped areas to drought resistant jowar, bajra and ragi. The modern medical science has discovered the therapeutic and nutritive values of these

coarse cereals due to their natural fiber and high glycemic index. Promotional bodies are required to popularize the consumption of these coarse cereals and pulses so that farmers get the right price in the market for these crops. It would be attractive and innovative to create niche markets for these products in India as well as abroad.

Defining water entitlement

The water entitlements (of individuals and communities, including traditional users) need to be separated from land rights. Moving towards a formal water entitlement system requires clarifying that water is publicly owned and that water entitlement is usufruct— it is a right to use, not a right to own water.

India has encouraging examples where communities have volunteered to define and use their water entitlements. In the pioneering watershed management project in Sukormajri initial entitlements were distributed to all in the village, giving people a valued new asset. Many of the poor later chose to cash in their entitlements by selling them to landowners who could put the water to better use.

Community efforts of water conservation and water entitlement rights

Sukhomajri, located near the city of Chandigarh, Ralegan Siddhi , a village situated in a drought-prone area of Maharashtra, the case of rebirth of river Arvari in dry and drought-prone Rajasthan, the village of Mahur,

fifty km from Pune, are shining examples of water conservation and distribution of water by community efforts. In Ralegan water right is shared equally between all households, which own land use water for irrigation. Gram sabha was created for community decisions. Since villagers were involved in the planning and decision making process, they were more open to any changes that were taking place in the village. In the case of River Arvari , the dead river started flowing with the water conservation efforts of the villagers. They have formed river parliament and adopted a constitution for the management of the river. In Mahur, Panipanchayat has been used to create success out of the minor irrigation schemes. Here the scheme was unique. Each landowner was allowed to irrigate only 2 acres of land and water was distributed equally. One trained person ensured that no one was denied his share.

In all these cases, where political will was lacking, community efforts had succeeded. Thus it is amply clear that water security cannot be treated as an isolated and engineering issue. It is dynamic and requires over all better governance and people participation. 'Business as usual' attitude will spell disaster in view of the Climate change predictions. In spite of maximum water conservation efforts which assuming the nation would take, still there is no way we could go on consuming water the way we are doing at present. We need to balance the use of water so that our descendents can also see running rivers, waterfalls and fishing lakes.

ANNEXURE I

CATEGORISATION OF BLOCKS / MANDALS / TALUKAS IN INDIA

Sl.No	States / UT	Total no of Assessed units	Safe		Semi critical		Critical		Over exploited	
	States		No	%	No	%	No	%	No	%
1	Andhra Pradesh	1231	760	62	175	14	77	6	219	18
2	Arunachal Pradesh	13	13	100	0	0	0	0	0	0
3	Assam	23	23	100	0	0	0	0	0	0
4	Bihar	515	515	100	0	0	0	0	0	0
5	Chattisgarh	146	138	95	8	5	0	0	0	0
6	Delhi	9	2	22	0	0	0	0	7	78
7	Goa	11	11	100	0	0	0	0	0	0
8	Gujarat	223	97	43	69	31	12	5	31	14
9	Haryana	113	42	37	5	4	11	10	55	49
10	Himachal Pradesh	5	5	100	0	0	0	0	0	0
11	Jammu & Kashmir	8	8	100	0	0	0	0	0	0
12	Jharkhand	208	208	100	0	0	0	0	0	0
13	Karnataka	175	93	53	14	8	3	2	65	37
14	Kerala	151	101	67	30	20	15	10	5	3
15	Madhya Pradesh	312	264	85	19	6	5	2	24	8
16	Maharashtra	318	287	90	23	7	1	0	7	2
17	Manipur	7	7	100	0	0	0	0	0	0
18	Meghalaya	7	7	100	0	0	0	0	0	0
19	Mizoram	22	22	100	0	0	0	0	0	0
20	Nagaland	7	7	100	0	0	0	0	0	0
21	Orissa	314	308	98	0	0	0	0	0	0
22	Punjab	137	25	18	4	3	5	4	103	75
23	Rajasthan	237	32	14	14	6	50	21	140	59
24	Sikkim	1	1	100	0	0	0	0	0	0
25	Tamil Nadu	385	145	38	57	15	33	9	142	37
26	Tripura	38	38	100	0	0	0	0	0	0
27	Uttar Pradesh	803	665	83	88	11	13	2	37	5
28	Uttranchal	17	12	71	3	18	0	0	2	12
29	West Bengal	269	231	86	37	14	1	0	0	0
	Total States	5705	4067	71	546	10	226	4	837	15
	UT									
1	Andaman & Nicobar	1	1	100	0	0	0	0	0	0

2	Chandigarh	1	1	100	0	0	0	0	0	0
3	Dadra & Nagar Haveli	1	1	100	1	100	0	0	0	0
4	Daman & Diu	2	0	0	3	150	0	0	1	50
5	Lakshdweep	9	6	67	0	0	0	0	0	0
6	Pondicherry	4	2	50		0	0	0	1	25
	Total UTs	18	11	61	4	22	0	0	2	11
	Grand Total	5723	4078	71	550	10	226	4	839	15

Source: Dynamic Ground Water resources of India (as on March 2004), Central Ground Water Board,2006

Cropping Pattern According to Land Use Statistics - All India —ANNEXURE—II

(Unit : '000 Hectares)

Sl. No.	Name of the crop	1950-51	1960-61	1970-71	1980-81	1990-91	1999-00	2000-01	2001-02	2002-03	2003-04
	2	3	4	5	6	7	8	9	10	11	12
1	Rice	31056 23.5	34056 (22.3)	37381 (22.6)	40237 (23.3)	42744 (22.9)	45451 (24.0)	44764 (24.1)	44893 (23.6)	42034 (23.8)	42634 (22.4)
2	Wheat	10010 (7.6)	12931 (8.5)	18293 (11.0)	22225 (12.8)	24046 (12.9)	27695 (14.6)	25797 (13.9)	26315 (13.8)	25203 (14.3)	26587 (13.9)
3	Jowar	15554 (11.8)	18426 (12.0)	16871 (10.2)	16412 (9.5)	14158 (7.6)	10343 (5.5)	9915 (5.3)	9843 (5.2)	9341 (5.3)	9360 (4.9)
4	Bajra	9744 (7.4)	11470 (7.5)	13391 (8.0)	11658 (6.8)	10735 (5.8)	9124 (4.8)	10021 (5.4)	9745 (5.1)	7932 (4.5)	10624 (5.6)
5	Maize	3250 (2.4)	4401 (2.9)	5856 (3.5)	6032 (3.5)	5893 (3.2)	6573 (3.5)	6803 (3.7)	6728 (3.5)	6761 (3.8)	7405 (3.9)
6	Ragi	2254 (1.7)	2478 (1.6)	2474 (1.5)	2504 (1.4)	2145 (1.2)	1738 (0.9)	1815 (1.0)	1735 (0.9)	1518 (0.9)	1766 (0.9)
7	Barley	3198 (2.4)	3140 (2.1)	2556 (1.6)	1799 (1.1)	972 (0.5)	746 (0.4)	789 (0.4)	714 (0.4)	703 (0.4)	739 (0.4)
8	Other cereals *and Millets*	5576 (4.2)	4997 (3.3)	4962 (3.0)	4033 (2.3)	2372 (1.3)	1404 (0.7)	1520 (0.8)	1339 (0.7)	1273 (0.7)	1213 (0.6)
	Total Cereals	80642 (61.1)	91899 (60.2)	101784 (61.4)	104900 (60.8)	103065 (55.4)	103073 (54.4)	101423 (54.6)	101312 (53.3)	94765 (53.6)	100328 (52.6)
9	Gram	7803 (5.9)	9274 (6.1)	7820 (4.7)	6547 (3.8)	7471 (4.0)	6315 (3.3)	5205 (2.8)	6418 (3.4)	5919 (3.3)	7139 (3.7)

Contd..

Cropping Pattern According to Land Use Statistics - All India

ANNEXURE-II

(Unit : '000 Hectares)

Sl. No.	Name of the crop	1950-51	1960-61	1970-71	1980-81	1990-91	1999-00	2000-01	2001-02	2002-03	2003-04
1	2	3	4	5	6	7	8	9	10	11	12
10	Tur	2228 (1.7)	2429 (1.6)	2639 (1.6)	2877 (1.7)	3600 (1.9)	3455 (1.8)	3664 (2.0)	3346 (1.8)	3362 (1.9)	3550 (1.9)
11	Other Pulses	10523 (8.0)	11962 (7.8)	12667 (7.7)	13284 (7.7)	13363 (7.2)	12393 (6.5)	12408 (6.7)	13309 (7.0)	12060 (6.8)	13826 (7.3)
	Total Pulses	20554 (15.6)	23665 (15.5)	23126 (13.9)	22708 (13.2)	24883 (13.4)	22163 (11.7)	21278 (11.5)	23073 (12.1)	21340 (12.1)	24515 (12.9)
	Total Foodgrains	101196 (76.7)	115564 (75.7)	124910 (75.4)	127608 (73.9)	126526 (68.1)	125237 (66.1)	122701 (66.1)	124385 (65.4)	116105 (65.7)	124843 (65.5)
12	Sugarcane	1757 (1.3)	2417 (1.6)	2589 (1.6)	2897 (1.7)	3908 (2.1)	4483 (2.4)	4577 (2.5)	4714 (2.5)	4770 '(2.7)	4380 (2.3)
13	Condiments & Spices	1244 (0.9)	1569 (1.0)	1864 (1.1)	2065 (1.2)	2325 (1.3)	2904 (1.5)	2808 (1.5)	3250 (1.7)	3056 (1.7)	3101 (1.6)
14	Fruits and Vegetables	2249 (1.7)	2649 (1.9)	3683 (2.0)	4924 (1.7)	6692 (3.6)	8155 (4.3)	8162 (4.4)	8769 (4.6)	8957 (5.1)	9046 (4.7)
15	Groundnut	4406 (3.3)	6467 (4.2)	7552 (4.6)	6789 (3.9)	8397 (4.5)	6980 (3.7)	6734 (3.6)	6354 (3.3)	6013 (3.4)	6151 (3.0)
16	Rapeseed & Mustard	1058 (0.8)	1145 (0.8)	1415 (0.9)	2268 (1.3)	5143 (2.8)	5609 (3.0)	4172 (2.2)	5079 (2.7)	4318 (2.4)	5445 (2.9)
17	Sesamum	1957 (1.5)	1575 (1.0)	1853 (1.1)	1747 (1.0)	2413 (1.3)	1753 (0.9)	1701 (0.9)	1885 (1.0)	1556 (0.9)	2003 (1.1)

Contd..

Cropping Pattern According to Land Use Statistics - All India —ANNEXURE-II

(Unit : '000 Hectares)

Sl. No.	Name of the crop	1950-51	1960-61	1970-71	1980-81	1990-91	1999-00	2000-01	2001-02	2002-03	2003-04
	2	3	4	5	6	7	8	9	10	11	12
18	Linseed	1226 (0.9)	1267 (0.8)	1199 (0.7)	1163 (0.7)	989 (0.5)	646 (0.3)	495 (0.3)	533 (0.3)	450 (0.3)	477 (0.3)
	Total Oilseeds	10968 (8.3)	12777 (8.3)	14719 (8.9)	15698 (9.1)	25152 (13.5)	26308 (13.9)	24633 (13.3)	25160 (13.2)	23933 (13.5)	26286 (13.8)
19	Cotton	5655 (4.3)	7610 (5.0)	7830 (4.7)	7752 (4.5)	7551 (4.1)	8776 (4.6)	8582 (4.6)	9083 (4.8)	7698 (4.4)	7589 (4.0)
20	Jute	561 (0.4)	633 (0.4)	753 (0.4)	940 (0.5)	783 (0.4)	861 (0.5)	842 (0.5)	887 (0.5)	877 (0.5)	891 (0.5)
21	Mesta	65 (0.1)	281 (0.2)	332 (0.2)	360 (0.2)	NIL	174 (0.1)	188 (0.1)	173 (0.1)	171 (0.1)	152 (0.1)
	Total Fibres	6667 (5.1)	8762 (5.7)	9108 (5.5)	9193 (5.3)	8667 (4.7)	9908 (5.2)	9714 (5.2)	10241 (5.4)	8836 (5.0)	8713 (4.6)
22	Tobacco	379 (0.3)	401 (0.3)	431 (0.2)	461 (0.3)	440 (0.2)	463 (0.2)	305 (0.2)	374 (0.2)	393 (0.2)	431 (0.2)
23	Other Crops	7433 (5.6)	8633 (5.7)	8486 (5.1)	9792 (5.7)	12032 (6.5)	11978 (6.3)	12805 (6.9)	13351 (7.0)	10669 (6.0)	13844 (7.3)
	Total Cropped Area	131893	152772	165791	172638	185742	189436	185705	190244	176719	190644
	Area sown more than once	13147 (10.0)	19573 (12.8)	25524 (15.4)	32625 (18.9)	42743 (23.5)	48478 (25.6)	44546 (24.0)	48828 (25.7)	44063 (24.9)	49761 (26.1)
	Net area sown	118746 (90.0)	133199 (87.2)	140267 (84.6)	140002 (81.1)	142999 (76.5)	140958 (74.4)	141160 (76.0)	141416 (74.3)	132656 (75.1)	140883 (73.9)

Source : Ministry of Agriculture, Directorate of Economics & Statistics.
Remarks: Figures within brackets are percentages to total cropped area.

ANNEXURE III

Water Cost per Crop Hectare — **Rupees per hectare**

Crop	Cost of water per hectare (*Rs 0.25 per 1000 litres*)
Rice	Rs. 932
Wheat	Rs. 973
Jowar	Rs. 118
Bajra	Rs. 53
Cotton	Rs. 1,528
Maize	Rs. 305
Groundnut	Rs. 1,002
Soyabean	Rs. 202
Gram	Rs. 431
Rapeseed & Mustard	Rs. 730
Sugarcane	Rs. 35,538
Tur (Arhar)	Rs. 299
Cocunut	Rs. 1,337
Sesame	Rs. 51
Mango	Rs. 705
Lentil (Masur)	Rs. 244
Potato	Rs. 779
Spices	Rs. 667
Sunflower	Rs. 122
Jute & Mesta	Rs. 529
Cashewnut	Rs. 353
LinSeed	Rs. 255
Tea	Rs. 2,929
Eggplants	Rs. 812
Banana	Rs. 3,009
Onion	Rs. 918
Natural Rubber	Rs. 598
Coffee	Rs. 2,433
Tobacco	Rs. 215
Apple	Rs. 799
Oranges	Rs. 2,885
Pineapple	Rs. 1,821
Grapes	Rs. 2,543

Source- Underground Water Development in India – Trends, Crops, Prepared by Prashant Gupta, faculty Guidance: Prof.Benjamin Jones, Kellogg School of Management

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