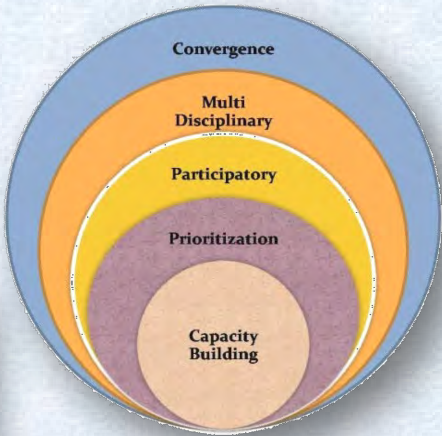
WATER-ITS CONSERVATION MANAGEMENT AND GOVERNANCE



Pune
May 2017

Government of India
Central Water Commission
National Water Academy

Water – Its Conservation, Management and Governance

Developed by:

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Preface

The natural resources scenario of the country is changing fast both in terms of availability as well as quality. The situation is further aggravated by the looming climate change which is going to alter the paradigm of management of natural resources. Water is critical natural resources and is being affected by increasing population, industrialization, urbanization, pollution, deforestation and above all climate change. We have to fight Water Scarcity by striking a balance between Water Usage and Water Replenishment through sensitizing all the stakeholders.

Water is everybody's business and indeed everybody is professing ways, means and solutions for addressing the issues. There is plethora of ideas, paradigms and philosophies put forth by experts, activities, civil society, media etc. from their own perspective for management of water. This has resulted in incoherent and divergent opinions regarding the current state of sector as well as the required future action to tackle the challenges. In order to have a focused and uniform approach to tackle the challenges in the coming decades, it is very much important that all stakeholders are sensitized about the current scenario, future needs and need for proper scientific and rational approach to mitigate the issues and challenges collectively.

The National Water Academy (NWA) conducts training programs covering the whole spectrum of topics pertaining to water resources development and management through its various programs, however, the training material prepared is largely technical in nature. A need had been felt since a long time to develop a comprehensive module covering the important aspects of Water Conservation and Management in India which will be useful for all stakeholders including the Civil Society, Academics, researchers etc. Moreover, a request was also recently received from The Lal Bahadur Shastri National Academy of Administration (LBSNAA) which is India's premier institution dedicated to training Officers of the country's highest civil services to evolve a module for use in their training programs. Accordingly, NWA developed a syllabi on "Water Conservation and Management" for LBSNAA, Mussoorie which was very much appreciated. Take a cue from this, NWA thought of coming out with a publication on ***"Water - its Conservation, Management and Governance***" wherein the current scenario of water sector, issues and challenges are discussed and scientific and rational approach to address these issues has been brought out for easy understanding to all stakeholders and to give them the right insight on the subject.

The module comprises of four chapters viz. Water Conservation and management in India – its need and important; Traditional Water Conservation in India; Contemporary Practices; Governance Issues in Water Management. **Chapter – 1** emphasizes that **water resource development is to be seen not merely as a single-sector-end objective**, but as a prime mover in achieving larger objectives with multiple linkages. This calls for a well set out multi-disciplinary agenda covering not only technological issues but also issues on social, economic, legal and environmental concerns. Therefore the planning, development and management of water resources is to be taken up in an integrated manner for addressing all the concerns facing the water sector at present. This integration has to be a multi-disciplinary approach which would take care of all the conflicting issues and deliver solutions that would be technically feasible, economically viable, socially acceptable and ecologically & environmentally sound.

Chapter– 2 throws light on **traditional water conservation techniques** which had evolved historically as per site specific conditions (topography) and according to the peculiar climate and geology (soil) prevailing therein. The scale of the structures was mostly localized and community owned serving multiple purposes during those times. These micro/small scale techniques were suited to enhance rural economy. These ecologically safe traditional systems are even now viable and cost-effective measures to rejuvenate India's depleted water resources in rural areas where bigger interventions are not possible or feasible. Productively combining these structures with modern rainwater-saving techniques, such as percolation tanks, injection wells and subsurface barriers, could rejuvenate the India's parched areas.

Chapter-3 describes the **Contemporary Water Conservation techniques** including the supply and demand side management. Till now emphasis was more on supply side management with related to development of water resources. to a substantial extent this development objective has been achieved. This development of water resources along with management has led to Green Revolution which made this country self-sufficient in food. This could be achieved through various developmental schemes, management practices and Research & Development activities. Owing to changing scenario of the water, in the recent time the focus now is more on demand side management which stresses on improving water use efficiency of agriculture sector and other sectors as well. The Chapter describes the various contemporary measures like use of Micro Irrigation; Advanced Irrigation Techniques; Application of Information Technology; Canal Automation, Large Scale irrigation etc. The Chapter concludes that in order to have sustainable development, there is urgent need for Integrated Water Resources Management with an objective of promoting coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Chapter-4 describes **legal, policy and institutional framework in India** for both the surface and ground water; roles and responsibilities of Central, State and Local & District Administration; Current issues in water governance; legislative initiatives by Ministry of Water Resources, River Development & Ganga Rejuvenation and way forward to achieve effective governance.

I would like to compliment Shri D S Chaskar, Director and Shri Sidhartha Mitra, Director for their untiring efforts in developing the contents of this publication. It goes without saying that collection and compilation of pertinent information and data for preparing such a useful publication needs hard labour, patience and sincerity and those concerned deserve special mention. I am also thankful to all other core faculty members who have directly or indirectly contributed and helped in preparation of this publication. I would also put on record my special appreciation to Ms. Uma G Sundaram, PA for in-depth literature survey and for providing all necessary stenographic support in bringing this publication in the present form.

I am sure this publication shall be of immense use to all stakeholders who are concerned with water resources development and management.

Place: Pune
Date: Vaisakha 22, Saka 1939
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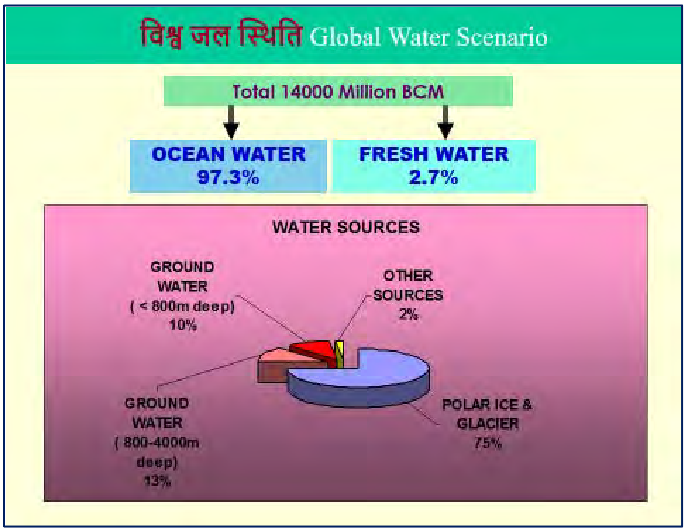
Acknowledgement:

National Water Academy, Pune hereby acknowledges the adaptation of content from different sources, including internet sources for this compilation.

Chapter 1

Water Conservation and Management in India: Its need and importance

1.1 OVERVIEW OF WATER RESOURCES OF INDIA

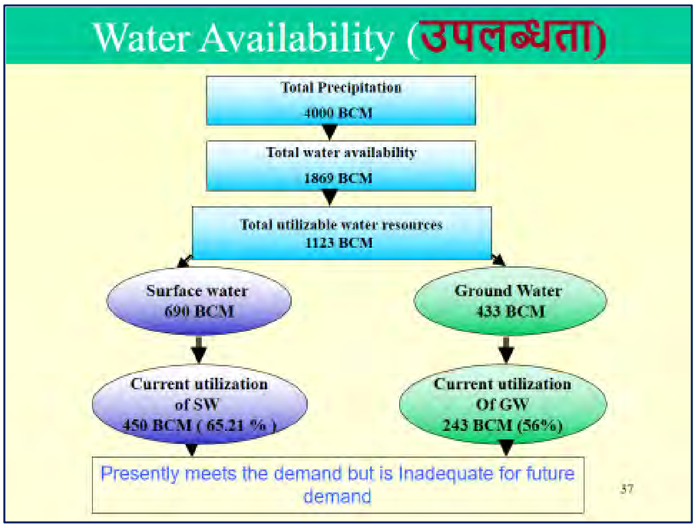


Water is prime life sustaining natural resource which cannot be created like other commodities. It is a nature's gift to all living beings on the earth. Water is the elixir of life. Unfortunately for our planet, supplies are now running dry – at an alarming rate. The world's population continues to soar but that rise in numbers has not been matched by an accompanying increase in supplies of fresh water. In India, the increasing stress on the availability of water is due to population explosion and improved standard of living. The scarcity is compounded further because of massive agricultural and industrial development coupled with improper and indiscriminate exploitation of ground water resources.

India has 4% of the world water resources and 18% of the world population. Only handful of countries in the globe can boast of such an extensive river network that our country has. The mighty Indus-Ganga-Brahmaputra in the North, the Narmada-Tapi-Mahanadi in the Central region and Godavari-Krishna-Cauvery in the South have been symbols of existence and growth of our country right from its inception. Yet, the availability of water resources in India has its unique complexities.

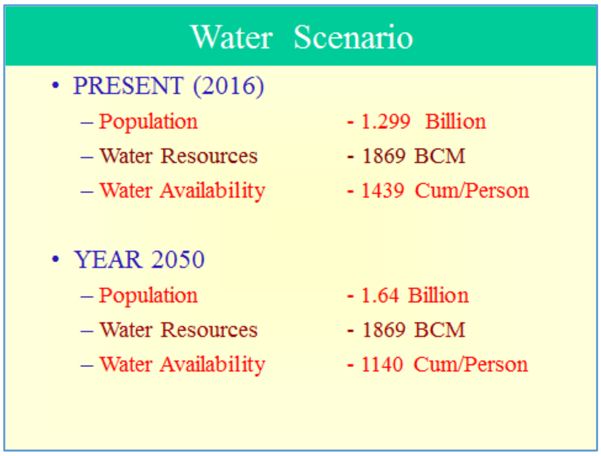
Post-independence, the population of the country has increased almost nearly fourfold and growth is expected to continue upto 2050 by which it will stabilize. The economy of the country is also increasing at a fast pace due to rapid urbanization and industrialization. The enormity of the quantum of water required for food production, meeting domestic requirements, and supporting the industrial growth is therefore easily understandable. What is required is an integrated planning, development and management of the water resources with the involvement of all stakeholders and taking into consideration the multi-sectoral needs and the judicious distribution of the water resources amongst various sectors based upon certain priorities. With a view to achieve this vision, the country adopted the National Water Policy in 1987 for the first time. Thereafter this was updated in 2002. This has since been guiding the formulation of policies and programmes for water resources development and its management. During last ten years, since then many new challenges have emerged in the water resources sector which again necessitated the review of the existing National Water Policy. Accordingly, the latest revised "National Water Policy – 2012" has been adopted to meet the new challenges in water resources sector.

1.2 PRESENT STATUS OF WATER AVAILABILITY



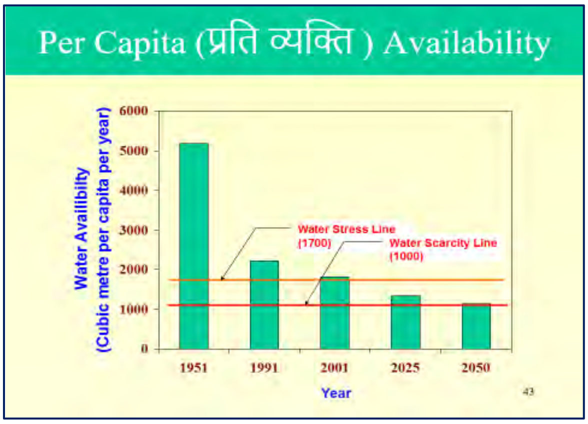
The total precipitation including snowfall, in the country is around 4000 Billion Cubic Meter (BCM). Of this, 3000 BCM precipitation is confined during three to four months (June – Sept). Thus, there is significantly high temporal variation. On the other hand, the spatial variability is also evident from the fact that while on one hand rainfall is of the order of 12,000 mm in Meghalaya, it is merely 100 mm in the western parts of Rajasthan. Taking into consideration the loss due o evaporation/evapotranspiration, soil absorption, percolation etc. the average annual natural runoff is about 1869 BCM. Because of topographical and other constraints only 690 BCM from surface water and 433 BCM from ground water can be put to beneficial use. Further out of the 690 BCM of utilizable surface water, about 40 percent is in the Ganga-Brahmaputra-Meghna system which drains the states lying in the north and north-eastern regions.

Taking into consideration the population of the country as per 2001 and 2011 census and projections of the population for the year 2025 and 2050, the average annual per capita availability of water is estimated to be 1818, 1567, 1340 and 1140 cubic meter respectively. Thus, there is decreasing trend in the per capita water availability due to increase in population, urbanization and industrialization.



1.3 WATER SHORTAGE AND SCARCITY

The per capita water availability is a widely accepted parameter for gauging the water security for a country. As per the population of 2011, per capita water availability in India was 1567 cu.m. per head annually . As per the International standards if the water availability is between 1000 to 1700 cu.m per year, it is a "water stress" situation and if the water availability is less than 1000 cu m it is "water scarcity " condition. As per this standard, India is already a water stress nation. By the year 2050, with the population of the order of 1.6 billion, the water availability will further reduce to 1140 cu m , nearing to the "water stress condition". These are the average figures, but , if we look at the basin wise statistics, except for Brahmaputra, Indus, Brahmani & Baitarni, Mahanadi, Narmada and West Flowing rivers basin all other basins are much below the "water scarcity" line which means water available is much less than 1000 cu.m per annum. All the basins, which are most populous are having water scarcity conditions.



Per Capita Water Availability

Year	Population (in million)	Per Capita water availability (in cubic metre) (wrt 1869 BCM)	Per Capita water availability (in cubic metre) (wrt 1123 BCM)
1951	361	5177	3110
1955	395	4732	2843
1991	846	2209	1327
2001	1027	1820	1093
2025	1400 (projected)	1341	802
2050	1600 (projected)	1140	702

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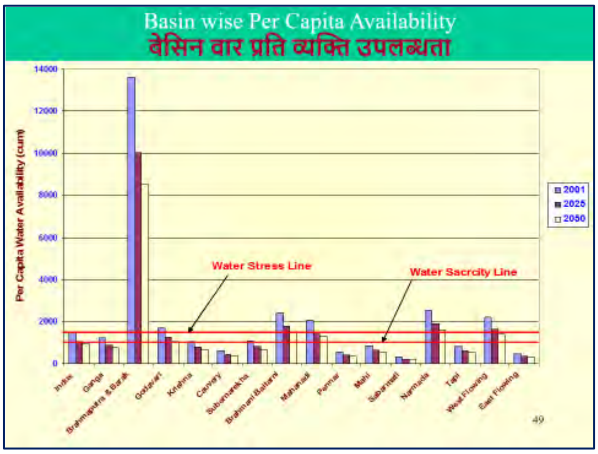


1.4 FOOD SECURITY

Food security, as defined by the United Nations, is the condition in which all people, at all times, have physical, social and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. It is only when we attain self-sufficiency in food and ensure sufficient nutrition for the population that we can progress and develop ourselves. In-sufficiency leads social & economical vulnerability. The constant pressure of circumstances & uncertainty brings trouble and misery on the population and sometimes shame and humiliation for the nation. India suffered two very severe droughts in 1965 and 1966. Subsequent Green Revolution made a significant change in the scene. India achieved self-sufficiency in food grains by the year 1976 through the implementation of the seed-water-fertilizer policy as well as shift in irrigated agriculture adopted by the Government of India. The irrigation infrastructure created so far through major & medium projects were instrumental in making the green revolution & food self-sufficiency a success.

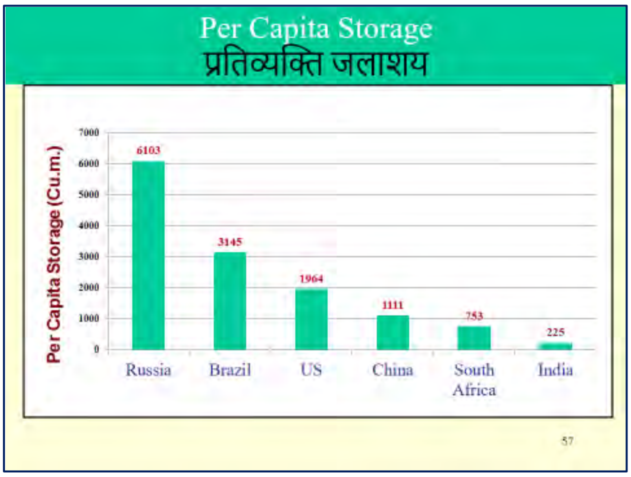
Food Requirement

Year	Population (in million)	Food production/ requirement (in million tonnes)
1950s	~ 400	~ 51
2000	~ 1025	~ 208
2010	~ 1200	~ 240
2025	~ 1400	~ 350
2050	~ 1600	~ 450

To remain self-sufficient in the coming decades, requires to know the pre-requisites for food production & take necessary measures in advance. India's food production was 22 million ton at the time independence, by the year 1950 it was raised to 51 million tonnes. As of now the population of India is about 1.25 billion and present food production is around 265 million ton (2013-14), which is sufficient to cater to the needs of the nation with a bit of surplus; So the today's situation looks comfortable. Through calculations, by all means the population of India is likely to be stabilized at 1.6 to 1.7 billion by 2050. By that time the prosperity and purchasing power of the population will also go up. It is assessed that the food requirement by 2050 will be 450 million tonnes. There is a close interdependency of water resources availability on food production. For Food production of 450 million tonnes, water storage that will be required will be of the order of 458 BCM. Considering the current storage capacity and projects in hand, additional 150 BCM will have to be added in the coming years so as to remain self-sufficient in food production.

1.5 NEED FOR RESERVOIRS

The reservoirs created through construction of dams were instrumental in achieving the Green Revolution and food sufficiency in India. It also acted as a catalyst for the economic and industrial growth in India. Per Capita availability of water is a vital parameter used worldwide to indicate resilience of the nation against uncertainties of water availability in space and time. Compared to the other developed and developing nations of the world like China, Brazil, USA, South Africa etc. the per capita water availability in India is very low. To sustain the economic growth, to ensure food security and water availability to the future generations, India will need a more reservoirs, at all locations wherever, techno-economically, socially and environmental feasible. The large reservoirs are also very important to mitigate the uncertainties that are likely to be introduced due to climate change. Adaptation to climate change requires



infrastructure that can absorb and even out large variations in hydrological events. Reservoirs are one of important tools to face the challenge of climate change.

1.6 PROBLMES OF SURFACE & GROUND WATER: QUANTITY & QUALITY

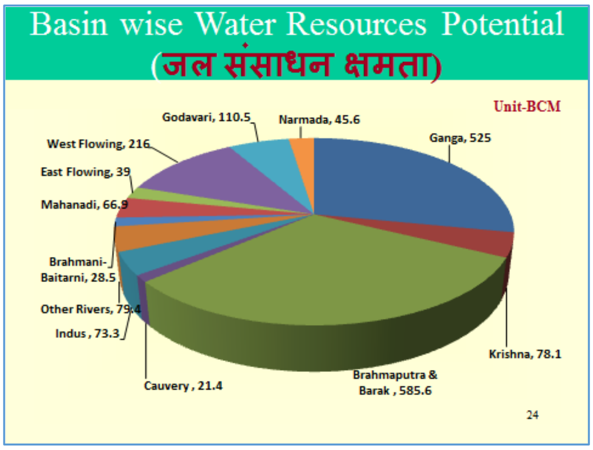
1.6.1 Surface water Scenario

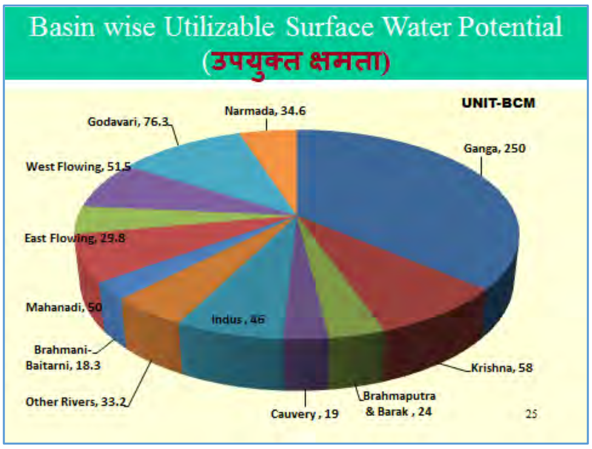
On an average, India receives about 4000 Cubic Kilometers (1 Cubic Km is same as one billion cubic meters, abbreviated as BCM) of precipitation every year. Precipitation means rainfall and snowfall together. As explained above, this precipitation is not uniformly distributed over the entire land area and varies from less 100 mm in Rajasthan to more than 12000 in Meghalaya. Of all the rain that falls on the land and mountains and forests, some evaporates back in to the atmosphere, some percolates in the ground and some is used by the forests. The remaining that flows in to the rivers is less than 50% on the total precipitation. The total annual water resources availability is estimated as 1869 BCM. The basin wise figures are as follows.

Basin-wise Surface Water Potential

(All figures in BCM)

Name of the River Basin	*Average flow*	*Estimate Utilizable Flow*
Indus (up to Border)	**73.31**	**46.00**
a) Ganga	**525.02**	**250.00**
b) Brahmaputra Barak and others	**585.6**	**24.00**
Godavari	**110.54**	**76.30**
Krishna	**78.12**	**58.00**
Cauvery	**21.36**	**19.00**
Pennar	**6.32**	**6.86**
East Flowing Rivers Between Mahanadi and Pennar	**22.52**	**13.11**
East Flowing Rivers Between Pennar and Kanyakumari	**16.46**	**16.73**
Mahanadi	**66.88**	**49.99**
Brahmani and Baitarni	**28.48**	**18.30**
Subernarekha	**12.37**	**6.81**
Sabarmati	**3.81**	**1.93**
Mahi	**11.02**	**3.10**
West Flowing Rivers of Kutch, Sabarmati including Luni	**15.10**	**14.98**
Narmada	**45.64**	**34.50**
Tapi	**14.88**	**14.50**
West Flowing Rivers from Tapi to Tadri	**87.41**	**11.94**
West Flowing Rivers from Tadri to Kanyakumari	**113.53**	**24.27**
Area of Inland drainage in Rajasthan desert	**Negligible**	**Negligible**
Minor River Basins Draining into Bangladesh and Myanmar	**31.00**	**Negligible**
Total	**1869.00**	**690.00**

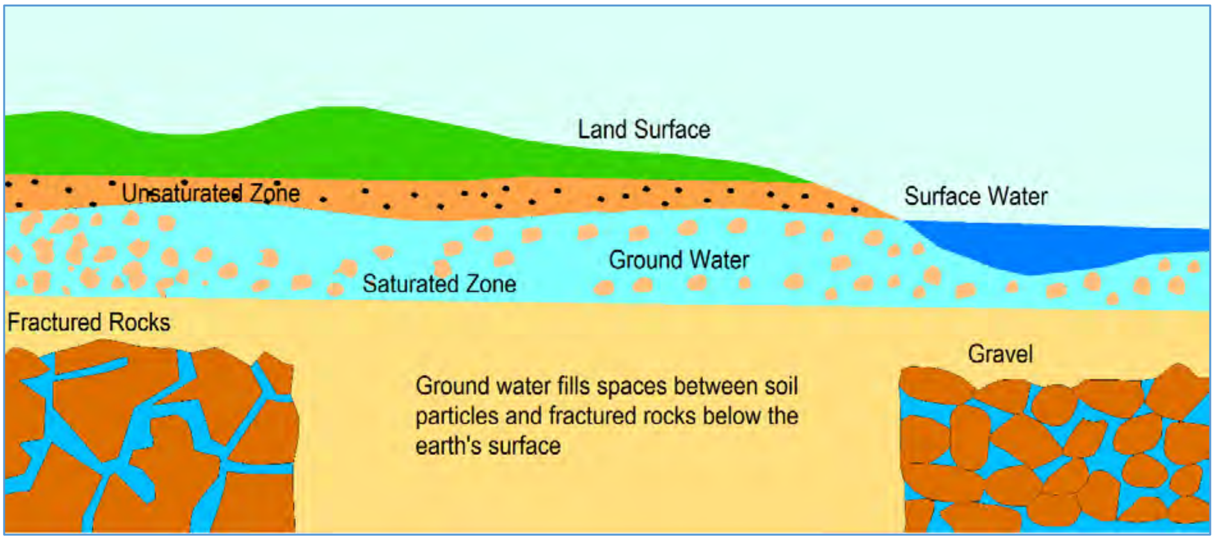




1.6.2 Ground Water Scenario

Ground water is the water that seeps through rocks and soil and is stored below the ground. The rocks in which ground water is stored are called aquifers. Aquifers are typically made up of gravel, sand, sandstone or limestone. Water moves through these rocks because they have large connected spaces that make them permeable. The area where water fills the aquifer is called the saturated zone. The depth from the surface at which ground water is found is called the water table. The water table can be as shallow as a foot below the ground or it can be a few hundred meters deep. Heavy rains can cause the water table to rise and conversely, continuous extraction of ground water can cause the level to fall. Figure below illustrates the major definitions used in the context of groundwater.

Figure: Graphical representation of ground water and associated terms



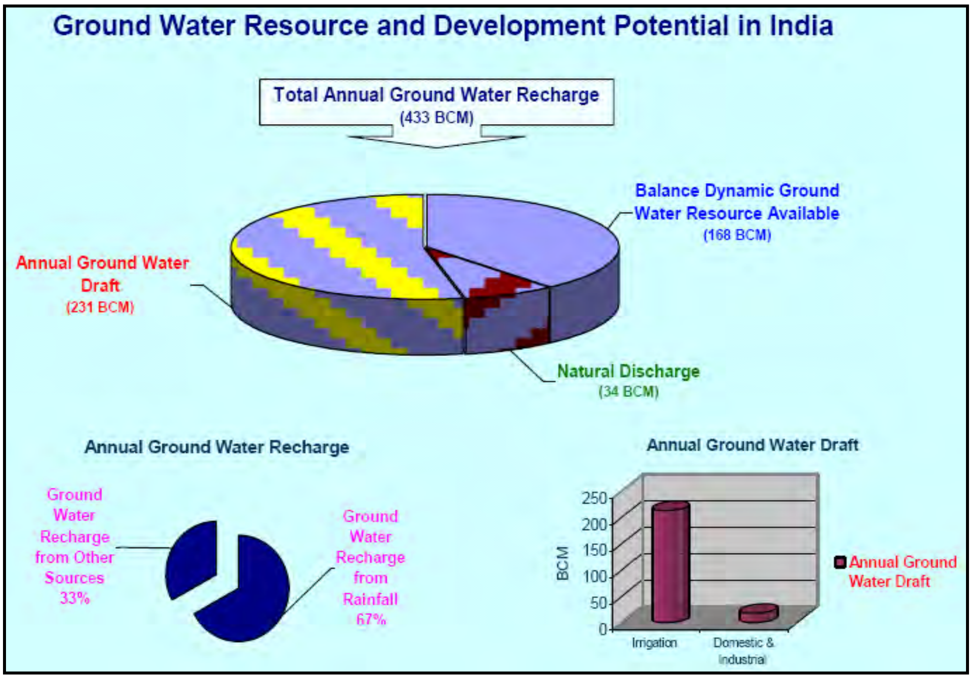
The underground (hydrogeological) setting of ground water defines the potential of this resource and its vulnerability to irreversible degradation. This setting in India can be divided into following categories, which are described below:

- *Hard-rock aquifers of peninsular India:* These aquifers represent around 65% of India's overall aquifer surface area. Most of them are found in central peninsular India, where land is typically underlain by hard-rock formations. These rocks give rise to a complex and extensive low-storage aquifer system, where in the water level tends to drop very rapidly once the water table falls by more than 2-6 meters. Additionally, these aquifers have poor permeability* which limits their recharge through rainfall. This implies that water in these aquifers is non- replenishable and will eventually dry out due to continuous usage.

- *Alluvial aquifers of the Indo-Gangetic plains:* These aquifers, found in the Gangetic and Indus plains in Northern India have significant storage spaces, and hence are a valuable source of fresh water supply. However, due to excessive ground water extraction and low recharge rates, these aquifers are at the risk of irreversible overexploitation.

1.6.2.1 Ground water availability

Out of the 1,123 BCM/year, the share of surface water and ground water is 690 BCM/year and 433 BCM/year respectively. The overall contribution of rainfall to the country's annual ground water resource is 68% and the share of other resources, such as canal seepage, return flow from irrigation, recharge from tanks, ponds and water conservation structures taken together is 32%.

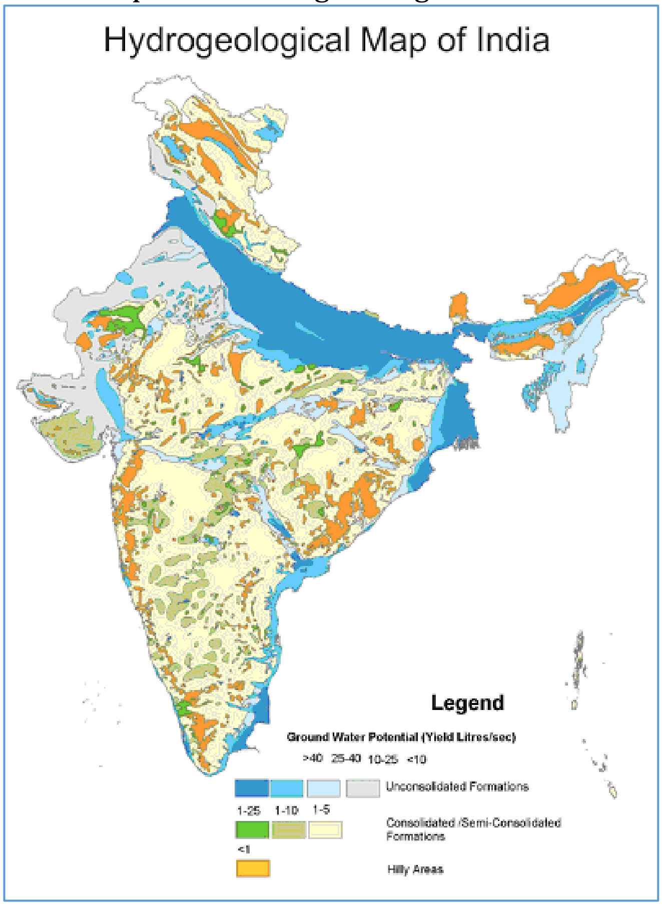


Total Ground Water Resources

1.	**Total Replenishable Ground Water Resource**	**433 BCM**
2.	Net Annual Ground Water Availability	398 BCM
3.	Annual Ground Water Draft for Irrigation, Domestic & Industrial uses	245 BCM
4.	Stage of Ground Water Development	62 %

1.6.2. Hydrogeological Units And Their Ground Water Potential

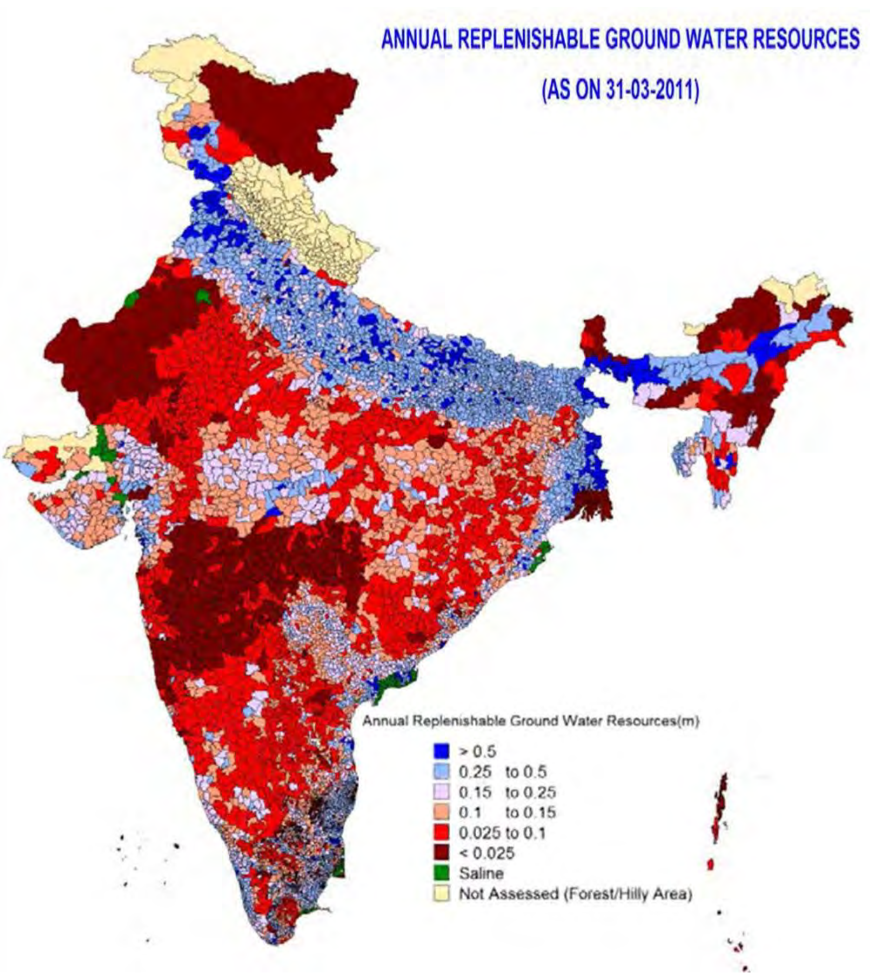
Hydrogeological map of India and the geographical distribution of hydrogeological units along with their Ground water potential are given figure



System	*Coverage*	*Ground Water Potential*
Unconsolidated formations - alluvial	Indo-Gangetic, Brahmaputra plains	Enormous reserves down to 600 m depth. High rain fall and hence recharge is ensured. Can support large-scale development through deep tube wells
	Coastal Areas	Reasonably extensive aquifers but risk of saline water intrusion
	Part of Desert area– Rajasthan and Gujarat	Scanty rainfall. Negligible recharge. Salinity hazards. Availability at great depths
Consolidated/semi-consolidated formations - sedimentary, basalts and crystalline rocks	Peninsular Areas	Availability depends on secondary porosity developed due to weathering, fracturing etc. Scope for GW availability at shallow depths (20-40 m) in some areas and deeper depths (100-200 m) in other areas. Varying yields.
Hilly	Hilly states	Low storage capacity due to quick runoff

The ground water behavior in the Indian sub-continent is highly complicated due to the occurrence of diversified geological formations with considerable lithological and chronological variations, complex tectonic framework, climatological dissimilarities and various hydro-chemical conditions.

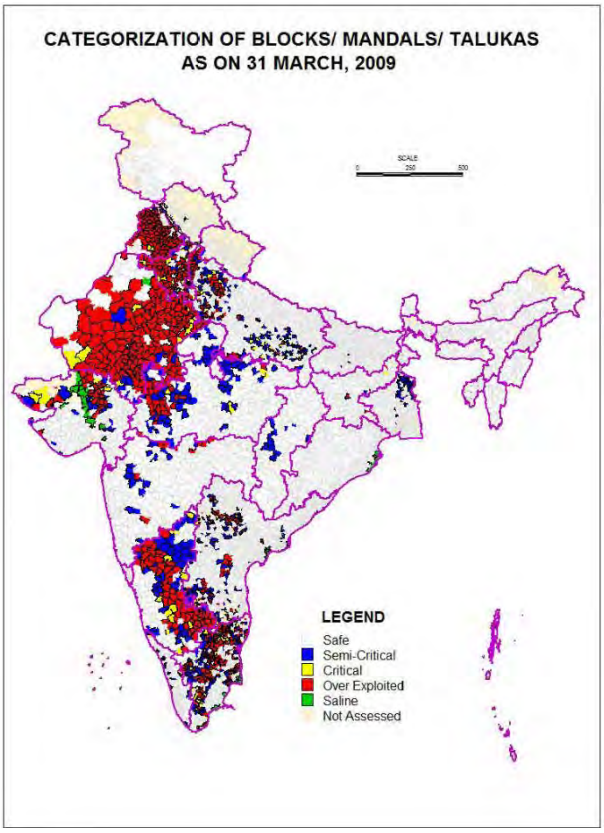
A perusal of past records reveal that there is a general decline in the water level as observed mostly in northern, north western and eastern parts of the country covering Uttar Pradesh, Rajasthan, Bihar, Jharkhand, West Bengal, Punjab and Haryana and in parts of Tamil Nadu and Andhra Pradesh. It also observed some rise in water level at isolated areas and is attributed to local causes or due to higher rainfall experienced in the area during the period of observation.



The assessment of the resources indicate that the replenishable Groundwater resource is estimated significantly high in the Indus–Ganga–Brahmaputra alluvial belt in the North, East and North East India covering the states of Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal and valley areas of North Eastern States, where rainfall is plenty and the aquifers found have high storage capacity and favor the recharge. The coastal alluvial belt particularly Eastern Coast also has relatively high replenishable ground water resources while in western India, particularly Rajasthan and parts of northern Gujarat the annual replenishable ground water resources are scanty as the region experiencing the arid climate. Similarly, in major parts of the southern peninsular India covered with hard rock aquifers, the replenishable ground water recharge is less which is attributed to comparatively low infiltration and storage capacity of the rock aquifers. The Central Indian region is mostly accounted for moderate recharge.

1.6.2.3 Ground Water Utilization

The assessment of ground water draft is carried out based on the Minor Irrigation Census data and sample surveys carried out indicates the Annual Ground Water Draft as 243 BCM. Agriculture sector remained the predominant consumer of ground water resources. About 91% of total annual ground water draft i.e. 221 BCM is for irrigation use. Only 22 BCM is for Domestic & Industrial use which is about 9% of the total draft. An analysis of ground water draft figures indicates that in the states of Arunachal Pradesh, Delhi, Goa, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Kerala, North Eastern states of Manipur, Meghalaya, Mizoram, Nagaland and Tripura, Orissa, Sikkim, and Union Territories of Andaman & Nicobar Island, Dadra & Nagar Haveli, Lakshadweep and Puducherry, ground water draft for domestic & industrial purposes are more than 15%.There has been about 5% increase in the overall estimate of the annual ground water draft of the country in 2009 as compared to 2004.



1.6.2.4 Stage of Ground Water Development

The stage of ground water development in the country is 61%. The status of ground water development is very high in the states of Delhi, Haryana, Punjab and Rajasthan, where the Stage of Ground Water Development is more than 100%, which implies that in the states the annual ground water consumption is more than annual ground water recharge. In the states of Gujarat, Tamil Nadu and Uttar Pradesh and UTs of and UT of Daman & Diu, Lakshadweep and Puducherry, the stage of ground water development is 70% and above. In rest of the states / UTs the stage of ground water development is below 70%. The ground water development activities have increased generally in the areas where future scope for ground water development existed. This has resulted in increase in stage of groundwater development from 58% in the year 2004 to 61% in 2009

1.6.2.5 Ground Water Assessment

Ground water resources in the country are assessed at different scales within districts, such as blocks/mandals/talukas/watersheds. Ground water development is a ratio of the annual ground water extraction to the net annual ground water availability. It indicates the quantity of ground water available for use. The overall assessment of resources reveal that out of 5842 numbers of assessed administrative units (Blocks/Taluks/Mandals), 802 units are categorized as Over-exploited (>100%

development) , 169 units as Critical (>90% and <=100% development), 523 units are Semi-critical (>70% and <=100% development) , and 4277 units are categorized Safe (<=90% but no Significant Long Term Water level Decline trend) . Apart from these unites, there are 71 units observed completely saline. Number of Over-exploited and Critical administrative units are significantly higher in states of Delhi, Gujarat, Haryana, Himachal Pradesh, Karnataka, Punjab, Rajasthan and Tamil Nadu and also the UTs of Daman & Diu and Puducherry. The reason for over-exploitation in the North Western part i.e. Punjab and Haryana is attributed to the indiscriminate extraction of ground water for various purposes and in other parts caused by arid climate resulting scanty and irregular rainfall and consequent less recharge. Table below compares the level of ground water development in the country over the past two decades.

Level of ground water development	Explanation	% of districts in 1995	% of districts in 2004	% of districts in 2009	% of districts in 2011
0-70% (Safe)	Areas which have ground water potential for development	92	73	72	71
70-90% (Semi-critical)	Areas where cautious ground water development is recommended	4	9	10	10
90-100% (Critical)	Areas which need intensive monitoring and evaluation for ground water development	1	4	4	4
>100% (Overexploited)	Areas where future ground water development is linked with water conservation measures	3	14	14	15

1.6.3 Water Quality Issues of Surface and Groundwater in India

Most of our water sources are polluted with untreated/partially treated wastes form industry, domestic sewage and fertilizer/pesticide run off from agricultural fields. Unregulated growth of urban areas, particularly over the last two decades, without infrastructural services for proper collection, transportation, treatment and disposal of domestic wastes led to increased pollution & health hazards. The municipalities and such other civic authorities have not been able to cope up with this massive task which could be attributed to various reasons including erosion of authority, inability to raise revenues and inadequate managerial capabilities. The over-exploitation of ground water resources is widespread across the country, and is projected to grow with time. The inappropriate land use practices prevalent in the country limit the groundwater recharge potential. Accordingly, the ground water levels are receding in some regions of the country at an alarming rate. On the other hand, due to excessive irrigation and large water storages, some regions have registered rise in ground water levels, at times leading to serious water logging problems.

Groundwater which used to provide guarantee against pollution, has not been spared either. Not only do pollutants from surface sources leach into the aquifer below, but with increasing groundwater exploitation, in-organics like fluoride and arsenic present below the ground also find their way into the extracted water. They cause fluorosis and arsenic poisoning, Groundwater pollution is particularly serious as 80 per cent of domestic water needs are met from this source. Over-exploitation of ground water is a very serious problem and the water table has steadily been falling in many parts of the country. Ground water is a shared common property resource and there is a need to evolve appropriate institutional mechanisms for its management.

The major WQ issues are;

- Pathogenic pollution in both sources
- Salinity in both sources
- Fluoride, Nitrate and Arsenic problems in Groundwater
- Oxygen depletion in Surface water
- Eutrophication in Surface water
- Toxicity in Ground and Surface water
- Ecological Health in surface water

Major causes for water quality degradation are:

- Domestic Wastewater
- Industrial Wastewater
- Rural and Slum Population
- Wastewater and Pollutants from Un-sewered Towns
- Pollutants in Agricultural Run-off and Drainage Waters (Diffuse pollution)
- Deposition of Air-Pollutants

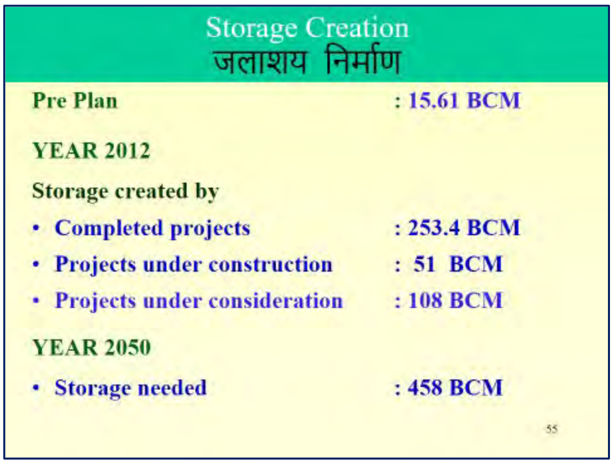
1.6.3.1 Water Quality Trend

The water quality monitoring results obtained during 1995 to 2006 indicate that the organic and bacterial contamination are continued to be critical in water bodies. This is mainly due to discharge of domestic wastewater mostly in untreated form from the urban centers of the country. The municipal corporations at large are not able to treat increasing the load of municipal sewage flowing into water bodies without treatment. Secondly the receiving water bodies also do not have adequate water for dilution. Therefore, the oxygen demand and bacterial pollution is increasing day by day. This is mainly responsible for water borne diseases.

1.7 WATER RESOURCES DEVELOPMENT – PRESENT SCENARIO

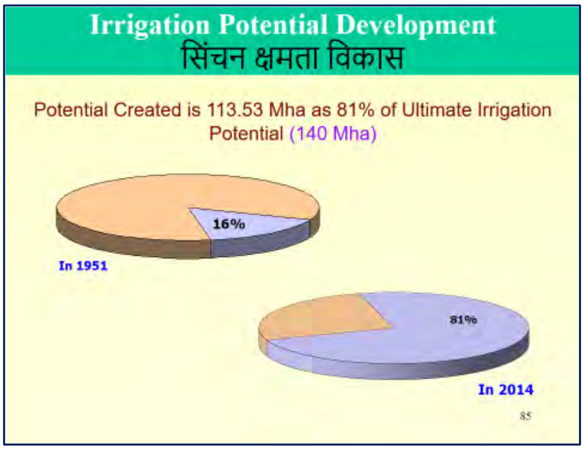
1.7.1 Creation of Surface Storage

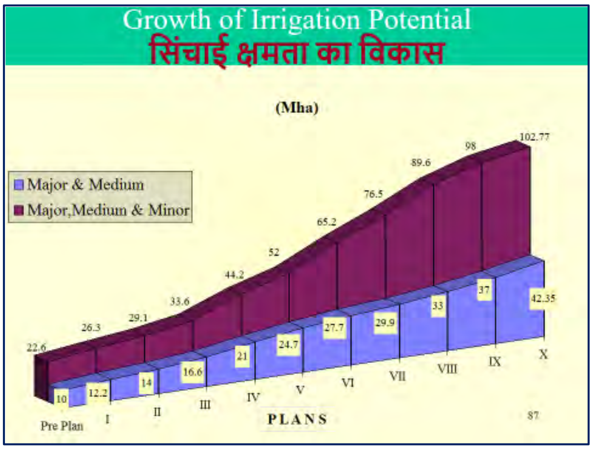
Large parts of the country are endowed with only 45 to 50 rainy days a year. Out of this also the major share of rainfall is concentrated in only a couple of days. Water resources development which received high priority in the successive five year plans initiated after independence has resulted in many achievements that are discernible. Many major, medium and minor water resources projects have been constructed during the past five-six decades. India ranks third in the World after China and USA in terms of number of dams. There are about 4850 completed large dams and another 250 are under various stages of constructions. All these projects have resulted in increasing the live storage capacity from 15.6 BCM at the time of independence to 253 BCM now. Projects under construction are likely to add another 51 BCM. Further 108 BCM is expected to be contributed by the projects under consideration. Storages held in these dams are an insurance against the vagaries of nature.



1.7.2 Development in Irrigation Sector

The total investment in irrigation sector during the period 1951 to 2012 is of the order of Rs.16000 billion. As a result of this, irrigation potential created by the end of Eleventh Five-Year Plan has gone upto approximately 110 m.ha. against 22.6 m.ha. in 1951. The ultimate irrigation potential is 140 m.ha (58.50 m.ha. by major and





medium irrigation projects, 17.40 m.ha. by minor surface water schemes and 64.10 mha. by ground water schemes). It is estimated that the expansion of irrigation systems alone has contributed to about 60 percent increase in food grains production. As a result the country today is not only self-sufficient, but in a position to export the food grains. The phenomenal development of water resources coupled with introduction of HYV seeds have propelled India from deficit food production at the time of independence to a country which now commands a sizeable share in the World Agriculture Scenario. India's success story in the agricultural sector largely owes to the number of major, medium and ERM projects accomplished/initiated during the successive plan periods as shown in the Table below.

Major, Medium & ERM projects in India

	Major	Medium	ERM	Total
Completed	295	1018	140	1453
Ongoing	176	170	66	412
Sub-Total	**471**	**1188**	**206**	**1865**
Total	1659			

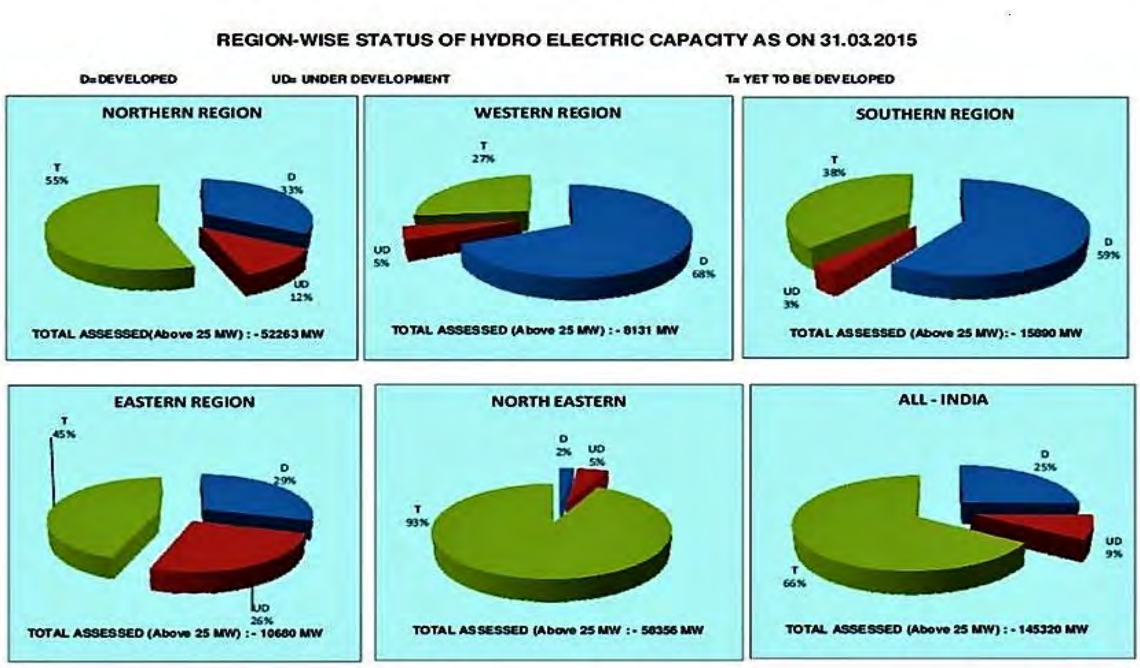
Irrigation through ground water has been achieved, mainly through construction of 9.2 million dug wells and 9.1 million shallow tube wells.

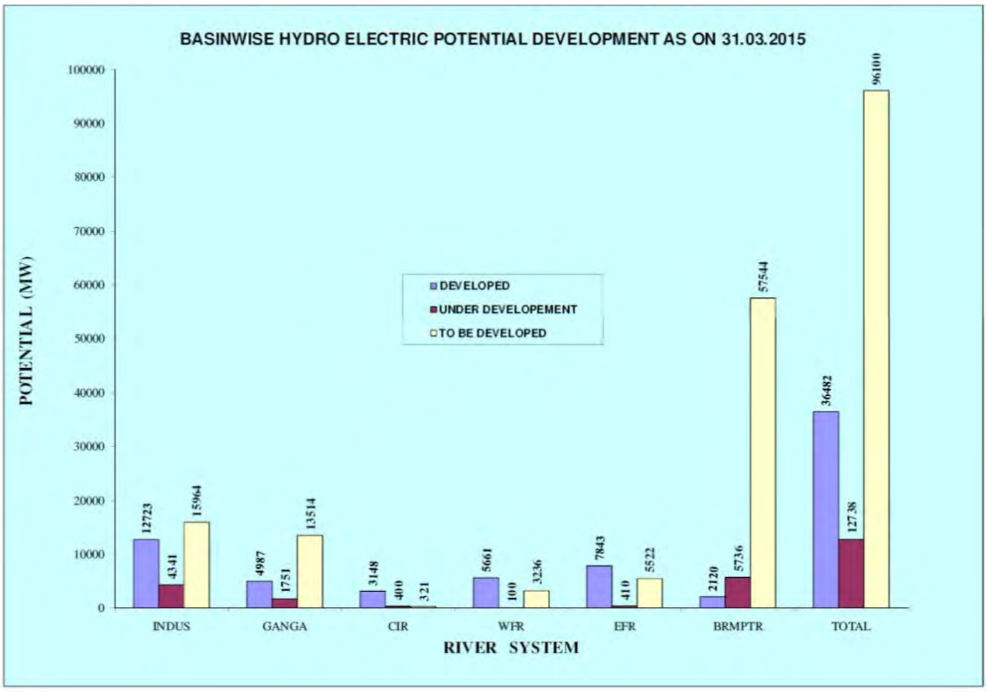
1.7.3 Domestic Sector - Urban and Rural Water Supply

About 92% of urban population has been covered by safe drinking water. Drinking water requirement of most of mega cities are met from reservoir of irrigation or multi-purpose schemes existing nearby and even by long distance transfer. The rural habitations have been provided access to the safe drinking water from nearly 3 million hand pumps and stand posts and about 0.11million mini and regional piped water supply schemes. More than 85 percent of rural water supply is ground water based and consumes about 5 percent of the total annual replenishable ground water.

1.7.4 Hydropower Development

Only 24 % of the hydropower potential of the country has been harnessed so far and 8% is under various stages of development. The total potential harnessed/under harnessing would thus be about 49,000 MW. The share of hydropower in the overall energy mix has been declining over the years. Against an ideal hydroelectric-thermal mix of 40: 60 it presently stands at 24:76.





In sharp contrast to what we have achieved in hydropower development, the continents of North America, Europe and Oceania have developed sizeable percentage of their respective practicable hydropower. India, even lags behind the world average.

1.7.5 Industrial & Other Uses

Water requirement for industries in India, is quite small compared to the quantity of water needed in agriculture. Only about 3 to 4 percent of present water use is for industrial purposes. However, when industrial demand is concentrated in specific locations, heavy point loads are created on available water resources. There are no fixed norms for water demand for industries but rather a range of values determined by the technology used, selection of plant and process, practice in providing maximum recycling to reduce demand and pollution. The requirement of water for other uses such as navigation, ecological recreation, etc., though not so significant in terms of consumptive use, will continue to be important and will have specific quantity and temporal needs.

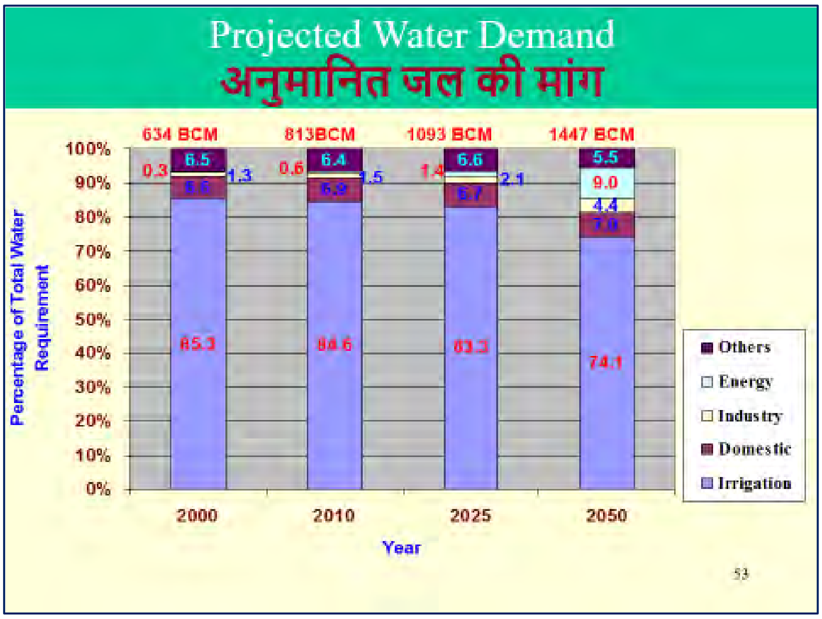
1.7.6 Projected Water Demand

The present water utilization and the probable trend for future water requirement for various sectors, as assessed is shown below in the table below:

Water Demand for Various Sectors

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

(Ref: Assessment of Availability and Requirement of Water for Diverse Uses in the Country - 2000)



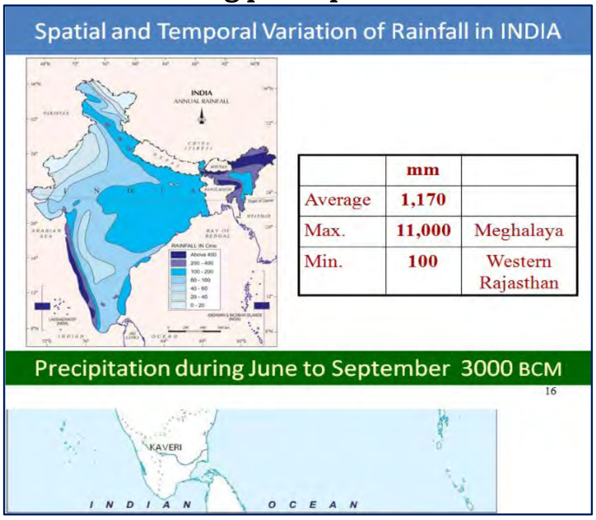
1.8 ISSUES AND CHALLENGES IN THE WATER RESOURCES DEVELOPMENT AND MANAGEMENT

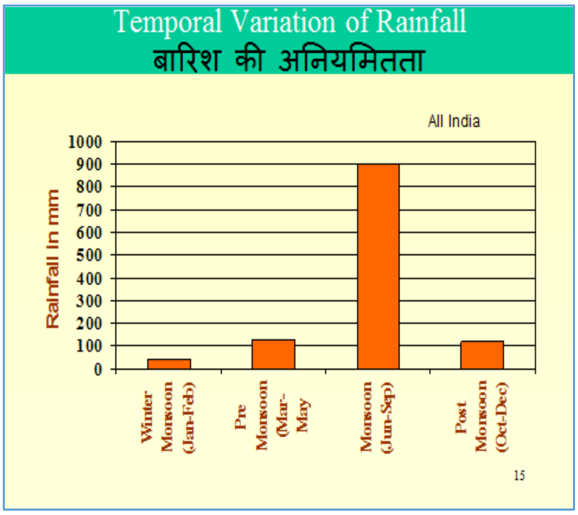
The pressure on our water & land resources is continuously increasing with the rise in population, urbanization and industrialization. Consequently, a number of issues have cropped up in water sector which call for timely and effective redressal. Some of these issues are being briefly brought out below:

1.8.1 Spatial and Temporal variation in water availability

The spatial unevenness and temporal variation in precipitation has led to complex situations like the distinctly different monsoon and non-monsoon seasons, the high and low rainfall areas and the drought-flood-drought syndrome

1.8.2 Declining per capita water availability





The declining per capita water availability is a cause of serious concern. Though from the point- of-view of the National level scenario, India may be above the Internationally accepted standards of water scarcity, yet the figures at the basin level vary widely from 13636 cu.m per year in Brahmaputra-Barak basin to 298 cu.m per year in Sabarmati basin. The situation is projected to get even more serious in 2050 when, about 22% of the area and 17% of the population in the country may be under absolute scarcity condition.

1.8.3 Rising multi-sectoral water demand for food production, energy generation etc.

The signal of the dwindling gap between availability and water demand is evident from the projections made for the coming decades. The projections clearly indicate that in 2050, the water demand may be significantly higher in comparison to the utilisable water resources of the country. Judiciously catering to this ever increasing multi-sectoral water requirement will be the most stringent challenge in the days ahead.

1.8.4 Reducing trend of Budget outlay for Irrigation sector

Declining budgetary allocation to irrigation sector in successive plan periods has resulted in the slow progress in completion of projects and delayed accrual of benefits. The States need to give higher priority to the irrigation sector and provide increased budget allocation.

1.8.5 Inequitable water distribution

Inequitable distribution of water among the head and the tail reaches of the command area has led to problems in bridging the gap between irrigation potential created & utilized as well as water logging and salinity.

1.8.6 Low Irrigation Efficiency

The irrigation efficiency in our country is of the order of only 25% to 35% in most irrigation system, with efficiency of 40% to 45% in a few exceptional cases. Some of the prime reasons for low irrigation efficiency are completion of dam/ head works ahead of canals, dilapidated irrigation systems, unlined canal systems, lack of field channels, lack of canal communication network, lack of field drainage, improper field leveling etc.

1.8.7 Deteriorating Water Quality

Water pollution is a major environmental concern in India. The main sources of water pollution are discharge of domestic sewage and industrial effluents, which contain organic pollutants, chemicals & heavy metals and run-off from land based activities such as agriculture and mining. Non-availability of minimum flow in the rivers has also reduced natural purification capacity of rivers thus increasing pollution.

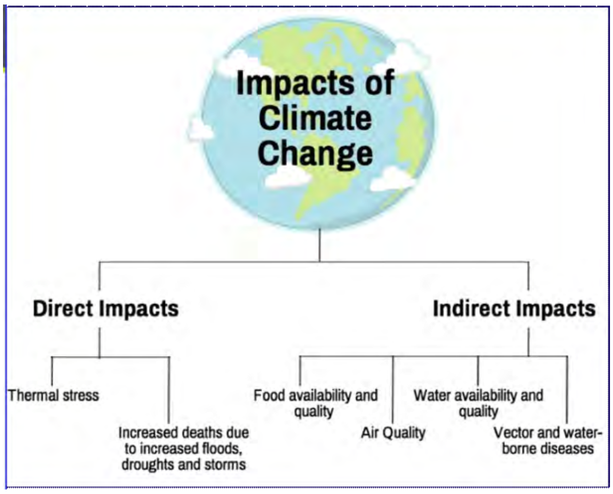
1.8.8 Over-exploitation of Ground water resources

Rapid pace of ground water development has resulted in a number of problems. In many arid and hard rock areas, overdraft and associated water quality problems are increasing. The unscientific development of groundwater in some coastal areas in the country has led to landward movement of seawater fresh water interface resulting in contamination of fresh water aquifers. In addition to problems caused due to human interference, natural factors like occurrence of high content of fluoride, arsenic and iron also affecting the ground water quality in several parts of the country.

Apart from these there are also governance issues like addressing the growing conflicts amongst the users of various sectors as also different regions, lack of co-ordination among the agencies involved in water sector; policy issue like shift from project specific planning to integrated approach with basin or sub-basin as a unit; and administrative issues like problems of land acquisition and Environment & Forests clearance of projects.

1.8.9 Climate Change and Water Resources

Climate change is predicted to have profound impact on to water resources. Temperature drives the hydrological cycle, influencing hydrological processes in a direct or indirect way. A warmer climate may lead to intensification of the hydrological cycle, resulting in higher rates of evaporation and increase of liquid precipitation. These processes, in association with a shifting pattern of precipitation, would affect the spatial and temporal distribution of runoff, soil moisture, and groundwater reserves and increase the frequency of droughts and floods. The future climatic change, though, will have its impact globally but likely to be felt severely in developing countries with agrarian economies, such as India. Surging population, increasing industrialization and associated demands for freshwater, food and energy would be areas of concern in the changing climate. Increase in extreme climatic events is of great consequence owing to the high vulnerability of the region to these changes.



The impacts of climate change are :

- Climate change makes extreme hydrological events more severe and more frequent at unexpected times
- Likely to alter hydrological cycle
  - Change in total amount of precipitation and its magnitude
  - Impact on regional water resource affecting river flows water supply
  - Change in floods and droughts situation
- Likely to aggravate water scarcity condition
- High risk of Violent conflicts

1.9 STRATEGIES FOR FACING THE CHALLENGES

There is urgent need for addressing the above-stated issues effectively. Broadly, the approach route for mitigating the issues & challenges can be categorized into three principal heads.

- **Developmental activities** to reduce Gap between availability and utilization
- **Management Practices** to bridge Gap between creation and utilization of facilities
- **Research & Development** to mitigate Gap between demand and availability

It is to be however noted that the proper implementation of all the activities identified under each category is of paramount importance to eradicate or even dilute the looming threats being mounted by those steep challenges. Therefore, co-operation and co-ordination among all the agencies involved in the water sector is a prerequisite for achieving any success in the future.

1.9.1 Developmental Activities: Gap between availability and utilization

✓ **Supply Management**

- Storages
- Inter-Basin Transfers (Interlinking of Rivers)
- Ground Water Recharge
- Watershed Development

- Rainwater Harvesting
- Desalination Of Water

Severe spatial and temporal variations in rainfall prompted that creation of storages be given due priority within the overall plan for water resources development. The successive Five year Plans initiated after independence, therefore laid significant emphasis on creation of storages that resulted in many remarkable achievements. Even after such relentless persuasion to create more storages, till date, the present level of development of the country, in terms of creation of live storages is only just more than 13.5% of the average annual water resources potential of the country.

The level of creation of storages in India is decisively lower compared to some other nations in the world. The per capita storage in the country which is about 207 m^3 is way below the storage achieved in many of the countries such as Russia (6103 m^3), Australia (4733 m^3), Brazil (3145 m^3), United States (1964 m^3), Turkey (1739 m^3), Spain (1410 m^3), Mexico (1245 m^3), China (1111 m^3) and South Africa (753 m^3) and there is an urgent need to vigorously pursue the case for creating storages, wherever feasible, given it's projected rise in population, urbanization & industrialization.

Restoring natural and man-made water bodies such as lakes, tanks, ponds and similar structure that have fallen into disuse is also extremely important. The Ministry of Water Resources has issued Guidelines for restoration of these water bodies. The exploitation of groundwater has been a matter of serious concern particularly in coastal and semi-arid areas causing salinity and depletion of ground water levels. Systematic development of ground water therefore needs to be fostered with right earnest.

1.9.2 Management Practices; to bridge a Gap between Creation and utilization of facilities

✓ **Demand Management**

- Water Use Efficiency
- Efficient Water Distribution Network
- Demand Management
- Equitable Water Distribution
- Participatory Water Management
- Cropping Pattern
- Realistic Water Rates
- Recycle and Reuse of Waste Water
- Pollution Control, Waste Water Treatment
- Conjunctive Use of Surface and Ground Water
- Extension, Renovation and Modernization of Old Structures

Improvement in water use efficiency is increasingly perceived to be a very important strategy for mitigating the receding gap between availability and demand. This is even more relevant in case of irrigation sector since a small improvement in the efficiency can lead to considerable saving of water that can be utilized for catering to the demand from other sectors. Different water management practices need to be followed in different sectors depending on their suitability, however, a few of them are discussed below.

1.9.2.1 Irrigation Sector

At present irrigation sector consumes as much as 83% of available water resources. With the demand from other sectors rising at a faster pace, the availability of water for irrigation would reduce. It is, therefore necessary to improve the performance of existing system. Higher degree of efficiencies in the management of water use in irrigation sector is required to be achieved to sustain production of crops. Some of the management practices that needs to be taken up in right earnest are implementation of restructured CADWM programme in States, participatory irrigation management (PIM), modernization of irrigation system and performance improvement, rationalization of water rates, benchmarking of irrigation systems, conjunctive use of surface and ground water, on farm management, etc.

1.9.2.2 Domestic Sector

There are real and apparent losses in domestic sector. Real loss is the actual loss of water due to leakages in distribution systems, service connections, storage tanks etc. apparent loss comprising of unauthorized use, meter/ record inaccuracies etc., is not a loss in actual sense but needs to be accounted for. Investigations suggest that accounted and unaccounted losses are as high as 50% of the total flow in the distribution system.

Thrust on water conservation in domestic supply sector will have twin benefit of saving of water over and above the saving in cost required for treatment and for supply too far off places. To improve the efficiencies in domestic sector various measures such as water audits, mass awareness programs, water pricing, proper maintenance and improvement in supply, control on leakages, prevention of unaccounted use of water, etc. Furthermore water conservation measures like artificial ground water recharge, rain water harvesting, public awareness & participation, reuse of water also need to be taken up vigorously.

1.9.2.3 Industrial & Other sectors

The water requirement of the industries used to be very small compared to other sectoral demands in earlier years. The rapid industrialization has changed the scenario. Most of the industrial production processes require large quantities of water. Adoption of most appropriate technology to ensure efficient use of cooling and process water apart from sound maintenance practices including leakage control is necessary for water conservation. Some of the action points towards water conservation for improving efficiency in industrial sector could be setting up of norms for water budgeting, modernisation of industrial process to reduce water requirement, recycling water for cooling purposes, rational pricing of industrial water to compel adoption of water saving technologies, proper treatment of effluents and use of treated water by industrial units.

Other major consumer of water is energy sector. The water requirements in the power sector are mainly met from the surface water resources. There is need to maintain the water use to the prescribed norms and reduce evaporation losses which would result in efficient water use. Recycling of water in pump storage plants would conserve water and should be encouraged, wherever feasible, for generation of peaking power.

The other miscellaneous water requirements are for recreation, navigation etc., most of which are non-consumptive. Necessity for maintaining minimum flow may arise out of the necessity to maintain water quality, river regime, maintenance of river eco system or other public necessities such as bathing etc. Maintenance of minimum flow in river can also be considered as a water use since it restricts the quality of water that can be diverted for other uses. The quantity will vary according to river regimes.

1.9.3 Research & Development: to mitigate gap between demand and availability

- Advanced Irrigation techniques
- IT tools for water distribution
- Development of Modelling Tools
- Less water consuming gadgets
- Water saving Technologies
- Research in desalination & waste water Treatment
- Developing water resistant crop varieties
- Policy Research, Etc.

The finite water availability and the ever rising demand due to rise in population, urbanization, industrialization etc. requires a well-focused Research and Development Programme to gauge the intensity of the problem as well as its remedial measures. Some of the areas where R&D activities could be concentrated are.

- Development of crops, which require minimum water and can sustain poor quality saline water.
- Biological control of drainage congestion in waterlogged areas.
- Improving energy efficiency of water pumps used for irrigation.
- Technology upgradation like using micro irrigation, micro sprinkler and micro sprayer, bucket kit drip irrigation system for small farm, auto irrigation system etc.

Since, after implementation of all the development as well as management strategies, the total utilizable water resources of the country may not be able to match the water demand by the year 2050 and therefore, exploration of newer concepts for augmenting the available resources is an equally vital area where the country needs to concentrate as a part of the long term strategy. Some of these are recycling & reuse of water, Inter-basin transfer of water, Artificial Recharge of ground water, Desalination of sea water etc.

1.9.4 Economic Development and Water Resources Management

One of the main input for economic development is water, India is largely an agrarian economy, moreover, industrial, energy and service sectors are also booming and a profound development are expected in the next few decades. In fact, India is amongst the BRIC block countries, which are going to be the drivers of the world economy. Further, the economic development is possible only if the entire water users sector get sufficient amount of the water required for its activities. The overall total requirement of water is getting exceeded with the total water availability. For sustainable economic development, water demand management will have greater impact on water user sector. Economic Development of India will depend how effectively the water is managed by the various water users. Huge water use efficiency is required in agriculture sector, industry and service sector too need to move on from the mere water user to a sector which comes up with an efficient water saving technologies, addressing the water quality issues, adopting recycling and reuse of water and alternative production processes. Conversely, economic development is going to have larger impact water resources sector in terms of increased demand and water quality.

1.10 NEED FOR WATER CONSERVATION AND MANAGEMENT

It is estimated that with increasing demand from other competing sectors, the availability of water for irrigation sector is likely to reduce progressively to about 75 percent in future. Irrigated agriculture which consumes the major part of the total water being used should be the focus and fore-runner for achieving maximum conservation in its use. Even a marginal improvement in the efficiency of water use in this area will result in the saving of a large volume of water which can be utilized either for extending the irrigated area or for diverting to other beneficial purposes. The inevitable reduction in loss in availability of total water for irrigation sector has to be offset by improvement in irrigation efficiencies. However, improvement in water application efficiencies and productivity levels alone will not be sufficient and it is an imperative to create additional potential and bring more area under irrigation. Therefore, there is urgent need to create more storages for conserving water which is available during monsoon period only, for its use during lean period.

To meet the increased competing demands of various sectors, it is essential to affect economy in industrial use of water. Most of the industrial uses being non-consumptive, recycling and reuse of water plays an important role for economizing water use in industries. For affecting efficient and economical use of water, the tariff rates have to be such as to compel the industry to look into technological interventions leading to reduced use per unit production of waste water. Some of the important issues pertaining to water conservation are incorporation of alternate production processes and technologies for reducing water use, recycling and reuse of water, ensuring sound plant maintenance practices and minimizing spills and leaks and appropriate pricing of water.

This scenario of rising competing demands for various sectors and mismatch of water availability and demand highlights the need for conservation of water. Water conservation has three dimensions:

i) **Water resources conservation**- efficient management of available water through proper storage, equitable allocation and transfer to scarcity areas for use. Preservation of the quality of the resource including ecosystem conservation.

ii) **Water use conservation** -water supply and distribution with minimum losses and consumption through prevention of wastage.

iii) **Efficient use of water** through adoption of water saving technologies and cropping patterns.

To achieve the objective of conservation of water in the agricultural and industrial sectors focus of attention will have to be on-augmentation and creation of additional resources, performance improvement of existing systems, coordination amongst various agencies, provision of adequate funds for creation of additional resources and conservation measures, ensuring users' participation, giving impetus for Benchmarking of irrigation system, creating mass awareness for better management of availability and demand and environment protection. Strategies will need to focus on augmentations and optimum utilization without sacrificing on quality with people’s participation.

1.11 CONCLUSION

Water resource development is to be seen not merely as a single-sector-end objective, but as a prime mover in developing larger systems with multiple linkages. This calls for a well set out multi-disciplinary agenda covering not only technological issues but also issues of social, economic, legal and environmental concerns. Therefore the planning, development and management of water resources has to be taken up in an integrated manner for addressing the concerns facing the water sector. This integration has to be a multi-disciplinary approach which would take care of all the conflicting issues and deliver solutions that would be technically feasible, economically viable, socially acceptable and ecologically & environmentally sound. Water use, in turn, has its impact on water quality and therefore utilization of water has to be so managed as not to contribute to the deterioration of water quality that may seriously jeopardize its future availability.

Chapter 2

Water Conservation and Management in India: Traditional Water Conservation in India

2.1 INTRODUCTION AND BACKGROUND

Water Resources of a country constitute one of its vital assets. With about four percent (4%) of world's water resources available in the country, the presumption that these are inexhaustible is proving incorrect. With the increase in population, urbanization and industrialization, the demand of water for various uses is increasing continuously, thereby reducing per capita water availability. India is a developing country with a vast territory, complex and diverse topography, varied climate and a large population. The precipitation and runoff in the country is not only unevenly distributed, but also uneven with regard to temporal distribution of water during the year. India being a predominantly agriculture dependent country, its economic development is linked to agriculture. The major limiting factor for agriculture is water. A growing population and consequent need for increase in food production thereby requiring increasing area of agricultural fields and irrigation are resulting in tremendous pressure over water. Due to over exploitation of water resources, it has become scarce in many parts of our country. Needless to say, under such a scenario "**Water Conservation and Management"** is of great importance to the economic, social and cultural development in India.

2.2 TRADITIONAL METHODS OF WATER CONSERVATION AND MANAGEMENT

Water conservation is a key element of any strategy that aims to alleviate the water scarcity crisis in India. With rainfall patterns changing almost every year, the Indian government has started looking at means to revive the traditional systems of water harvesting in the country. Given that these methods are simple and eco-friendly for the most part, they are not just highly effective for the people who rely on them but they are also good for the environment.

History tells us that both floods and droughts were regular occurrence in ancient India. Perhaps this is why every region in the country has its own traditional water conservation and management techniques that reflect the geographical peculiarities and cultural uniqueness of the regions. The basic concept underlying all these techniques is that rain should be harvested whenever and wherever it falls.

Archaeological evidence shows that the practice of water conservation and management is deep rooted in the science of ancient India. Excavations show that the cities of the Indus Valley Civilization had excellent systems of water conservation, harvesting and drainage system. The settlement of Dholavira, laid out on a slope between two storm water channels, is a great example of Water Engineering. Chanakya's Arthashashtra mentions irrigation using water harvesting systems. Sringaverapura, near Allahabad, had a sophisticated water harvesting system that used the natural slope of the land to store the floodwaters of the river Ganga. Chola King Karikala built the Grand Anicut or Kallanai across the river Cauvery to divert water for irrigation (it is still functional) while King Bhoja of Bhopal built the largest artificial lake in India.

Drawing upon centuries of experience, Indians continued to build structures to catch, hold and store monsoon rainwater for the dry seasons to come. These traditional techniques, though less popular today, are still in use and efficient. Drawing upon centuries of experience, Indians continued to build structures to catch, hold and store monsoon rainwater for the dry seasons to come. Water has been conserved and managed in India since antiquity, with our ancestors perfecting the art of water management. Many water conservation structures and water conveyance systems specific to the eco-regions and culture has been developed as shown in figure.

The traditional Water Conservation and Management practiced based on the Ecological Regions of India are tabulated below:

Sr. No.	*Ecological Region*	*Traditional Water Management System*
1.	Trans - Himalayan Region	Zing
2.	Western Himalaya	Kul, Naula, Kuhl, Khatri
3.	Eastern Himalaya	Apatani
4.	North Eastern Hill Ranges	Zabo
5.	Brahmaputra Valley	Dongs / Dungs/ Jampois
6.	Indo-Gangetic Plains	Ahars – Pynes, Bengal's Inundation Channels, Dighis, Baolis
7.	The Thar Desert	Kunds, Kuis/beris, Baoris / Ber/ Jhalaras, Nadi, Tobas, Tankas, Khandins, Vav/Bavadi, Virdas, Paar

8.	Central Highlands	Talab, Bandhis, Saza Kuva, Johads, Naada/Bandh, Pat, Rapat, Chandela Tank, Bundela Tank
9.	Eastern Highlands	Katas / Mundas / Bandhas
10.	Deccan Plateau	Cheruvu, Kohli Tanks, Bhandaras, Phad, Kere, The Ramtek Model
11.	Western Ghats	Surangam
12.	West Coastal Plains	Virdas
13.	Eastern Ghats	Korambu
14.	Eastern Coastal Plains	Eri / Ooranis
15.	The Islands	Jack Wells

These traditional techniques, though less popular today, are still in use and efficient. Brief details of these techniques of water conservation and management systems prevalent in India who have practiced them for decades before the debate on climate change even existed based on ecological Regions of India are given below:

- **Jhalara**

Jhalaras are typically rectangular-shaped step wells that have tiered steps on three or four sides. These step wells collect the subterranean seepage of an upstream reservoir or a lake. Jhalaras were built to ensure easy and regular supply of water for religious rites, royal ceremonies and community use. The city of Jodhpur has eight jhalaras, the oldest being the Mahamandir Jhalara that dates back to 1660 AD.

- **Talab /Bandhi**

Talabs are reservoirs that store water for household consumption and drinking purposes. They may be natural, such as the *pokhariyan* ponds at Tikamgarh in the Bundelkhand region or manmade, such as the lakes of Udaipur. A reservoir with an area less than five *bighas* is called a *talai,* a medium sized lake is called a *bandhi and* bigger lakes are called *sagar* or *samand.*

.Bawari

Bawaris are unique step wells that were once a part of the ancient networks of water storage in the cities of Rajasthan. The little rain that the region received would be diverted to man-made tanks through canals built on the hilly outskirts of cities. The water would then percolate into the ground, raising the water table and recharging a deep and intricate network of aquifers. To minimize water loss through evaporation, a series of layered steps were built around the reservoirs to narrow and deepen the wells.

- **Taanka**

Taanka is a traditional rainwater harvesting technique indigenous to the Thar Desert region of Rajasthan. A Taanka is a cylindrical paved underground pit into which rainwater from rooftops, courtyards or artificially prepared catchments flows. Once completely filled, the water stored in a taanka can last throughout the dry season and is sufficient for a family of 5-6 members. An important element of water security in these arid regions, taankas can save families from the everyday drudgery of fetching water from distant sources.

- **Ahar Pynes**

Ahar Pynes are traditional floodwater harvesting systems indigenous to South Bihar. Ahars are reservoirs with embankments on three sides that are built at the end of diversion channels like pynes. Pynes are artificial rivulets led off from rivers to collect water in the ahars for irrigation in the dry months. Paddy cultivation in this relatively low rainfall area depends mostly on ahar pynes.

- **Johads**

Johads, one of the oldest systems used to conserve and recharge ground water, are small earthen check dams that capture and store rainwater. Constructed in an area with naturally high elevation on three sides, a storage pit is made by excavating the area, and excavated soil is used to create a wall on the fourth side. Sometimes, several johads are interconnected through deep channels, with a single outlet opening into a river or stream nearby. This prevents structural damage to the water pits that are also called madakas in Karnataka and pemghara in Odisha.

- **Panam Keni**

The Kuruma tribe (a native tribe of Wayanad) uses a special type of well, called the panam keni, to store water. Wooden cylinders are made by soaking the stems of toddy palms in water for a long time so that the core rots away until only the hard outer layer remains. These cylinders, four feet in diameter as well as depth, are then immersed in groundwater springs located in fields and forests. This is the secret behind how these wells have abundant water even in the hottest summer months.

- **Khadin**

Khadins are ingenious constructions designed to harvest surface runoff water for agriculture. The main feature of a khadin, also called dhora, is a long earthen embankment that is built across the hill slopes of gravelly uplands. Sluices and spillways allow the excess water to drain off and the water-saturated land is then used for crop production. First designed by the Paliwal Brahmins of Jaisalmer in the 15th century, this system is very similar to the irrigation methods of the people of ancient Ur (present Iraq).

- **Kund**

A kund is saucer-shaped catchment areas that gently slope towards the central circular underground well. Its main purpose is to harvest rainwater for drinking. Kunds dot the sandier tracts of western Rajasthan and Gujarat. Traditionally, these well-pits were covered in disinfectant lime and ash, though many modern kunds have been constructed simply with cement. Raja Sur Singh is said to have built the earliest known kunds in the *village of Vadi Ka Melan in the year 1607* AD.

- **Baoli**

Built by the nobility for civic, strategic or philanthropic reasons, baolis were secular structures from which everyone could draw water. These beautiful step wells typically have beautiful arches, carved motifs and sometimes, rooms on their sides. The locations of baolis often suggest the way in which they were used. Baolis within villages were mainly used for utilitarian purposes and social gatherings. Baolis on trade routes were often frequented as resting places. Step wells used exclusively for agriculture had drainage systems that channeled water into the fields.

- **Nadi**

Found near Jodhpur in Rajasthan, nadis are village ponds that store rainwater collected from adjoining natural catchment areas. The location of a nadi has a strong bearing on its storage capacity and hence the site of a nadi is chosen after careful deliberation of its catchment and runoff characteristics. Since nadis received their water supply from erratic, torrential rainfall, large amounts of sandy sediments were regularly deposited in them, resulting in quick siltation. A local voluntary organization, the Mewar Krishak Vikas Samiti (MKVS) has been adding systems like spillways and silt traps to old nadis and promoting afforestation of their drainage basin to prevent siltation.

- **Bhandara Phad**

Phad, a community-managed irrigation system, probably came into existence a few centuries ago. The system starts with a *bhandhara* (check dam) built across a river, from which *kalvas* (canals) branch out to carry water into the fields in the phad (agricultural block). *Sandams* (escapes outlets) ensure that the excess water is removed from the canals by *charis* (distributaries) and *sarangs* (field channels). The Phad system is operated on three rivers in the Tapi basin – Panjhra, Mosam and Aram – in the Dhule and Nasik districts of Maharashtra.

- **Zing**

Zings, found in Ladakh, are small tanks that collect melting glacier water. A network of guiding channels brings water from the glacier to the tank. A trickle in the morning, the melting waters of the glacier turn into a flowing stream by the afternoon. The water, collected by evening, is used in the fields on the following day. A water official called a *Chirpun* is responsible for the equitable distribution of water in this dry region that relies on melting glacial water to meet its farming needs.

- **Kuhls**

Kuhls are surface water channels found in the mountainous regions of Himachal Pradesh. The channels carry glacial waters from rivers and streams into the fields. The Kangra Valley system has an estimated 715 major kuhls and 2,500 minor kuhls that irrigate more than 30,000 hectares in the valley. An important cultural tradition, the kuhls were built either through public donations or by royal rulers. A kohli would be designated as the master of the kuhl and he would be responsible for the maintenance of the kuhl.

- **Zabo**

The Zabo or Ruza (meaning 'impounding run-off') system of Nagaland combines water conservation with forestry, agriculture and animal care. Rainwater that falls on forested hilltops is collected by channels that deposit the run-off water in pond-like structures created on the terraced hillsides. The channels also pass through cattle yards, collecting the dung and urine of animals, before ultimately meandering into paddy fields at the foot of the hill. Ponds created in the paddy field are then used to rear fish and foster the growth of medicinal plants.

- **Bamboo Drip Irrigation**

Bamboo Drip irrigation System is an ingenious system of efficient water management that has been practiced for over two centuries in northeast India. The tribal farmers of the region have developed a system for irrigation in which water from perennial springs is diverted to the terrace fields using varying sizes and shapes of bamboo pipes. Best suited for crops requiring less water, the system ensures that small drops of water are delivered directly to the roots of the plants. This ancient system is used by the farmers of Khasi and Jaintia hills to drip-irrigate their black pepper cultivation.

- **Jackwells**

The Shompen tribe of the Great Nicobar Islands lives in a region of rugged topography that they make full use of to harvest water. In this system, the low-lying region of the island is covered with jackwells (pits encircled by bunds made from logs of hard wood). A full-length bamboo is cut longitudinally and placed on a gentle slope with the lower end leading the water into the jackwell. Often, these split bamboos are placed under trees to collect the runoff water from leaves. Big jackwells are interconnected with more bamboos so that the overflow from one jackwell leads to the other, ultimately leading to the biggest jackwell.

- **Ramtek Model**

The Ramtek model has been named after the water harvesting structures in the town of Ramtek in Maharashtra. An intricate network of groundwater and surface water bodies, this system was constructed and maintained mostly by the malguzars (landowners) of the region. In this system, tanks connected by underground and surface canals form a chain that extends from the foothills to the plains. Once tanks located in the hills are filled to capacity, the water flows down to fill successive tanks. This system conserves about 60 to 70 % of the total runoff in the region.

- **Pat System**

The Pat system, in which the peculiarities of the terrain are used to divert water from hill streams into irrigation channels, was developed in the Bhitada village in Jhabua district of Madhya Pradesh. Diversion bunds are made across a stream near the village by piling up stones and then lining them with teak leaves and mud to make them leak-proof. The Pat channel then passes through deep ditches and stone aqueducts that are skillfully cut info stone cliffs to create an irrigation system that the villagers use in turn.

- **Eri**

The Eri (tank) system of Tamil Nadu is one of the oldest water management systems in India. Still widely used in the State, eris act as flood-control systems, prevent soil erosion and wastage of runoff during periods of heavy rainfall, and also recharge the groundwater. Eris can either be a system eri, which is fed by channels that divert river water, or a non-system eri, that is fed solely by rain. The tanks are interconnected in order to enable access to the farthest village and to balance the water level in case of excess supply. The eri

system enables the complete use of river water for irrigation and without them, paddy cultivation would have been impossible in Tamil Nadu. There are several other hyper local versions of the traditional method of tank irrigation in India. From *keres* in Central Karnataka and *cheruvus* in Andhra Pradesh to *dongs* in Assam, tanks are among the most common traditional irrigation systems in our country.

- **Apatani**

It is a multipurpose water management system, which integrates land, water and farming systems by protecting soil erosion, conserving water for irrigation and paddy-cum-fish culture. This is wet rice cultivation cum fish farming system practiced in elevated regions of about 1600 m and gentle sloping valleys, having an average annual rainfall about 1700 mm and also rich water resources like springs and streams. This system harvests both ground and surface water for irrigation. It is practiced by Apatani tribes of Ziro in the lower Subansiri district of Arunachal Pradesh.

In Apatani system, valleys are terraced into plots separated by 0.6 meters high earthen dams supported by bamboo frames. All plots have inlet and outlet on opposite sides. The inlet of low lying plot functions as an outlet of the high lying plot. Deeper channels connect the inlet point to outlet point. The terraced plot can be flooded or drained off with water by opening and blocking the inlets and outlets as and when required. The stream water is tapped by constructing a wall of 2-4 m high and 1 m thick near forested hill slopes. This is conveyed to agricultural fields through a channel network. There is necessity to introduce high yielding varieties of paddy and fish to augment the income of the farmers from this system. This system and structures are highly successful and has been continued for years in the area. This is an ideal example of indigenous technology developed by the rural farmers.

- **Cheo-ozihi**

The river Mezii flows along the Angami village of Kwigema in Nagaland and the river water is tapped in seven different places in different elevations by means of channel diversion. The river water is brought down by a long channel from which many branches take off, and water is often diverted to the terraces through bamboo pipes. One of the channels is called Cheo-ozihi. Ozihi means water and Cheo was the person responsible for the laying of this 8-10 km-long channel with its numerous branches. The channels are maintained and cleared each year by the local community. This channel irrigates a large number of terraces in Kwigema, and some terraces in the neighboring village.

- **Roof top water harvesting in Mizoram**

In Mizoram most of the hills are steep having slope more than 50 per cent and are separated by deep river gorges. Despite of heavy monsoon rain, the people face acute water problems every year in the dry season. The geological formation does not permit water retention; runoff is quick and springs and small streams dry up when there is no rain. Roof top harvesting structures for drinking purpose have been developed locally and now spread in the entire Mizoram. It has proved to be quite successful. Most houses are built with sloping roofs with galvanized iron sheets to be quite successful. Most houses are built with sloping roofs with galvanized iron sheets which are conducive to rain water harvesting. A common method of storing rain water is to place horizontal rain gutters along the sides of sloping roof, which is normally made of corrugated iron sheets. Rain water pours into a pipe connected to the tank which is mostly made from GCI sheets or galvanized plain sheets. But many people have started using reinforced cement concrete tanks, located in the court yard or under the house. Now the government of Mizoram has a policy to replace thatch roof with GCI sheet roofs to improve village houses and also to provide loan for promoting roof top water harvesting.

2.3 CONCLUSION

It can be noted from above that these techniques had evolved historically as per site specific conditions (topography) and according to the peculiar climate and geology (soil) prevailing therein. The scale of the projects/schemes was not large and mostly located in a decentralized manner and community owned serving multiple purposes at times. These micro/small scale techniques were suited to subsistence economy, till the population pressure was controlled and there were limited uses of water (mostly drinking and household). A major reason for the breakdown of this traditional system is the pressure of centralization and agricultural intensification. At the same time, there were occurrences of floods and instances of droughts/famines in spite of such practices in vogue.

Small projects, per se cannot by themselves, adequately intercept the large quantum of rainfall available for exploitation in a sustained manner. Economy of scale, much lesser evaporation losses, the safety and flood absorption potential, are only available with large storage projects. However, small dams can be considered as worthy supplements but not substitutes for large dams. The storage behind large dams in any basin ensures that there is a cushion of reserve as well as in-built carry-over storage. In view of significant storage capacity, the large dams can have adequate flood cushion to moderate heavy floods. Further even without specifically earmarked flood storage, the flood moderation is being achieved in large dams by suitable regulation of outflows. Of course, before taking a decision of construction of large dams, all other alternatives like several smaller dams or cascade development schemes need to be considered in detail and compared with the large dam option.

Water is also a source of energy. The large dams and reservoirs can help generate considerable hydro-power which also helps in enhancing the economic viability of the project. In fact, most of the existing dams provide multiple benefits. Thus, for harnessing untapped water resources, apart from irrigation and drinking water supply, energy generation can also be provided, where feasible, thereby facilitating proper hydro-thermal mix for improving operational reliability. It has been seen that the existing dams have also significantly increased economic activity in the catchment areas, because of increased tempo of construction activities, commerce and tertiary development as well as promotion of tourism, fishing etc.

In the critical monsoon years, large storage provides buffer against threat whereas the smaller ones yield to the climatic stresses. Further, these type of practices are very much likely in areas where no canal irrigation or lift irrigation is feasible. There is no other way to make water reach in those terrain other than tapping the rain water wherever it falls. Water reuse and recycling can also be clubbed with the existing practices for further reliability of the system. However, these success stories have been possible with charismatic leadership of few socialists and not as per any legal provisions and therefore could not be replicated in adjoining villages or blocks. There is an urgent need for institutionalization of such best practices as per law like formation of WUA in such areas as well. Also, the system such developed is suitable for subsistence economy and provides livelihood to very limited population. Scientifically designing the watershed models and traditional practices with proper operation and maintenance procedures with the WUAs and finally integrating the model with the larger river basin master plan would be sustainable, holistic and inclusive in longer run. T**hese ecologically safe traditional systems are viable and cost-effective alternatives to rejuvenate India's depleted water resources. Productively combining these structures with modern rainwater-saving techniques, such as percolation tanks, injection wells and subsurface barriers, could be the answer to India's perennial water woes.**

2.4 MODERN DAY EXAMPLES OF CONTINUING AGE OLD TRADITIONAL PRACTICES OF WATER CONSERVATION AND MANAGEMENT.

Some of the modern day examples of continuing the age old traditional practices of water conservation and management are given below:

2.4.1 River Arvari Parliament (Tarun Bharat Sangh, Alwar, Rajasthan)

The River-Basin focused approach of TBS has led to the rejuvenation of seasonal rivulets as perennial rivers. When there was plenty of water in River Arvari, there was natural growth of fish, which continued to multiply. The government wanted to get hold of fish and brought in a contractor. The people resisted and the Government had to cancel the contract. It is not that the local people wanted control over the fish. Far from it! They are all vegetarians and do not eat fish, but they realized that today it was fish tomorrow it would be water.

This incident led to the formation of Arvari Sansad (River Arvari Parliament). The Sansad represents 72 villages, each of which sends two representatives. Thus, it has 142 members who are nominated by their respective village institutions (Gram Sabhas). The primary objective of the Sansad is to safeguard Integrated and Water Management efforts of the community of river catchment. It follows Gandhian ethos of participatory, equitable and decentralized paradigm for water management (Jal Swaraj), where decisions are made at the grassroots not by centralized institutions. Thus Arvari Sansad develop policies and enforce rules to govern the integrated management of interlinked natural resources like water, soils and the forest for the wellbeing of the villagers as well as other forms of life-flora and fauna.

The Sansad convene its general meeting twice a year to deliberate upon best strategies for resource conservation and management issues. A co-ordination committee comprising members selected by the Sansad handles the routine operations and ensures compliance with the rules. The Sansad has framed 11 rules for the river basin conservation and management on following issues:

- Arvari basin shall not have sugarcane, paddy & chilli. People growing these to be penalized.
- No one shall draw water from the river after Holi (Mar Apr) up to monsoon (July).
- Bore wells not be allowed in Arvari catchment.
- Recommended crops– barley, makka, bajra in upper and vegetables in lower reaches.
- No axe can be carried to Bhairodev people’s sanctuary, catchment of the source of Arvari.
- Fishing can be done only for food.
- Large-scale trade of food grains and vegetables was banned. Local production and consumption to be emphasized.
- Village people to help people from other areas for implementing water harvesting structures.
- Cattle outside the region are not permitted for grazing.
- Rotational grazing to be followed by farmers in their own pasturelands.
- Industrial units prohibited in **405 sq km of Arvari basin**.

In situations where village-level violations are reported, solutions are arrived at cordially through discussion and mutual consent within the village communities.
A vital water-use policy formulated by the Arvari Sansad, was to enforce a cropping pattern that comprise of crops that consume very less water and discourage water intensive crops (e.g. sugar cane). However, this policy initially faced unyielding opposition from saansads (parliament members) as it was argued that sugarcane provide cash, jaggery and sugar for domestic use. Through a long process of debate and discussions in various meetings with the farmers (in Gram Sabhas), Saansads, social workers and TBS volunteers, the Arvari Sansad arrived at a **"compensatory agricultural crop pattern".** Under this system, a farmer can devote 25% of his land under water intensive crop i.e. sugar cane and the rest of his landholding would be under less water intensive crops. This was unanimously agreed upon in the Sansad and is being successfully implemented. **Another triumphant policy was to prevent the sale of agricultural land to industries or big private companies interested in water based enterprises such as brewery**. The Arvari Sansad is also taking advantage of **a law that requires special permission for conversion of agricultural land for non-agricultural purposes.** Growing evidence in terms of various studies prove that compliance of rules and regulations stood at about more than 80 % now.

This example demonstrates community leadership in action in protecting a resource. This is the only region in the country where the people themselves have set up a unique river basin organization for Demand-side Water Management.

The Arvari Sansad meets on a regular basis and thus has traveled more than 10 years and has been successful in keeping wrong-doers at bay. Though this 'river Sansad' has no legal status and its decisions are not legally binding, the moral force of people makes its survival possible. The workers of Tarun Bharat Sangh have served as facilitators. This success has been a product of contributions, participation and sharing as every member of the rural community bear ownership of river and its waters thereby ensuring the safety and maintenance of the resources. Most of the time, the community has succeeded in driving away the manipulative forces. But in future, if the social fabric of the community weakens, some from within the community and stronger external forces could question the legal status of the Sansad and the norms laid down by it. For this purpose the TBS is in process of drafting a strategic legal environment for community management of river basin to give teeth to the rules promulgated by the Arvari Sansad.

Dark Zone to Flow

Few words of a wise old-man spoken to Rajendra Singh changed the path of Tarun Bharat Sangh's approach towards development. After that TBS never look back. It is 'Johad' which made TBS a champion in the sphere of Rain-Water Harvesting. Till today, TBS constructed around 10,000 of johads with the contribution of villagers.
The impact of 25 years of tireless effort has brought about a significant increased from an officially marked "dark zone" to "a water surplus" zone.

Now begin with the story of the rivulet Arvari. The first step to make this stream alive was taken in 1987 by constructing a small Johad in a village Bhaota. Later seeing the advantage of johad, many villagers came forward to build such structures in their own areas. Now there was simply a craze for johads. And to this date, there are 375 RWH structures in the catchment area of the river Arvari.
Water in RWH structures raised the water table in the entire catchment area of the river. This in turn, enriched the forest in the same area. Forests and scrubs helped to retard the run-offs of monsoon waters. This way, in a decade, the river Arvari came to life from a dried up dead water-course. Today, the river-flow continues the year round.

Expert opinion R.N. Athavale, emeritus scientist at the National Geophysical Research Institute in Hyderabad, assessed the work done by TBS. His aim was to gauge the changes brought about by the RWH structures through certain estimates of the water balance of a typical river in the area. Here are some of his findings:

a) The annual average rainfall in the region is about 600 mm. Most of this rain (about 80 per cent) falls during the monsoon.
b) Before TBS's intervention in encouraging RWH, 35 per cent of the rainwater was lost immediately as seasonal run-off. Another 50 per cent was lost due to evaporation or transpiration.
c) Only 15 per cent of the rainfall naturally recharged the groundwater. Of this, 5 per cent became soil moisture, as the soil was too dry. Another 5 per cent constituted the base flow, implying the amount of groundwater returned to the surface stream or river. Of the remaining 5 per cent, some parts were tapped by wells and used, but the rest percolated to depths below the wells and stream beds.
d) After RWH structures were built, there was an additional recharge of groundwater to the tune of 20 per cent.
e) Though the base flow to the stream or river remained the same, there was an additional seepage (effluent seepage) of 17 per cent of rainfall to the river in non-monsoon months. This phenomenon contributed to the revival of the River Aravari and made it perennial.
f) Seasonal run-off has come down from 35 per cent of the rainwater to only 10 per cent.
g) There has been an increase in soil moisture: an additional 5 per cent of the rainwater is retained in the soil. Groundwater table has risen.
h) In all 5 per cent of the total rainwater is being used for irrigation, one-third of which is returned to the ground. It should be noted that the villagers have not been unscrupulous in drawing out groundwater.
i) About 22 per cent of the run-off (excluding the 10 per cent seasonal run-off during the monsoon) is better regulated and spread out over the year. This has been crucial in reviving the Arvari. If this run-off had not been regulated,

the river would not flow throughout the year. This shows how fragile the ecosystem is.

2.4.2 "Mewat: A village becomes water secure"

Mewat, a historical region comprising of the present Mewat district of Haryana and parts of Alwar, Bharatpur and Dholpur districts of Rajasthan, lies in a semi-arid belt. It experiences variable rainfall annually and receives, on average, 336 mm to 540 mm, as per the Mewat Development Agency.

Groundwater is the major source of water in the district as surface water storage is scarce. Saline groundwater is found in 442 of the 503 villages in the district, making it unusable for drinking or agriculture. Sweet water is found in villages that are mostly located along the foothills of the Aravalli range that passes through the district.

Some 30% of the households own wells or tube wells in the region. It is not surprising that **well-off farmers have begun consolidating their lands in the freshwater zones near the ridges and foothills.** Water from the bore wells from these patches is taken kilometers away through pipes for irrigation. During drought, many villages wait for their supply of water through tankers but the larger problem is that there is a gradual spreading out of the saline zone.

Finding solutions to the problem of salinity

With help from the S M Sehgal Foundation, a Gurgaon based NGO, people of Patkhori village adopted certain conservation practices to tide over the prevailing water shortage.

People in the area took up steps ranging from constructing check dams to developing rooftop rainwater harvesting systems in the school. Although these steps aren't enough to meet the overall water demand of the region, locals feel that the small gains through the S M Sehgal Foundation promoted initiatives help them tide over the crisis to a considerable extent. People say that all this has helped reverse salinisation of wells and some of them are indeed yielding sweet water now.

A 25,000 litre storage tank

Hari Bhagwan, S M Sehgal Foundation, explains how the 646 households in the village got together to construct a community water tank in the village to address the drinking water problem. While Meena ji, a local farmer donated his land for the community effort, S M Sehgal Foundation goaded the local Health Engineering Department to pay for the pipeline, which was a major chunk of the cost.

The problem of erratic water supply was tackled now that the community had a 25,000-litre tank for storing water. The tank has five outlets from where about 200 households of the village take turns to collect water. Fights for water have reduced now.

In Patkhori, the community revived abandoned wells and converted them into recharge wells. Eleven such recharge structures were developed in the village and according to Hari Bhagwan, these wells are able to collect a vast amount of water flowing down the catchment.

The structure is shaped like an inverted filter where the incoming water is passed through a four foot deep and four foot diameter chamber. The chamber has boulders, pebbles and sand for arresting the suspended solids in the water. The water from this is then diverted to an abandoned dug well, which is now being used as a recharge well. The water percolates into the ground from the sides as well as the bottom. Farmers indicate a rise in water levels up to five feet because of the structures.

2.4.3 Rooftop rainwater harvesting at Patkhori High School

The condition of this school, like most other rural schools in the district, was abysmal. "Water and toilets facilities were inadequate", says Arti Manchanda of S M Sehgal Foundation.

The school's 8000 litre capacity water tank only held water for about a month. After that, it had to be refilled by tankers that cost Rs. 100-120 per kilolitre. Due to this, there was no water for the toilets. The dropout rates of girls in particular are very high and the lack of sanitation facilities was a big contributor.

The school has now been provided with a rooftop rainwater harvesting system. The water passes through various stages of filtration and includes bio-sand filters to remove the bacteriological contamination apart from the suspended impurities. Tests have been done that confirm that the water from the system is suitable for drinking. Now, the school has water year-round. "There are separate toilet blocks for girls and boys now and water-borne diseases have decreased", says Hari Bhagwan of S M Sehgal Foundation.

As Mewat reels under the water crisis induced by salinity, the solutions implemented by the people of Patkhori be it catchment treatment, rooftop rainwater harvesting or building of a community water tank could very well hold the key to water security for the villages of the region.

Chapter 3

Water Conservation and Management in India: Contemporary Practices

3.0 Introduction

Both the traditional and the conventional methods of water conservation, development and management have their own contributions and importance in enhancing water storage, but considering the present scenario of water sector in India, one has to certainly deliberate, whether the traditional and conventional methods together can handle the current emerging challenges in the water sector effectively and efficiently. To evaluate the same, let us see in depth the unprecedented current challenges of water sector.

- *Spatial and Temporal variation in Water Availability*

The spatial unevenness and temporal variation in precipitation has led to complex situations like the distinctly different monsoon and non-monsoon seasons, the high and low rainfall areas and the drought-flood-drought syndrome. The unforeseen climate change phenomena magnify this issue.

- *Declining per capita Water Availability*

The declining per capita water availability is a matter of serious concern. Though from the point of view of the National level scenario, India may be above the Internationally accepted standards of water scarcity, yet the figures at the basin level vary widely from 13636 cum per year per capita in Brahmaputra-Barak basin to 298 cum per year per capita in Sabarmati basin. The situation is projected to get even more serious in 2050 when about 22% of the area and 17% of the population in the country may be under absolute scarcity condition. Definitely, this population pressure and density of population was not experienced earlier and which is still on the rise.

- *Rising multi-sectoral water demand for food production, energy generation, processing and manufacturing industries, commercial activities etc.*

The signal of the dwindling gap between water availability and water demand is evident from the projections made for the coming decades. The projections clearly indicate that in 2050, the water demand may be significantly higher in comparison to the **utilizable water resources** of the country. There has been growth in the multi-sectoral economy of the country combined with change in lifestyle and purchasing power of the people which promotes demand for water. Judiciously catering to this ever increasing multi-sectoral water requirement will be the most stringent challenge in the days ahead. The complicated water-food-energy nexus is also deepening viciously.

- *Low Irrigation Water Use Efficiency*

The irrigation efficiency in our country is of the order of only 25% to 35% in most irrigation system, with efficiency of 40% to 45% in a few exceptional cases and that too with low productivity. Some of the prime reasons for low irrigation efficiency are completion of dam/ head-works ahead of canals, dilapidated irrigation systems, unlined canal systems, lack of command area development, lack of canal communication network, lack of field drainage, improper field leveling etc. Also, inequitable distribution of water among the head and the tail reaches of the command area have led to problems in bridging the gap between irrigation potential created & utilized as well as water logging and salinity.

- *Water Governance Issues*

Apart from these there are also governance issues like addressing the growing conflicts amongst the users of various sectors as also different regions and upstream and downstream States, lack of co-ordination among the agencies involved in water sector; deficient institutional arrangements, poor management practices, local and narrow approach of project specific planning and administrative issues like problems of land acquisition, Rehabilitation & Resettlement and Environment & Forests clearance of projects. There is no control on overdraft of ground water or water quality degradation.

- *Deteriorating Water Quality and Degradation of Environment*

Water pollution is a major environmental concern in India. The main sources of water pollution are discharge of domestic sewage and industrial effluents, which contain organic pollutants, chemicals & heavy metals and run-off from land based activities such as agriculture and mining. Non-availability of minimum flow in the rivers has also reduced natural purification capacity of rivers thus increasing pollution. Rampant deforestation and changing land use, land cover is hampering the hydrological cycle with resultant soil erosion from upper catchment. Water quality is also threatened during floods when combined sewerage of cities, towns etc. gets mixed with flood water thereby leading to unhygienic conditions, water borne diseases, epidemics etc. Water quality degradation affects in its turn utilizable water quantity.

- *Over-exploitation of Ground Water Resources*
  Rapid pace of ground water utilization has resulted in a number of problems. In many arid and hard rock areas, overdraft and associated water quality problems are increasing. The unscientific development of groundwater in some coastal areas in the country has led to landward movement of seawater fresh water interface resulting in contamination of fresh water aquifers and consequent reduction in water availability. This in turn accentuates the drought proneness of a region. In addition to problems caused due to human interference, natural factors like occurrence of high content of fluoride, arsenic and iron also affecting the ground water quality in several parts of the country.

The **Traditional Methods** of Water Conservation and Management was basically designed for implementing schemes at a very small scale and micro level. The methods were designed keeping in view the availability of local resources, limited population and water demands/usages to cater, and as per local geographic conditions. Famine, floods and droughts were still occurring leading to major loss, and demand on food production kept on increasing.

During post-independence era, the responsibility of development was in our hands. The **Conventional Methods** of Water Resources Planning & Development was adopted for the overall development of the economy. Big storage structures were designed and constructed keeping in view the then climatic conditions and requirement. No doubt the conventional method helped India in becoming self-reliant on food grain production; combating the extreme hydrological events; overall boom to economy, but the gap between the demand & supply could not be bridged. The challenges described above also cropped up simultaneously. The reasons which can be attributed towards this is that

- Unlike the traditional method, the conventional system was centralized and project centric approach and there was lack of stakeholders participation and thereby onus of responsibility of the end user was missing;
- Stressed Centre-State Relationships: In spite of Central Assistance, State governments were not in a position to handle & execute the projects effectively. This has created a gap in IPC and & IPU.
- As on date more than 50% new storages are yet to be created to harness the utilizable potential and potential sites are located in remote and difficult places.
- Also there were enormous water losses while supplying water to the end users.
- Lack of Capacity Building of all stakeholders added to the non-performance and further woes. On the whole it was not an integrated, holistic and sustainable approach.

There is an urgent need of paradigm shift to address the above emerging challenges. The journey up to the present scenario is appreciated but at the same time it is pointed out that breakeven point has now come and there is a need for strategic change in the form of result oriented demand driven approach to bridge the gap. Also the water managers have to orient themselves to consider the **demand side management**. Considering the existing status of water resources and increasing demands of water for meeting the requirements of the rapidly growing population of the country as well as the problems that are likely to arise in future, a holistic, well planned, long term comprehensive strategy is needed for water conservation and management in India. The water resources management practices should be based on **integrated approach of augmenting the water supply as well as managing the water demand and its utilization/application under the stressed water availability conditions.**

Data collection, monitoring, processing, storage, retrieval and dissemination constitute very important aspect of water resources management. These data may be utilized not only for management but also for the planning and design of the water resources structures. In addition to these, decision support systems need to be developed for providing the necessary inputs to the decision makers for water resources management. Also, knowledge sharing, people's participation, mass communication and capacity building are essential for effective water resources management. Thus, there is an urgent need to make a critical appraisal of the traditional & conventional method and devise a viable medium and strategy together with the traditional & conventional methods and updated available technologies which can be blended for better, precise, judicious and scientific water conservation and management in the near future.

3.1 MODERN METHOD OF WATER CONSERVATION AND MANAGEMENT

Some important modern methods and innovations with management techniques/practices for mitigating the present day challenges in water conservation are described below:

3.1.1 Water Conservation and Management in Agriculture Sector (Sector Specific)

Water conservation implies improving the availability of water through augmentation by means of storage of water in surface reservoirs, tanks, soil, and groundwater zone. It emphasizes the need to modify the space and time availability of water to meet the demands.

There is a great potential for better conservation and management of water resources in its various uses. On the demand side, a variety of economic, administrative and community-based measures can help conserve water. Also it is necessary to control the growth of population since large population is putting massive stress on all natural resources Since agriculture accounts for about 70% of all waters withdrawn, the greatest potential for conservation lies in increasing irrigation efficiencies. Just 10% improvement in irrigation efficiency could conserve enough water to double the amount available for drinking.

The agriculture sector has to tackle multiple water related issues: Low efficiency in water use; declining water availability; increasing food demand due to population increase; changing food habits and the commitment of the Right to Food; & competitive demands over water. It is also predicted that water demand for irrigation will rise over time. Around 80 per cent of freshwater is used by the agriculture sector, having the highest share of freshwater usage. Water Use Efficiency is poor with 38 – 40 per cent for canal irrigation and 60 per cent for groundwater irrigation schemes. There are several ways by which the water use efficiency in agriculture can be increased along with undertaking measures for increasing water productivity by increasing more crops per drop. Some of the options include:

Canal Lining

Canal lining is a must for increasing the Water Conveyance Efficiency. New technologies like use of geo-membranes and concrete canvas can be used to line existing canals quickly and efficiently.

Mechanized lining of canals using moving gantry form-work and precast lining slabs can speed up the process of lining. This not only reduces the loss of water, but also enables tail-end farmers to get sufficient water for their crops.

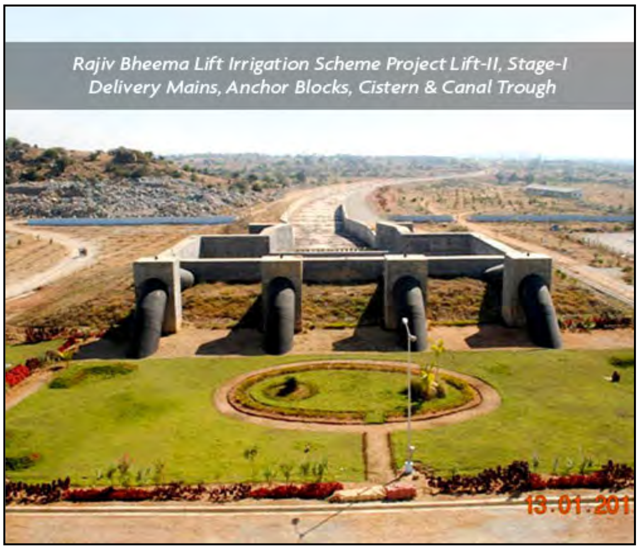
Piped/ Pressurized Irrigation

Pipelines are enclosed conduits that convey water from a source to an outlet. Water

flows in the pipeline because of gravity pressure (elevation changes), pumping pressure, or a combination thereof. Two biggest causes of water loss in an irrigation infrastructure are **evaporation and seepage**. Both these can be overcome by use of piped irrigation infrastructure. Although costly initially, but in long term it proves economical because of low friction losses, less evaporation loss and less seepage loss. The pipes can be installed underground to further prevent damage and theft.

For use of sprinkler and drip irrigation, supply through pressure pipe is required. As far as possible it is recommended to convey irrigation water through closed pipe under gravity pressure from the source to individual farm holding. The water received at the farm head can be stored and then applying pump pressure it can be used on farm by sprinkler or drip irrigation.

Lift Irrigation Technique



Lift irrigation is a method of irrigation in which water instead of being transported by natural flow (as in gravity-fed canal systems) requires external energy through fuel based or electric power using pumps or other mechanical means.

Lift irrigation schemes must accomplish two main tasks: First, to carry water by means of pumps from the water source to the main delivery chamber/cistern, which is situated at the top most point in the command area. Second, they must distribute this water to the field of the beneficiary farmers by means of a suitable and proper distribution system. The source of water is mainly groundwater, river streams (during floods primarily), contour canals, ponds, lakes, and reservoirs.

For a viable lift irrigation scheme, the requirements are constant water source for the whole irrigation season at the site and the feasibility to lift water to the desired location. Different capacity pumps are required depending upon the duty point head, and discharge. The rising main may be of steel, concrete or any other suitable material. Lift irrigation schemes are useful where the target land is at higher level.

The advantage of lift irrigation is the minimal land acquisition problem and low water losses. The lift irrigation scheme are instrumental in stabilizing agriculture production particularly in the years of droughts and increase food production as water is available whenever it is required and thereby increase in income level.

Lift irrigation schemes are either individually owned or owned by a group of farmers in a cooperative mode. For successful functioning the lift irrigation schemes require appropriate technique, planning, designing and execution through knowledgeable technical person. Participation of beneficiaries is quite necessary. Unplanned development of lift irrigation systems have the potential to have its adverse impact on the groundwater levels, as has been the case in many south Asian countries in the recent years. Continuous drop in groundwater table is making the cost of running and maintenance of lift irrigation schemes more costly. Cooperative lift irrigation schemes have the potential to be participatory in development and management.

Land Management Practices & Laser Land Leveling

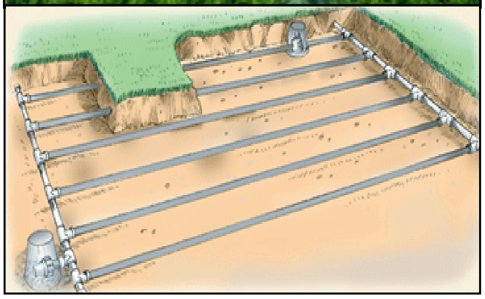
These include integrated practices such as soil-water conservation, adequate land preparation for crop establishment, rainwater harvesting, efficient recycling of agricultural wastewater, conservation tillage to increase water infiltration, reduce run off and improve soil moisture storage and adequate soil fertility to improve nutrient content.

Laser land leveling technique can be used to remove unevenness of the soil surface having significant impact on the germination, stand and yield of crops. It can save around 20-30 per cent of water and enhance outputs by minimum 10 per cent.

Micro Irrigation

Surface irrigation methods, which are traditionally used in our country, are unsuitable for water scarce areas, as large amount of water is lost through evaporation and percolation.

Micro irrigation has helped in increasing water application efficiency in a great way. Sprinkler is a very popular technology in use to increase the efficiency of water application. Although less efficient than drip system, it is far more efficient than flood irrigation system. In addition to irrigation, this system can also be used to apply fertilizer and pesticides to the plants.



Drip irrigation is another very popular micro irrigation technique. By the use of drip irrigation, water can be supplied directly to the root zone of plants and quantity of water being supplied at each drip location can be controlled precisely. The system can also be used to supply fertilizers directly to the root zone. In addition to water saving it also increases the yield of crops. This method is particularly useful in row crop.

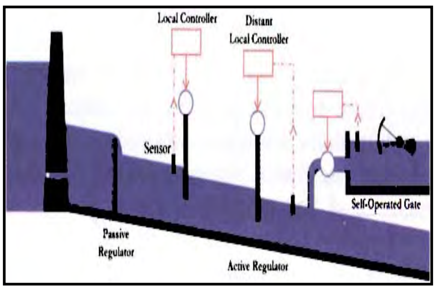
Sub surface irrigation systems can be used to further minimize the use of water and increase the crop yield. This system reduces the evaporation loss as the water is applied directly to the roots in controlled quantities. Although it is costlier than sprinkler and drip irrigation systems, but it offers great savings of water.

Large Scale Advanced Micro Irrigation Project is implemented for improving water use efficiency in major canal command areas through Integrated Conduit Distribution (piped irrigation) and use of Micro Irrigation Systems e.g. Ramthal Integrated Micro Irrigation Project is a major breakthrough in adoption of Micro Irrigation with modern irrigation networks in the command areas. On successful completion, this project will assume the status of the largest and first of its kind in terms of the extent of command area under modern drip irrigation in an integrated, automated system with little human intervention.

<u>Installations of Solar Panels over Canals</u>

New innovations and new ideas many a times prove to be more successful than conventional approach. A very good example of a very simple idea implemented to prevent water loss is installation of solar panels on canals. This reduces the evaporation loss and also provides free power to neighboring villages. Another example is installation of floating solar panels on reservoirs and lakes to reduce evaporation loss and to avoid land acquisition for solar panel installation.

<u>Canal Automation(SCADA)</u>



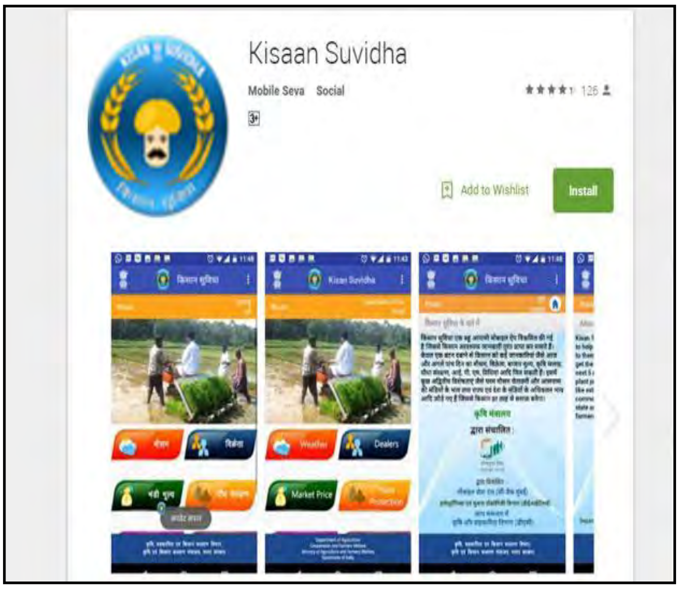
Canal automation can be used in Indian irrigation infrastructure to precisely control the quantum of water being supplied to fields. This will ensure the availability of water to every field in command area. It will also prevent over-irrigation of fields in the upstream reaches of canals. Canal automation can be used very effectively to plan the systematic supply of water. SCADA based canal automation system can be used to schedule the supply of water to specific area/outlet.

Computerized/ Automated Green Houses

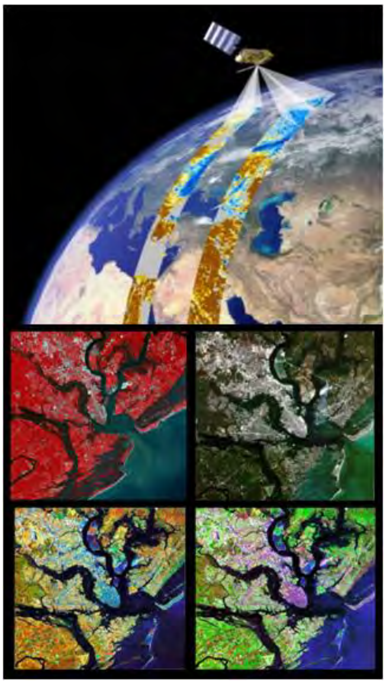
Fully automated green house can minimize the use of water and increase the crop yield in a significant manner. Parameters like humidity, temperature, soil moisture content, etc. in green house are constantly monitored in a centralized control system and suitable adjustments are made from time to time using fully automated system. Water is also given directly to the root zone of plant using drip irrigation system and volume of water is controlled from central control unit. Humidity and temperature is controlled using overhead sprinklers.

Use of Information Technology for Benefit to the End User

The revolution in information technology is proving to be of great benefit to the end users. Farmers can be given information about almost everything in an instant. Farmers can be given weather forecast, flood forecast, etc. on their mobile phones via sms or internet. They can be given advice on how to optimize the use of water for increasing the yield, and this information can be customized depending on the soil type, topography and weather conditions of that particular area. Farmers can be given information on the use of best seeds, fertilizers, pesticides and cropping pattern so as to maximize the yield and minimize the water use. They can also be given knowledge about the latest technologies in irrigation.



Use of Remote Sensing and Geographical Information System



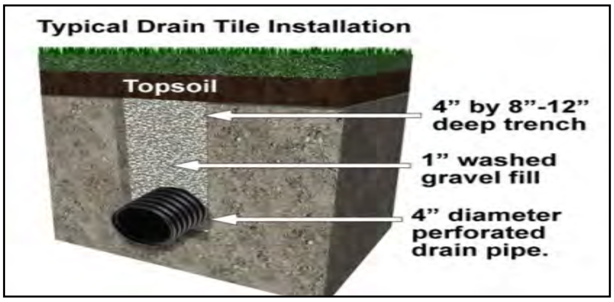
RS-GIS is used in a wide variety of ways for water resources management. One of the practical uses is the satellite based monitoring of physical progress of ongoing irrigation projects. Image processing of images obtained from remote sensing can also be used to assess quality of crops to determine that in which areas crops need water, and the same can also be used to determine whether the farmers are following the designed cropping calendar or not.

Remote sensing can be used to forecast river meandering and thus saving crops which are susceptible to damage due to changing course of rivers. It can also be used to assess the quality of soils and identify the areas affected by soil salinity and the same can be used for wetland classification.

GIS can be used for flood map generation and hence reduce the effect of water induced disasters. Various simulation techniques on modern computers can be used to estimate and forecast effects of weather and climate change on water availability in different parts of the country.

Remote Sensing and GIS can be used together to obtain integrated management of river basin and ultimately lead to integrated water resources management.

Drainage management and Water Reuse in Agriculture



In present scenario, due to lack of proper drainage management, the soil gets saturated and saline if over-irrigated. Also, the runoff after irrigation, which contains valuable nutrients, goes to rivers and water bodies causing eutrophication as well as wastage of water and fertilizers.

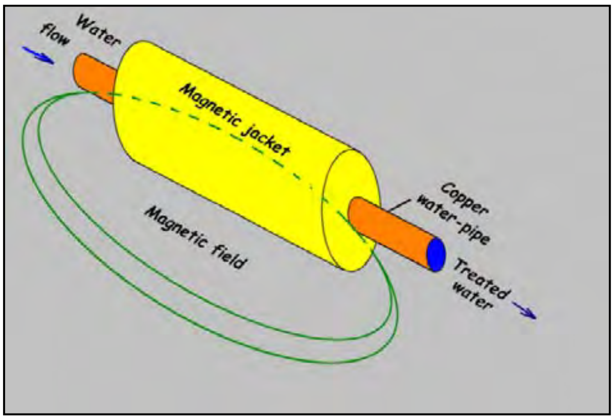
In Japan, the excess water after irrigation is trapped in underground perforated pipes, is given a primary treatment and then is redirected to other fields for irrigation. This helps in saving water and the nutrients, which otherwise go to water bodies, are used for benefit of new crops. These

technologies can help Indian farmers for effective use of water in a better way.

Genetically Modified Crops

Genetically modified crops are being developed by scientists across the world. These crops are "genetically engineered" to grow even when very less water is available. The crops can also be engineered to grow in less fertile soils and to give large yields.

Irrigation with Magnetic Water



Utilization of magnetic water technology is considered as a promising technique to improve water use efficiency and crop productivity. Water is magnetized by passing water through permanent magnet installed on a feed pipeline for irrigation.

There is no energy requirement for magnetization and it can be used for long run without any maintenance requirements. Some preliminary experiments have been conducted in India and it was observed that surface tension and viscosity of magnetized water decreases. Due to this, the fluidity & wet ability of the water increases and it could easily pass through the cell membranes of the plant. Consequently, it enables improved crop growth in less irrigation. Magnetized water also improves germination of seeds and increases soil moisture in the root zone as compared to non-magnetized water.

Water Budgeting

Water budgeting is a comprehensive process involving assessment of available water resource, losses due to various reasons, present consumption pattern & demand from all water use sectors. A water budget reflects the relationship between input and output of water through a region. The region/unit can be a village, a watershed, a project, sub basin or a basin.

Aligning crops as per water availability

Crops and cropping patterns should be aligned to water availability and increasing seasonal evapo- transpiration. Irrigation methods, irrigation scheduling, tillage, mulching and fertilization can increase the transpiration component of evapo-transpiration which results in higher utilization of water by crops enhancing their productivity.

Land use Planning and Cropping Pattern

Another strategy that could be adopted refers to planning of land use especially in new land development. Areas where water supply priorities are low can be planted with drought-resistant varieties of trees. **Considerable information exists on time distribution of water requirements for various crops and various planting dates.** This knowledge is required to be integrated systematically with water supply probabilities to develop planting strategies.

The selection of cropping pattern as per availability of water will reduce adverse impacts of drought on potential water consuming crops. The plants suitable for water scarce areas can be:

- with shorter growth period,
- high-yielding plants requiring no increase in water supply,
- plants that can tolerate saline irrigation water,
- plants with low transpiration rates, and
- plants with deep and well-branched root.

Participatory Irrigation Management

India is today the number one country in the World as far as the creation of irrigation potential is concerned. However, as far as the equitable, judicious and efficient utilization of created irrigation potential is concerned there is tremendous scope for improvement because the difference between created potential and its actual utilization is day-by-day increasing. Several studies suggest that one of the reasons for this underutilization is the lack of involvement and active participation of the farmers /stakeholders in water management. This establishes the need for Participatory Irrigation Management (PIM) through Water Users Associations (WUAs). People's need, people's involvement, people's co-operation and people's contribution (cash or kind) are four key parameters for the success of PIM.

Benefits of PIM through WUAs

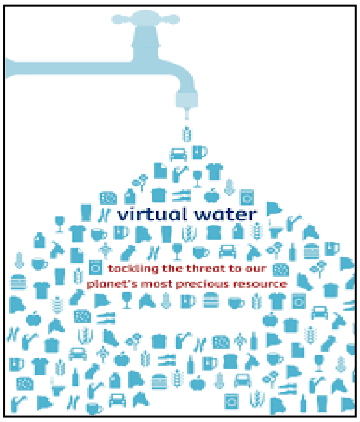
Quality of water supply to farmers is increased i.e. assured, timely and adequate water supply which is a prime requirement for improving the Water Use Efficiency; Collective activities like maintenance of field channels (water courses), adoption of improved water management techniques, etc. are organized by some WUAs; Increase in agricultural production; Increase in income of farmers; Increase in water use efficiency, especially field application efficiency is improved; Increase in conjunctive use of canal and well water; Number of wells in the command area of irrigation projects has increased; Increase in the practice of night irrigation by the farmers in cropping pattern i.e. increase / inclusion of cash crops; Tail enders problems getting resolved slowly; Water use entitlements to WUAs.

Performance Evaluation and Benchmarking of Irrigation Projects

Fierce competition, globalization and development of new information and communication technologies have forced us to continuously search for and adopt new processes, structures and tools in order to survive and compete in their respective spheres. The explosion of management tools and techniques in the 1990s to help systems successfully change is evidence of this situation. One among these techniques is benchmarking, which has proved to be valuable in helping individual systems evaluate their competitive position.

Benchmarking is relevant for India and we should do it, as per capita water availability in coming years will dwindle and hence efficient use of water would be must. Benchmarking would help in appropriate interventions and help in formulation and implementation of policies for improvement of projects. This would result in bringing transparency in Irrigation sector along with many benefits viz. equitable distribution, improvement in irrigation efficiency, help bringing additional area under irrigation leading to diversification of crops, enable putting cap on O&M expenditure, increased productivity per unit of water etc.

Virtual Water Transfer



By definition virtual water is the water embedded in a product, i.e. the water consumed during its process of production. Virtual water refers to all sorts of production where water is used, e.g. it is not restricted to food grain only. The production includes other inputs or investments like energy, labour, soil, market, etc. The concept emerged in the 1990s and receives more and more attention from people concerned with water management and in particular with water related to food production. The water requirements of food are by far the highest. It takes 2 to 4 litres per day to satisfy the drinking water needs of a human being and about 1000 times as much to produce the food. In this way, the concept of virtual water is important for food production and consumption. The importance of virtual water at global level is likely to increase as projections show that food trade will increase rapidly, i.e. doubling for cereals and tripling for meat between 1993 and 2020. Therefore, the transfer of virtual water embedded in the food that is traded is becoming an important component of water management on global and regional level, particularly where water is scarce. India is a vast country with large spatial and temporal variations in availability of water resources. Hence, **it is important that virtual water is properly assessed in terms of its value in space**

and time. It also needs to be analyzed how virtual water is considered at policy level on food trade, water management and agriculture.

Water Audit

Water audit improves the knowledge and documentation of the distribution system, problem and risk areas and a better understanding of what is happening to the water after it leaves the source point. It is thus an effective management tool for minimizing losses, optimizing various uses and thus enabling considerable conservation of water. It helps in correct diagnosis of the problems faced in order to suggest optimum solutions. It is also an effective tool for realistic understanding and assessment of the present performance level and efficiency of the service and the adaptability of the system for future expansion & rectification of faults during modernization.

Peoples Participation and Capacity Building

For making the people of various sections of the society aware about the different issues of water resources management, a participatory approach may be adopted. Mass communication programmes may be launched using the modern communication means for educating the people about water conservation and efficient utilization of water. Capacity building should be perceived as the process whereby a community equips itself to become an active and well-informed partner in decision making. The process of capacity building must be aimed at both increasing access to water resources and changing the power relationships between the stakeholders. Capacity building is not only limited to officials and technicians but must also include the general awareness of the local population regarding their responsibilities in sustainable management of the water resources. Policy decisions in any water resources project should be directed to improve knowledge, attitude and practices about the linkages between health and hygiene, provide higher water supply service levels and to improve environment through safe disposal of human waste. Sustainable management of water requires decentralized decisions by giving authority, responsibility and financial support to communities to manage their natural resources and thereby protect the environment.

Water Pricing

Another strategy, which needs consideration, is changes in water pricing structures. Mostly water rates are based only on a portion of what it costs to obtain, develop, transport, treat and deliver water to the consumer. The NWP-2012 highlights the principles of Water Pricing as under:

- ✓ Equitable access to water for all and its fair pricing, for drinking and other uses such as sanitation, agricultural and industrial, should be arrived at through independent statutory Water Regulatory Authority (WRA), set up by each State, after wide ranging consultation with all stakeholders.
- ✓ In order to meet equity, efficiency and economic principles, the water charges should preferably / as a rule be determined on volumetric basis.
- ✓ Recycle and reuse of water, after treatment to specified standards, should also be incentivized through a properly planned tariff system.
- ✓ The principle of differential pricing may be retained for the pre-emptive uses of water for drinking and sanitation; and high priority allocation for ensuring food security and supporting livelihood for the poor. Available water, after meeting the above needs, should increasingly be subjected to allocation and pricing on economic principles so that water is not wasted in unnecessary uses and could be utilized more gainfully.
- ✓ Water User Associations (WUAs) should be given statutory powers to collect and retain a portion of water charges, manage the water allocated to them and maintain the distribution system. The WUAs should be given the freedom to fix rates subject to floor rates determined by WRA.
- ✓ The over withdrawal of groundwater should be minimized by regulating the use of electricity for its extraction. Separate electric feeders for pumping ground water for agricultural use should be considered.
- ✓ In urban areas, technologies like pre-paid water meters can make significant contributions in preventing wastage of water.

Legal restriction on use of water

One of the active strategies could include provisions of legal restrictions on use of water, mainly during the period of scarcity.

In India, a National Water Policy has been adopted, which includes policy directions for development and management of water resources.

Also, provision of legal restrictions on proper utilization of groundwater resources has been advocated at various forums in the country. In fact, Gujarat has already enacted such legislation and other states may also follow the suit.

However, provision of legal restrictions should be carefully thought of and need mobilization of qualified water specialists to explore effective solutions. The legal strategies so adopted should be such which can be implemented with minimum probability of being rendered ineffective by injunctions. Also, laws are required to check littering as well as to implement 'polluter pays' principle. More importantly, these laws should be strictly enforced to ensure quality of water.

3.1.2 Water Conservation and Management in Industrial Sector (Sector Specific)

Industries contribute substantially to the Indian GDP and their demand for water will increase with the expansion of the industrial sector. Out of all the industries, it is the **thermal power plants** that account for 88 per cent of water used by industries. Water use by industries has led to misuse and pollution creating a situation of **water scarcity and poor water quality**. To begin with, there has to be a change in the way industries perceive water as a resource– from the traditional view of water as a cheap resource available in plenty to one that has competitive users and affects basic human right.

Water dependent industries are competing for water with local farmers, households and other users. On the positive note, the risk of water being a scare resource often motivates companies to reduce their water usage and pollution and implement innovative water technology in the production process. Companies are eager to reduce their water footprint2, get certified for their water responsive behavior and products and work with water shed approach. Further with the changes in the Companies Act 2013, it encourages companies to invest in policies and activities related to natural resource conservation. Some of the strategies are as given below:

Role of industry

The current challenge requires participation from all people and sectors of society. Given the competencies of the industry, there are specific roles that the industry can play, some of which are given below:

- Reducing own water footprint through
  - a) Reducing water requirement in production processes and technologies
  - b) Wastewater utilisation
  - c) Using more efficient cooling systems
  - d) Reducing leakages
- Meeting their own water requirements through rainwater conservation
- Working with communities for water conservation for collective action.
- Going beyond individual efforts by partnering with NGOs
- Including water in a priority area in CSR
- Investment in augmenting water sources
- Supporting innovation

<u>**Increasing Water Efficiency**</u>

Increasing water efficiency is pivotal in reducing water demand in the industrial sector. If a systematic approach is followed the rate of water consumption can be reduced by 25-50 per cent in industrial units. Some industries exhibit the possibility of saving water by 30-50 per cent. Some of the methods that can reduce water footprint include change in technology from water cooling to air cooling, replacing of water intensive equipment and fixtures, waste water recycling and reuse into industrial process, rainwater harvesting and use. Step wise approach to increase water use efficiency in the industrial sector area as under:

Step 1	✓ Identification of water intensive industry ✓ Evolving mechanism to report their consumption ✓ Setting targets for yearly reduction
Step 2	✓ Evaluation of sustainable industrial water management practices for wider replication
Step 3	✓ Demonstration of sustainable water management practice
Step 4	✓ Compilation of best practices for wider replication
Step 5	✓ Hand holding willing industries to achieve sustainable water management through implementation of identified measures
Step 6	✓ Award companies that reduce their water footprint
Step 7	✓ Learn and adopt best practices

Recycling and Reuse of Water

Another way through which we can improve freshwater availability is by recycle and reuse of water. It is said that in the city of Frankfurt, Germany, every drop of water is recycled eight times. **Use of water of lesser quality, such as reclaimed wastewater, for cooling and firefighting is an attractive option for large and complex industries to reduce their water costs, increase production and decrease the consumption of energy. This conserves better quality waters for potable uses.** Currently, recycling of water is not practiced on a large scale in India and there is considerable scope and incentive to use this alternative. Estimates show that recyclable water is between 103 and 177 BCM/year for low and high population projections. Advanced technologies are being developed in sewage treatment which can treat waste water with greater efficiency.

Desalination Plant

Earth has abundant water available. But about 97 percent of all water available on earth is considered unusable to human beings just because that it is sea water and saline. Desalination of sea water is a promising technology which can provide almost unlimited supply of fresh water. Techniques for desalination are already present but they are very costly. With the emerging new technologies, the cost of desalination is coming down exponentially and the day is not far when the cost will become low enough to make desalination economically viable. Additionally the cost of power generation is expected to go down due to ground breaking innovations in solar power generation. The cost of solar power generation is also going down in a significant manner. Additionally use of sea surface for installation of floating solar panels for generation of power for desalination is an innovative technique. Thus we can say that with new technologies and low cost solar power, in near future, we might have access to unlimited supply of low cost fresh water through the use desalination.

3.1.3 New Technologies for Water Conservation in Urban Areas

There are many new technological innovations that are helping the cities to save water. For example installing water-less urinal can save thousands of litres of water per week in a busy shopping mall. Technologies like water-less urinals, tap aerators, automatic taps, low-flow shower heads, dual flush tanks, etc. are now making their way into the cities and saving substantial amount of water. Rain water harvesting has already become popular in urban areas and is helping many societies to reduce their dependencies on external water sources. Similarly ground water recharge using permeable pavements and footpath is facilitating the passage of rain water to increase ground water table.

3.1.4 Corporate Social Responsibility towards Sustainable Development in Water Sector

Contributing to the efforts on Water Projects, various industrial houses have shared their initiatives on water, implemented with the involvement of the communities. The following CSR Success stories have been listed:

National Thermal Power Corporation (NTPC)

The contribution of NTPC in providing safe drinking water as a part of their CSR initiative is remarkable. The key initiatives taken by NTPC in providing drinking water are briefly enumerated below:

- Installation of about 500 hands pumps & bore wells in Jharkhand (Garhwa and Dhanbad districts); Uttar Pradesh (Raebareli, Siddharth Nagar, Jaunpur and Santravidas Nagar districts) and Bihar (Arrah and Darbhanga districts).
- Piped Drinking Water System to neighbourhood of Talcher Kaniha and Thermal, Odisha.
- Piped water scheme and RO plants provided at 11 locations.
- A total of about 150 bore-wells were sunk and hand pumps installed at various locations during last two years.
- During extreme summers supply of water through water tankers relieved close to 32000 individuals.

Hindustan Unilever Limited (HUL): Hindustan Unilever Foundation

The HUL is doing a remarkable work in water sector through its CSR activities. The HUL manufacturing plant in Khamgaon, Maharashtra started a pilot watershed management project on a five-hectare plot, to prevent soil degradation and conserve water. The construction of dams and trenches resulted in the transformation of this dry and arid land into a verdant forest of about 6,300 trees. The total land under cultivation during the second crop season increased to 470 acres. The annual income of farmers in the vicinity of the projects increased from an average of INR 36,000 to approximately INR 85,000, per farmer. This project received widespread appreciation at the 2002 World Summit on Sustainable Development in Johannesburg.

HUL and the NGO Vanarai collaborated in Silvassa and other locations in Dadra and Nagar Haveli. The project has secured sustainable development of water and land resources, helped the local population attain self-sufficiency in basic needs of food, water, fodder and fuel, and generated local employment opportunities through increased economic activity. More than 67 million litres of water have been harvested since 2004, with soil conservation treatment carried out on 282 hectares of land. The villagers accrued an additional income of INR 160 lakh during the project period (2004–2010). HUL's Puducherry unit partnered with DHAN Foundation in 2008-09 to renovate eight village ponds. The project focused on building social capital by empowering especially formed villagers' pond association to execute the work. The renovated rainwater harvesting system has fulfilled the multiple domestic needs of 4,519households and 346 acres of land have been irrigated due to the rejuvenation of ground water.

Other Examples:

- The Ambuja Cement Foundation initiatives towards saline mitigation and water management has resulted into harvesting of 1067mcft of water and benefited an area of 23,254 hectare. It has immensely contributed in improvement of agriculture productivity in the project area.
- The construction of water harvesting structure by A L Paper House in current water scarcity area caters to the drinking and irrigation needs of the community. The construction of five water harvesting structures, watershed development of 17 villages along with formation of water user groups has resulted more water availability & better water management.
- Adoption of cutting edge technology (RO) has also led to provisioning of drinking water in fluoride contaminated area with the assistance of BOSCH Ltd.
- Coca-Cola has demonstrated the efficacy of drip irrigation in water scarce area near Jaipur resulting in water saving to the tune of 1MCM.
- Reliance Infrastructure Ltd undertook various measures for harnessing the rain water for catering the drinking water and agricultural needs in Dahanu (Maharashtra).

- HINDALCO Industries Ltd has implemented integrated development of land & water in poverty stricken villages thereby leading to improvement in social and economic status of the local population.
- A symbiotic arrangement is demonstrated in the implementation of integrated watershed management on a Public Private Community Partnership approach, by ITC Ltd.
- LUPIN successfully demonstrated the importance of rain water harvesting as a measure not only for salinity management but also catering to drinking water needs of the human population.
- The initiative of LUPIN to restore traditional water bodies through de-silting of ponds has ensured all round availability of water in the villages of Bharatpur.
- SABMiller India has innovatively employed Natural Ground Water Recharge Technologies at Neemrana, Rajasthan.
- Tata Chemicals Ltd initiative on integrated watershed management highlights the relationship between comprehensive water management and its effect on productivity of the land.

The variety of cases demonstrates the involvement of community and importance of CSR activities for ensuring the sustainable management of water resources. It also provides road map for the corporate sector, governmental organization and the community to work hand-in-hand for sustainable development.

3.1.5 Water Quality and Environment Management (Environment Sector)

- Implementation of water pollution prevention strategies and restoration of ecological systems are integral components of all development plans. To preserve our water and environment, we need to make systematic changes in the way we grow our food, manufacture the goods, and dispose off the waste.
- In India, agriculture is the biggest user and polluter of water. If pollution by agriculture is reduced, it would improve water quality and would also eliminate cost incurred for treatment of consequent diseases. Like all other inputs, there is an optimal quantity of fertilizer for given conditions and excess application does not improve the crop yield.
- **Pricing of fertilizers and pesticides as well as appropriate legislation to regulate their use will also go a long way in stopping indiscriminate use.**
- Industries need to carefully treat their waste discharges. Manufacturers may reduce water pollution **by reusing materials and chemicals and switching over to less toxic alternatives.** Also, there is a need to encourage reductions or replacement of toxic chemicals, possibly through fiscal measures. Pollution taxes in the Netherlands, for example, have helped the country slash discharges of heavy metals such as mercury and arsenic into waterways by up to 99% between 1976 and the mid-1990s. Such measures in India would also be helpful. Environmental improvement and restoration should be planned and

implemented such that the freshwater resources are protected and their quality is maintained and/or enhanced.

- An understanding of watershed linkages allows long-term and sustainable solutions to a variety of natural resource problems. Model efforts in this direction include **the capture, storage and safe release of water and the prevention of accelerated soil erosion through the structures and vegetation**.
- While utilizing water and land resources, their ability to serve other uses is often degraded either inadvertently or due to carelessness. Efforts should be made to **restore landscapes and ecosystems to more efficiently protect water quality, aquatic and wildlife.**

Increasing Forest Cover

According to hydrological movements, water is received through rainfall every year in different quantities on the surface of the earth. This water flows on the surface and reaches the sea and oceans. Some part of rainwater is stored in stable water reservoirs (lakes and tanks), whereas some quantity of water infiltrates into the land and takes the form of groundwater.

Due to increasing deforestation during the last century, most of the rainwater flowed away to the saline seas without infiltrating into the ground. Water crisis also developed during the last decade in Cherapunji, which gets highest rainfall in the world, because forest cover has been destroyed there due to mining of limestone. As a result of it, rain water flows away very fast to the rivers. A similar thing is happening in the Dehra Dun area of Uttarakhand.

The old tradition of tree plantation on the banks of rivers and tanks will have to be revived. Forest cover will have to be developed on uncultivable waste lands and hilly slopes on a large scale. Since trees bear drought conditions for a long duration as compared to crops, hence trees are helpful in reducing the demand for water along with recharging water sources.

Environment Flow Requirement

An environmental flow (EF) is the water regime provided within a river, wetland or coastal zone to maintain ecosystem and their benefits where there are competing water uses and where flows are regulated. Environmental flows provide critical contributions to river health, economic development and poverty alleviation. They ensure the continued availability of many benefits that healthy river and groundwater systems bring to society. EF normally includes the flow requirements in rivers and estuaries for maintenance of riverine ecology. Most Indian rivers have monsoon-driven hydrological regimes where 70–80% of the annual flow occurs in 3 to 4 months. Such rivers fall into the category of highly variable flow regimes. The total environmental flow requirement (EFR) for most of Indian rivers ranges between 20 and 27% of the renewable water resources. But these EFRs estimates may be considered as preliminary. These need verification through detailed, basin-specific assessments of the EFR. At the same time, it is important to appreciate that EFR allocations of less than about 20% of the mean annual flow are likely to degrade any river beyond the limits of possible rehabilitation. An additional factor, not yet considered in the assessment, is that a reduction in river flows decreases the ability of a river to cope with pollution loads. These loads are known to be massive in many Indian basins. Un-utilizable portion of surface runoff in most Indian basins is adequate to meet the EFR. Only in a few basins, namely Pennar, west-flowing rivers in Kutch, Saurastra and Luni, Cauvery and east-flowing rivers between Pennar and Kanyakumari, the EFR exceeds the un-utilizable runoff. In these basins, a part of the potentially utilizable water resources has to be earmarked for EFR. Sometimes, during the period of water scarcity it may be difficult to meet the EFR considering the importance of the demands from the other water sectors such as drinking water supply, irrigation, hydropower, etc. In such a situation, an optimum allocation policy may be evolved considering the potential demands and available supply. **Efforts must be made to restrict the pollution loads to the rivers and other water bodies from the point and non-point sources of pollution in order to minimize the EFR and thus help in water conservation indirectly.**

Eco-hydrological approach to water resources management

The eco-hydrological approach to water resources management considers the water flow domain and water use domain for categorizing the water as green and blue. **The green water** concept refers to the water used in growth of economic biomass, i.e. rain-fed food, timber, fuel-wood, pastures, etc. as well as the ecosystems biomass growth, i.e. plants and trees in wetlands, grasslands, forests, etc. **The blue water** concept refers to economic use of water in society, i.e. irrigation, industry and domestic uses as well water flow required for ecosystem functions such as aquatic freshwater habitats etc. Green and blue water approaches indicate that there is plenty of water around and the conventional blue water crisis is misleading. However, almost all water is involved in securing ecosystem service which supports human livelihoods and provides us resilience to cope with shocks. The water crisis is therefore different in character not primarily about direct human use**, but just balancing water between humans and nature.**

Adaptation Strategies combating vulnerability to Climate Change

Climate change is posing a challenge before the water resources engineers. Water resources assessment and planning assumes that the past records of variability are reflections of what will happen in the future.

A review of current coping strategies of populations already affected by climate variability is needed. The likely impacts of increased climate variability and climate change on the water resources are required to be assessed. The coping strategies need to be evolved considering major factors, viz. social, economic, institutional etc. to reduce vulnerability and enhance adaptation to climate-related developments and events. Some part of the country facing the frequent drought are adopting the dry land farming practices to grow the crops which require less amount of water. However, there is a need to take up such studies for assessment of available water resource for different agro-climatic regions of India and various adaptation practices under the changing climatic scenarios. Hydrological studies are required to be taken up for assessment of water resources under changing climatic scenarios. For predicting the future climatological variables on micro, meso and macro watershed scales, a comprehensive general circulation model (GCM) is required to be developed for India, giving due consideration to the global phenomena and scenarios.

Some recommendations to cope with the problems in a systematic and a planned manner are: (i) a nation-wide climate monitoring programme should be developed; (ii) while formulating new projects that influence climate, it should be ensured that no action is taken which causes irreversible harmful impact on the climate; (iii) improved methods for accounting of climate-related uncertainty should be developed and made part of decision making process; (iv) existing systems should be examined to determine how they will perform under the climate situations that are likely to arise; (v) water availability and demands in all regions, particularly in water-scarce regions should be reassessed in the new climate regime/scenario; (vi) a re-examination of the water allocation policies and operating rules should be taken up to see how these need to be updated to handle extremes that are likely to arise; and (vii) there should be proper coordination among concerned organizations so as to freely share the data, technology and experience for capacity building.

3.1.6 Water Management in Flood Prone Areas (Area Specific)

Among all natural disasters, floods are the most frequent occurrence in India. The main causes of floods in India are inadequate capacity within river banks to contain high flows, river bank erosion and silting of river beds. The additional factors are as landslides leading to obstruction of flow and change of the river course, retardation of flow due to tidal and backwater effects, poor natural drainage in the flood-prone area, cyclone and associated heavy rain storms or cloud bursts, snowmelt and glacial outbursts and dam break flows.

For mitigating the effects of floods, broadly two types of measures are adopted

Structural Measures	Dams & reservoirs, Embankments, Cut-offs, Improvement of Channels, Floodways/detention basins, river training works, Improvement of the drainage system, etc.
Non -Structural Measures	Flood Forecasting & warning, Control of Floodplain development/Flood Plain Zoning, Flood insurance, Flood proofing, Catchment management, Flood emergency response planning, Flood fighting, Evacuation, Emergency assistance & relief, etc.

- There is a need for Flood Management Policy integrating both Structural and Non Structural Approach.
- The flood management measures have to be more focused and targeted towards the decided objectives within a stipulated time frame. For flood plain zoning, methods have to be evolved in consultation with the local bodies so that the **legislation on flood plain zoning is adopted.**
- Flood forecasting constitutes one of the most important actions of flood disaster preparedness. Technological advancement in a well-planned flood forecasting and warning system can help in providing higher lead time for timely action.
- It is well recognized that long-term solution of flood problems lies in creating appropriate flood storage in reservoirs. The total live storage capacity of completed projects in India is about 174 BCM. A large flood storage space in reservoirs is required for a successful flood management programme.
- Flood management also calls for **community participation.** Farmers, professional bodies, industries and voluntary organizations have to be aware about flood management. People's participation in preparedness, flood fighting and disaster response is required. Media like radio, TV, newspapers can also play an important role in flood management and so also information technology.
- As India shares river systems with six neighboring countries, viz. Nepal, China, Bhutan, Pakistan, Bangladesh and Myanmar, **bilateral cooperation for flood management is necessary for India and the concerned country.**

3.1.7 Water Management in Drought Prone Areas (Area Specific)

The drought-prone area assessed in the country is of the order of 51.12 Mha. The planning and management of the effects of drought appear to have a low priority due to associated randomness and uncertainty in defining the start and end of droughts. Further, most of the drought planning and management schemes are generally launched after persisting drought conditions.

- The traditional system of drought monitoring and estimating losses by crop cutting needs to be replaced with **real time remote sensing, GIS, GPS and modelling techniques for ensuring transparency and quick response**. There is a need for the development of the **decision support systems (DSS)** for the monitoring and management of the drought on basin scale **utilizing the advanced capabilities of remote sensing, geographical information system and knowledge based systems.**
- Need for robust Drought Mitigation Strategy covering off-farm livelihood, accounting for losses to groundwater depletion, crop damage and depletion in fertility of live stocks.
- **Conjunctive use of surface and groundwater, aquifer recharge and watershed development and management with community participation** is another important policy paradigm shift to be internalized fully.
- The Drought Management Schemes are based on the administrative units, while planning of water resources is based on basin scale. Therefore, an **integrated basin development approach is required to be developed and implemented for preparing the drought management plan before, during and after the occurrence of the drought.**
- **Timely dissemination of information** at different spatial and temporal scales to take corrective management measures.
- **Mass awareness** campaigns for water conservation with the help of electronic and print media.
- **Need for stakeholders participation** at political, administrative, technical and local level in drought management for optimum utilization of the available water supply to meet the demands through Water Budgeting.
- **Strengthening of R&D and capacity building** in terms of emerging information technologies is also called upon to bring in resilience in the drought coping strategies.

Water Budgeting

Water budgeting is a comprehensive process involving assessment of available water resource, losses due to various reasons, present consumption pattern & demand from all water use sectors. A water budget reflects the relationship between input and output of water through a region. The region/unit can be a village, a watershed, a project, sub basin or a basin. Though it is advisable to use perform water budgeting for a Hydrologic unit, however it can be applied to an administrative unit as well e.g. District or state.

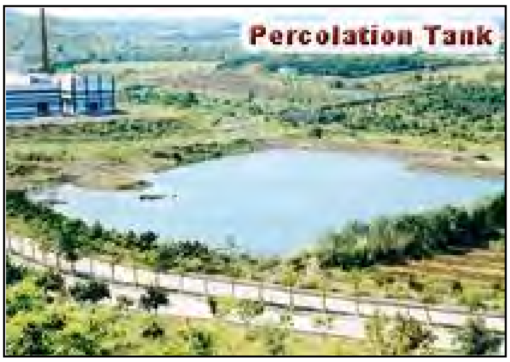
Ground Water Management

To protect the aquifers from overexploitation, an effective **groundwater management policy oriented towards promotion of efficiency, equity and sustainability is needed.**

Overexploitation of groundwater should be avoided, especially near the coasts to **prevent ingress of seawater into freshwater aquifers.**

Joint management approach combining **government administration with active people participation is a promising solution.**

Bore-well drilling should be regulated till the water table attains the desired elevation.



Artificial recharge measures need to be urgently implemented. Amongst the various recharge techniques, **percolation tanks** are least expensive in terms of initial construction costs. Many such tanks already exist but a vast majority of these structures have silted up. In such cases, **cleaning of the bed of the tank will make them reusable.**

Promotion of participatory action in rehabilitating tanks for recharging would go a long way in augmenting groundwater supply.

Due to declining water table, **the cost of extraction of groundwater has been increasing over time and wells often go dry.** This poses serious financial burden on farmers. **Special programmes need to be designed to support these farmers.**

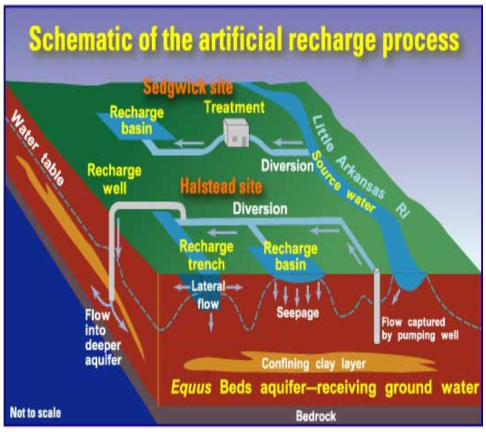
Finally, the role of government will have to switch from that of a **controller of groundwater development to that of a facilitator of equitable and sustainable development**.

Three large-scale responses to groundwater depletion in India have emerged in recent years but in an uncoordinated manner, and each presents an element of what might be a coherent strategy of resources governance as follows:

- Energy–Irrigation nexus: The International Water Management Institute Research has shown that with intelligent management of power supply to agriculture, energy–irrigation nexus can be a powerful tool for groundwater demand management in livelihood supporting socio-ecologies to create tradable poverty rights in groundwater.
- Inter-basin transfers to recharge unconfined alluvial aquifers: In western India's unconfined alluvial aquifers, it is being increasingly realized that groundwater depletion can be countered only by importing surface water. One of the major users Gujarat has found for water of the Sardar Sarovar Project on Narmada River is to recharge the depleted aquifers of North Gujarat and Kutch. A key consideration behind India's proposed mega-scheme to link its northern rivers with peninsular rivers too is to counter groundwater depletion in western and southern India.
- Mass-based recharge movement for management of groundwater resources: Fragmented land holdings, poor socio-economic status, poor infrastructure facilities, lack of knowledge of modern technologies are some of the reasons for the under-utilization of ground water resources. Apart from scientific development of available resources, proper ground water resources management requires to focus attention on the judicious utilization of the resources for ensuring their long-term sustainability. Ownership of ground water, need-based allocation, pricing of resources, involvement of stake holders in various aspects of planning, execution and monitoring of projects and effective implementation of regulatory measures wherever necessary are the important considerations with regard to demand side ground water management. Micro-level studies needs to be taken up in such areas on a regular basis to assess the impacts of the regulatory measures on the ground water regime. Real-time dissemination of information on the ground water situation in the affected areas is to be provided to the stakeholders. Involving local people in the administrative process, as social volunteers, may also help.

Artificial groundwater recharge

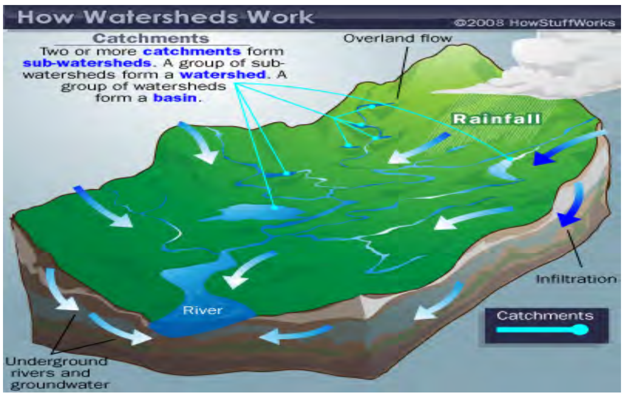
Artificial groundwater recharge is the infiltration of surface water into shallow aquifers to (a) increase the quantity of water in the subsurface, and (b) improve its quality by natural attenuation processes. It can be practiced in river valleys and sedimentary plains by infiltrating river or lake water into shallow sand and gravel layers. Water can be infiltrated into aquifers through basins, pipes, ditches and wells. Artificial infiltration of surface water into aquifers offers qualitative and quantitative advantages: Natural processes reduce the contamination of infiltrated river water.



Infiltration also allows for better water management as the level of water between the river and groundwater aquifer can be manipulated during periods of low and high river water discharge. Over time, a balance is struck between the river and the aquifer, allowing for water availability throughout the year. This enables a continuous water supply over the entire year. Generally, artificially recharged groundwater is better protected against pollution than surface water and is a distributed source in itself & the delimitation of water protection zones makes it safer. If done at scale, the volume of water that can be saved is enormous.

While there are environmental, financial and social issues with constructing artificial storage spaces such as dams, recharging groundwater aquifers is a 'natural' choice. Artificial recharge thus offers tremendous potential.

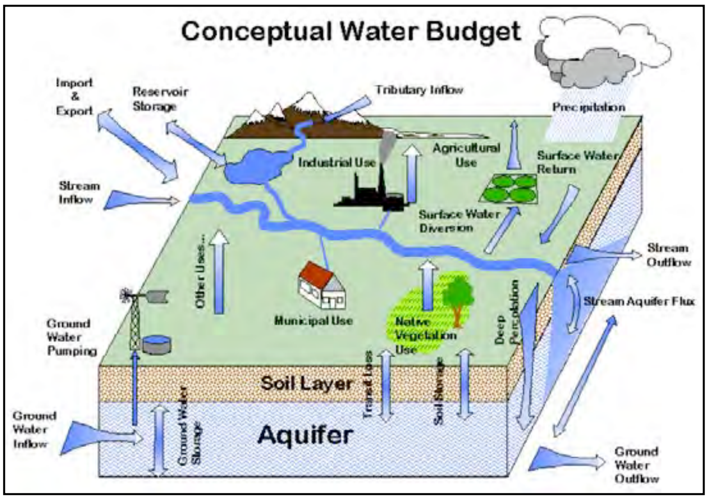
Watershed Development



- Watershed is the unit of management, **where surface water and groundwater are inextricably linked and related to land use and management.**
- Watershed management aims to establish a **workable and efficient framework for integrated use, regulation and development of land and water resources in a watershed (small scale) for socio economic growth. Various structures like check dams, continuous contour trenches, sub surface dykes, percolation wells etc are the various interventions in a Watershed.**

- Local communities play a central role in the planning, implementation and funding of activities within participatory watershed development programmes. In these initiatives, people use their traditional knowledge, available resources, imagination and creativity to develop watershed and implement community centered programme.
- Undoubtedly, **coordinated watershed development programmes need to be encouraged and awareness about benefits of these programmes must be created among the people.**

Conjunctive use of Surface and Groundwater



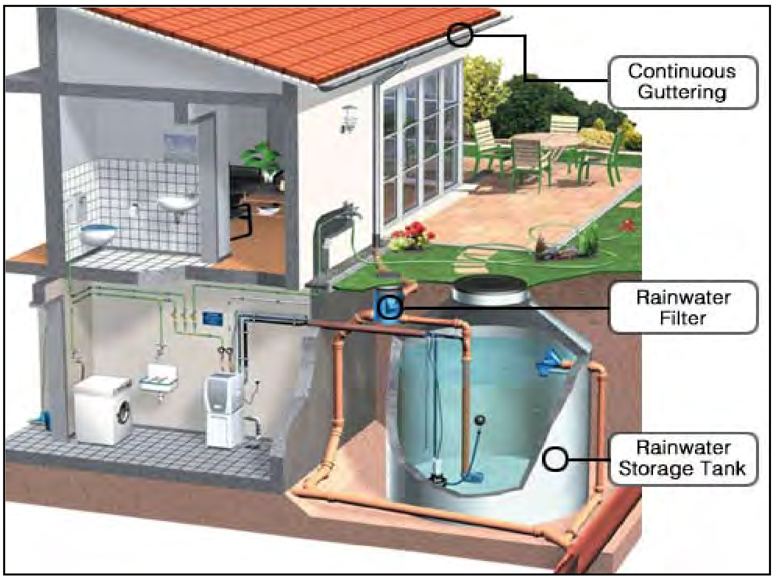
Large canal infrastructure network for providing irrigation has been the prime goal of the Government of India, since the first five-year plan, which continued up to seventh five-year plan. In some of the irrigation project commands such as Sarda Sahayak in UP, Gandak in Bihar, Chambal in Rajasthan, Nagarjuna Sagar in Andhra Pradesh, Ghataprabha and Malaprabha in Karnataka etc. problems of water logging are being faced.

The main reason for excessive use of surface water as compared to groundwater is its much lower price for irrigation as compared to the cost incurred in using groundwater.

Water logging problems could be **overcome if conjunctive use of surface and groundwater is made.** Groundwater utilization for irrigation in waterlogged areas can help to lower the groundwater table and reclaim the affected soil.

Many research workers have focused the causes of water logging. Several groundwater flow modeling studies have focused on assessing the waterlogged areas and measures to control problems of water logging and salinity. It is desirable that the irrigation needs for fulfilling crop water requirements should be satisfied by judicious utilization of available **canal water in conjunction with groundwater** so as to **keep the water table within the acceptable range.** Thus, the **optimal conjunctive use of the region's surface and groundwater resources would help in minimizing the problems of water logging and groundwater mining and over exploitation as the two extreme situations.**

Rainwater Harvesting



Rainwater harvesting is the process to capture and store rainfall for its efficient utilization and conservation to control its runoff, evaporation and seepage. Some of the benefits of rainwater harvesting are:

It increases water availability, checks the declining water table.

It is environmentally friendly and improves the quality of groundwater through dilution, mainly of fluoride, nitrate, and salinity. It also prevents soil erosion and flooding, especially in the urban areas.

Even in ancient days, people were familiar with the methods of conservation of rainwater and had practiced them with success. Different methods of rainwater harvesting were developed traditionally to suit the geographical and meteorological conditions of the region in various parts of the country be it rural or urban. Traditional rainwater harvesting, which is still prevalent in rural areas, is done by using surface storage bodies like lakes, ponds, irrigation tanks, temple tanks, etc. There is a need to recharge aquifers and conserve rainwater through water harvesting structures.

In urban areas, rainwater will have to be harvested using rooftops and open spaces. Harvesting rainwater not only reduces the possibility of flooding, but also decreases the community's dependence on groundwater for domestic uses. Apart from bridging the demand–supply gap, recharging improves the quality of groundwater, raises the water table in wells/bore-wells and prevents flooding and choking of drains. One can also save energy to pump groundwater as water table rises. These days rainwater harvesting is being taken up on a massive scale in many states in India. Substantial benefits of rainwater harvesting exist in urban areas as water demand has already outstripped supply in most of the cities.

3.2 INNOVATIVE WATER CONSERVATION PRACTICES

Ferro-Cement Tanks

This is a low cost alternative for expensive water harvesting containers made of masonry, plastic and RCC. It has proved highly effective in high rainfall regions where large amount of water needs to be stored in clean form. These tanks requiring materials like sand, cement, mild steel bar and galvanized iron wire mesh, can be easily constructed by semi skilled labours. It is light in weight and can be moulded into any shape required. It is believed to last for around 25 years with little maintenance. Picture above shows a ferro-cement tank under construction. It can be appropriate for use in Indian villages and disaster prone areas as it is fireproof and tough in build.

Cycle Run Water Pumps

A saver of time and cost of electricity and fuel, this technology utilizes human power generated by pedaling a bicycle to lift water from streams, ponds, canals and wells. When cycle is pedaled, it creates an up and down motion of pistons which pressurizes water flow to outlet. A portable model which can be installed on site has also been developed. Designed for small scale farmers who don't have capacity to afford costly diesel run motors, this arrangement can bring a flow of 100 litres per minute. The complete unit made of cast iron and aluminium costs from rupees 2500 to 7000. These pumps have also supported women, kids and old people who at times found operating hand pumps in bend position a strenuous task. Some models have replaced bicycle by steppers (commonly seen if gyms), making pumping water a healthy and fun activity. In India, it was conceptualized by poor farmer from a village of West Bengal, Nasiruddin Gayen in 1980s. Xylam water solutions, a Vadodara based company is also designing and selling this innovation. If made applicable in urban areas, this concept can do wonders in making people realize importance of water.

Joy Pumps

Ever imagined filling up an overhead tank by kids playing around? This innovation was designed to mitigate water scarcity problems in villages with no clean surface water source, no electricity and poor monetary capacity. Attached below a merry-go-round wheel or a see-saw, is an arrangement similar to a conventional hand pump. As children ride on these wheels, groundwater is drawn and tank (around 8-10 meters above ground) is filled. It can also be used to pump water from bore wells and large storage tankers. It can be installed even at far off places and has easy maintenance. It's basically a community structure and can be set up in schools, parks, villages and relief camps. It has been used in developing countries like India and Africa. Span pumps pvt. limited, a Pune based company is designing such pumps in India.

Rain Water Syringe

Most of the open wells and tube wells in coastal areas contain salty water due to seepage of sea water. Rainwater harvesting is a viable option for solving the issue of drinking water, but construction of rainwater overhead tanks is unaffordable for marginal farmers. Antoji in Kerala has innovated a cost effective method for harvesting rainwater in coastal areas. Rainwater is collected from the roof tops of houses and stored in a pressure tank on the ground and with the help of PVC pipes, water is lowered below sea level (16-24 feet). The water is retained in the underground water column which is then harvested during summer by a simple piston pump or motor by constructing a tube well in the vicinity. It has proved successful in diluting recharging ground water in coastal areas of Kerala and Antoji has installed 150 tanks in different parts of Kerala.

Water Wheel

This innovation comes from a foreign visitor who was inspired by women from villages of Rajasthan, who carried round earthen matkas on head for long distances in hot weather. This invention has made carrying water not only an effortless but fun activity. It is a round wheel shaped storage tanker with an attached handle on top to provide painless mobility. It has already become popular in villages of Gujarat, Madhya Pradesh and Rajasthan. Designed to reduce the drudgery and save time of working women, water wheel can store up to 10 to 50 litres of water in hygienic conditions. It is designed for lasting on rough terrains and made from high quality plastic. It is affordable too costing around 2000 rupees. It was the innovation of a US based social entrepreneur, Cynthia Koeing under an organization called Wello.

3.3 INITIATIVES OF COMMUNITY IN WATER CONSERVATION AND MANAGEMENT

In 2016, India has been witnessing one of the severest droughts after independence. The phenomena has led to a 'never before' kind of water crisis across the country. As a result the surface water sources are under severe stress and aquifers beneath ground have been over drafted. An already depressed agrarian community is worst hit in thousands of parched villages in the rural landscape. Many somewhat immune urban centers are also facing the wrath of heat.

However there is no dearth of inspiring tales in the field of water conservation pan nation presenting a ray of hope amid gloomy scenario. The exemplary works being done by several villages, people and organizations across the country offer some lasting solutions to growing water scarcity. So here is an attempt to present **a State wise account of drought hit areas which have been wading through the water crisis sound and safe by reinventing the community driven and local water harvesting practices.**

3.3.1 MAHARASHTRA

SAGUNA RICE TECHNIQUE – SRT, (Zero till, more yield & Better Soil fertility!)

Introduction

Saguna Baug is a 55-acre farm with various agricultural activities such as agro forestry, dairy, aquaculture, agro tourism, horticulture, traditional and non-traditional farming. Farm is located at Neral-Malegoan which is equal distance front Pune and Mumbai (Approx. 100 KM). Many people visit Saguna Baug for various reasons such as many farmers visit to get information on agricultural activities. Urban people visit for information on farm house development as well as for unique leisure learning experience in Agro-tourism. Chanrdashekhar H Bhadsavle is the person who is largely responsible for the success story of Saguna baug and development of SRT (Saguna Rice Technique). Saguna Rice Technique is a unique new method of cultivation of rice and related rotation crops without ploughing, puddling and transplanting (rice) on permanent raised beds. This is a zero till, Conservation Agriculture (CA) type of cultivation.

What's So Special About SRT?

The permanent raised beds used in this method facilitates ample of oxygen supply to root zone area while maintaining optimum moisture condition there. This changes the conventional rice cultivation to ease farmers' laborious work and to prevent fertility loss during puddling. It reduces treacherous labor by 50%, cost of production by 40%, stops emission of greenhouse gases and improves soil fertility. The permanent raised beds used in this method facilitates ample of oxygen supply to root zone area while maintaining optimum moisture condition there. SRT iron forma facilitates planting of crop in predetermined distances enabling precise plant population per unit area. Absence of puddling and transplanting of rice makes it possible for "Not dependent on erratic behavior of rain." This means 'No more waiting for Rain God to shower just optimum rain for best transplanting operation'. Similarly if rain vanishes for few days during crop season it doesn't lead to cracking of land or 'crop kill' immediately.

How is it Developed?

- ✓ In this method we have to till the soil and make the raised beds only once. The same permanent beds will be used again and again to grow various rotation crops after rice in Kharif season.

- ✓ Till the soil with rotavator or power tiller to make it workable. Draw parallel lines with help of rope and lime or wood ash at 136 cm i.e 4.5 feet apart.


- ✓ Use tractor drawn 'Bed maker' or any other means to open furrows at marked lines and make raised beds.

- ✓ Make depressions / holes with SRT iron forma on the raised beds. Sow / dibble 2 seeds of either Wal beans (Kokan Wal no. 2) or Gram (Vijay), or bush type Cowpea (Kokan Sadabahar) or Horse Gram (Dapoli no. 1) as per recommended variety and distances.


- ✓ Apply fungicides and / or beneficial microorganisms to the seed as per the agriculture university guidelines.

- ✓ Irrigate plot with best possible available method. 3 to 4 hours later spray the plot with selective weedicide Goal (Oxyfluorfen 23.5% EC) @ 1 ml per litre of water.

- ✓ The crop is ready for harvest till 3rd or 4th week of February. Cut the plants leaving roots and 2 to 3 inches stem on the beds.

- ✓ It is very important to leave the roots of previous crop in to soil and spray the plot with
- ✓ Glyphoset (15 lit water + 100 ml Glyphoset + about 200 g of sea salt or 150 g of Urea) 2 to 3 days after harvesting.
- ✓ Earthworms eat the decaying roots and plants and in turn they make holes which provide the required aeration in soil. The new crop can then be planted again. Summer moong beans can be planted after the winter crop on the same bed.
- ✓ SRT iron forma and selective weedicide like Goal are to be used. Same raised beds are to be used again without any ploughing or puddling or transplanting for next Kharif rice crop.

Important Principles

- ✓ SRT insists that all roots and small portion of stem should be left in the beds for slow rotting.
- ✓ Weeds are to be controlled with weedicides and manual labour. No ploughing, puddling and hoeing is to be done to control weeds.
- ✓ This system will get the crop ready for harvesting 8 to 10 days earlier. Take this into consideration while choosing a variety to avoid getting harvesting caught in receding rain.

Advantages

This could be the best solution in natural calamities such as hail storm, floods, cyclones, untimely rain-storms, etc. because the crop cycle is shortest (NO TILL) and it involves multiple choices of short-term rotation crops such as pulses, vegetables, onion, sun-flower, groundnuts, and so on. Also better crops and productivity can be achieved with minimum damage to soil and environment. The various advantages are:

- ✓ Avoiding of puddling will drastically reduce diesel consumption, emission of CO_2 over thousands of acres of paddy cultivation.
- ✓ Also SRT being aerobic method it will prevent methane generation. Both CO_2 and methane are responsible for global warming.
- ✓ The traumatic shock caused to the rice seedlings during transplanting is avoided in SRT. This reduces possibility of pest & disease problem.

- ✓ SRT is feasible for organic farming method. Can be coupled with micro irrigation.

SRT being used with Drip irrigation system for better water efficiency

- ✓ Due to excessive water in low-lying plots removing of harvested paddy from the plot for drying can be avoided with SRT raised beds.
- ✓ Rice crop gets ready 8–10 days earlier. Also it saves time required for soil tilling between two crops. This leaves valuable 10–15 days of crop season for the farmer enabling him to take more than one crop in the same plot in a year.
- ✓ During milling of paddy, SRT will yield higher percentage recovery of grains.
- ✓ Non-use of heavy agricultural machinery for tilling in field will prevent compaction & formation of hard pan of lower strata of soil enabling better percolation of water into dipper soil & permanent establishment of earthworms.

Presence of Earthworms in the paddy field

Unusual bird Black Ibis seen in various SRT fields

- ✓ Required aeration in soil is achieved by earthworms. Also the soil retention capacity and permeability gets increased and soil erosion can be controlled.
- ✓ Longer and healthier plants. It is possible to get high returns (more than Rs 5,00,000 per hectare per annum) with crop rotation such as Basamati Rice (PS-5) in Kharif, leafy vegetables in Rabbi, Bold Groundnut (W-66) in Summer, while improving health of the soil.

Healthier and better crop quality and quantity achieved

- ✓ Damaged soils can be recovered by SRT, which is caused by lashing, scrubbing & natural calamities, in quickest possible time

Impacts

A. **Impact on Farmer**

- ✓ Farmers become more confident about their profession.
- ✓ Lost dignity toward farming is regained through various systematic procedures carried out in SRT.
- ✓ Farmers have gain independence from the problem of labour shortage.

B. Impact on Soil:

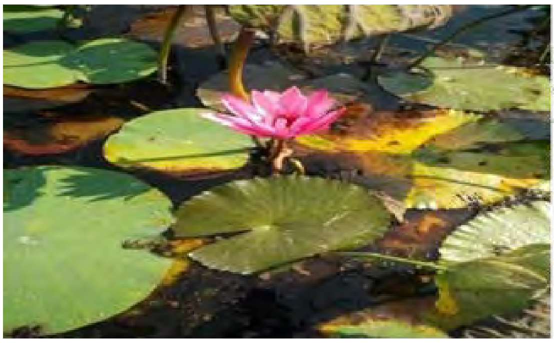
- ✓ Fragrance of a soil improved in the process of keeping roots beneath the earth surface.
- ✓ Soil becomes more productive.
- ✓ Water holding capacity of soil has been drastically improved.

C. Impact on Nature

- ✓ Presence of earthworm in farms attracts some of the rare species of birds, so it improves the eco-system.
- ✓ Groundwater level increases.
- ✓ Reduction in Methane Gas generation.
- ✓ It reduces water, Fertilizers & other chemicals requirements.

There are several other activities carried out in Saguna Baug

- ✓ Fish Farming
- ✓ WB Ride (buffalow ride)
- ✓ Dairy
- ✓ Gardening and Farming
- ✓ Ponds and Lotus in Saguna Baug
- ✓ Swimming
- ✓ Rod Fishing
- ✓ Paddle wheel Boating
- ✓ Archery



Ahmadnagar

The State is among worst drought hit particularly the Marathwada region. It is interesting to see that the most of remarkable water conservation work has also happened in this State. Hiware bazaar village in Ahmad Nagar district has become a buzzword for watershed management for which it was specially mentioned in PM Narendra Modi's `Mann ki Baat' programme. During 1990s the village used to face a major water crisis due to scanty rain. It was that time, when various watershed management programmes and water conservation initiatives were started by the villagers including refraining from sowing water-intensive crops and opting for crop diversification. Dairy development was also encouraged. The villagers meet on December 31 each year, during which a review of the rainfall and available water is taken. As a result of several such steps and community formed norms, underground water table in Hiware Bazar is now available at 20 to 40 feet below. Women in the village are glad that they don't have to trek miles in search of water.

Aurangabad

On the same line a tiny village Patoda, on the fringes of water-starved Aurangabad city, is offering valuable lesson in water conservation and harvesting. Villagers regard water as more precious than money. They follow strict rules about usage and strictly carry the water audits. Water meters are installed in every households and entire village recycles each drop of waste water it generates. Today no rain water flows out of the village. Percolation has recharged the aquifers and the water table has risen.

Water shed development work carried out to arrest rain water and regenerate ground water

So effective is its water conservation model that Patoda has now become a model for the rest of Marathwada and has won 22 state & national awards. But it did not happened over nights. In fact it is a result of over 10 years joint effort done by villagers.

Jalna

Similarly the villages of Wadhona, Vizora, Sunderwadi, Padmavati, Bhorkheda & Vadod Tangda in Jalna district of Marathwada has been greatly benefited by using alternatives like water shed development, afforestation, farm bunding, organic farming, vermi-composting, agro-meteorology, farm pond, renewable energy, water budgeting, micro-irrigation, fodder cultivation as steps initiated under a watershed development project by WOTR. The project is built on a hill, with the first village, Jaydevwadi, on top followed by Wadhona, Vizora, Sunderwadi, Padmavati, Bhorkheda and Vadod Tangda. The most important aspect of the model is the work that the villages have undertaken to arrest and conserve rain water, regenerate ground water and plan water consumption. At each level, at each village, some amount of rain water should be held back or go into the ground. The mammoth task of developing a watershed, de-silting, bunding etc. has also led to massive employment opportunities for the farm workers giving them additional income.

Osmanabad

Moving a step ahead, farmers of Horti village of Tuljapur Taluka in drought stricken Osmanabad district have resorted to online crowd funding to de-silt and renovate a canal. Around 700 farmers have come together to widening, deepen and de-silt an 8km long canal that runs across their farms to increase its water holding capacity ahead of the monsoon. The cost of the work is approximately Rs 6 lakh, of which the villagers have collected approximately Rs 3 lakh for the work and the rest of which will be raised through an online crowd funding campaign that has been put together to help them raise the remaining amount. The crowd funding campaign has collected over Rs 1.9 Lakh in less than a week. The work started on May 17 and is almost completed. Villagers now are hopeful that this attempt to revive a water source and the prediction of a good monsoon will wash away all their woes.

While under Participatory Ground Water Management Project, Arghyam organization has brought the villagers of Muthalane in Pune, Randullabad in Satara and Pondhe in Purandar taluka together and got them to understand the issue of ground water management. Accordingly groundwater management plans based on aquifer mapping were made in the villages. This experience showed that the use of groundwater and aquifer based knowledge by demystifying it for the villagers and combining it with local knowledge helped them become aware of the common nature of their water resources and the need for its better management to become water secure.

3.3.2 MADHYA PRADESH

Dewas

A district in parched Malwa the region has won five national awards for rain water harvesting. Courtesy to the unique idea of farm pond now named ‘Pani Bachao Dhan Kamao’ (save water, earn money) campaign introduced ten years back. Under the campaign administration chipped in with technical inputs and farmers were urged to dig out one tenth area of their land and turn it into farm ponds. After knowing about the benefits of farm pond, farmers started digging ponds on their own land with the help of tractors. Today there are more than 1,000 irrigational ponds out of which 564 ones, which are known as Rewa Sagar, were made without any government fund. The concept of farm ponds has made about 400 villages drought proof. The United Nations also had selected Dewas district's community water management works in the best three water management practices in the world under the category of 'Best Water Management Practices' for 2011-2012.

Over 3 lakh truckloads of soil had been excavated and works worth Rs 40 crore had been successfully completed by farmers.

Indore

Inspired by the success of the campaign, the neighboring Indore district administration has also worked out a smart plan. It has asked farmers to de-silt water bodies and transport the mineral rich soil to manure fields. The idea is working both ways as it is saving the district administration money in deepening water bodies and giving farmers mineral-rich manure for the fields at an affordable cost. All they have been asked to do is dig 3-5 feet deep and use 1/10th of the soil to strengthen the embankment. The plan has begun to pay rich dividends to both government and farmers in water crisis-hit areas.

3.3.3 UTTAR PRADESH

Banda

In water starved Bundelkhand region that has 113 farmers' suicides since Jan. 2016, farmer Prem Singh is scripting a success story, and has set an example by practicing organic farming, horticulture and animal husbandry for past many years. On his farm in Banda district, one can see full water bodies, fruit-laden trees which have improved the risk-taking capacity of the farmer and healthy cattle, which in turn provide manure for organic farming. Locals and activists are now approaching Prem Singh to find out how his practices have transformed his farm into a lush area and 22% of the people in his village have grown an orchard on their farms. Indeed his model of diversification can be replicated by small farmers in the region.

Jalaun, Hamirpur, Lalitpur

Meanwhile women groups in Jalaun, Hamirpur and Lalitpur districts also in Bundelkhand have joined hands to form paani-panchayat. The focus of these paani panchayats, mostly led by dalit women, is to create more water resources, revive old ones and conserve natural water bodies with the help of traditional and modern technology. The first paani panchayat was formed in 2011 in Jalaun district. By September 2011, a total of 96 such water resource management councils were formed. Local organization Parmarth Samaj Sevi Sansthan is supporting both the initiatives in Bundelkhand.

Similarly, a group of villagers from Malakpur in Shamli district of western UP are trying to breathe new life into local stream Katha, a 150-km long river which is dead now. With help from a local scientist, farmers are leading the effort to turn a 1 km of the barren riverbed into a lake. The plan is to put up check dams to harvest monsoon water along the 1 km stretch of the river bed which is 5-40 feet deep. At present, in the absence of check dams, it flows into the Yamuna. Over the last two weeks the villagers have launched a "one house, one pot" water donation movement.

3.3.4 ANDHRA PRADESH

Anantapur district in the State has been facing a severe drought. After 2000, the area has seen rapid fall in ground water table mainly due to subsidized power connections and absence of formal legislation or social regulation to govern extraction. Despite water shortage the cultivation of water-intensive crops continued resulting in increasing water disputes among farmers. Now working towards a solution, 25 farmers of Kummaravandla Pally have formed a collective Kolagunti Ummadi Neeti Yajamanya Sangham to "share groundwater with each other" to sustain their crops with the help of government bodies and NGO WASSAN. The joint efforts of all three stakeholders have led to the concept of networking of bore wells to secure rain-fed crops of all farmers, irrespective of bore well ownership. By linking all bore wells with a network of pipelines and outlets, all farmers can now access groundwater. To ensure compliance, the farmers have also signed an agreement which aims at sustainable use of ground water resource encouraging farmers to switch to crop diversification, System Rice Intensification, horticulture, micro irrigation systems etc. the farmers' committee has also put a ban on new bore well connection in critical area.

Farmers are also using government schemes such as water and soil conservation works under the MGNREGS and NADEP compost pits. The mutual agreement has led to a new way of agriculture in the 72 acres of land of 25 farmers. Since 2010, the cropping pattern has changed, leading to diversity of crops, reduction in costs of cultivation; improvement in value of produce and profit.

3.3.5 TELANGANA

Learning from the Anantpur success story, several villages in six districts (Mahbubnagar, Ranga Reddy, Warangal, Medak, Karimnagar and Adilabad) of neighbouring Telangana are also piloting this participatory groundwater management programme.

The weir of a pond on the outskirts of Karimnagar

The government of newly formed State has also been receiving a lot of appreciation for its flagship programme Mission Kakatiya aiming at de-silting, reviving and restoring the minor irrigation tanks ponds and lakes. The programme with the tagline "Mana Ooru, Mana Cheruvu" (our village, our pond) intends to create storage capacity of 265 TMC in the 10 districts. It has received kudos from the many governmental agencies and leading water experts has described it as historic decision to revive water sources. The tanks and ponds are important to Telangana because both rivers Godavari and Krishna flow at a lower level while the agricultural lands of Deccan plateau are at a higher level. Irrigation was possible only by using water from the tanks and ponds.

3.3.6 RAJASTHAN

Jaipur

Laporiya, a village 80 km from Jaipur, has been defying drought for the past 30 years with a collective effort of water harvesting by 350 families. While ground water has gone down to 500 feet in nearby areas, it is found at 15-40 feet in this village. Not only does lush Laporiya have enough water for its population of nearly 2,000, it even supplies water to some 10-15 surrounding villages. This journey from scarcity to self-sufficiency started in 1977 when an 18-year-old Laxman Singh realized that the only way to make the area agriculturally prosperous was making the area water rich through traditional method of water harvesting called ***Chowka***. Under the chowka system, small, interconnected, sloping rectangular pits, nine inches deep, are made in pasture land. Over 15 years, the chowka system was developed on about 400 bighas of pasture land. The villagers came together and contributed money and labour to make the bunds. With the soil gaining moisture, villagers were able to harvest their

rabi crop without irrigating their fields. There has been some smart crop planning too. Villagers stay away from water-intensive crops.

Barmer & Jaisalmer

In certain areas of Barmer and Jaisalmer districts in west Rajasthan, communities have taken it upon themselves to handle their water, food and fodder needs, and have come up with long-term sustainable solutions following Sambhaav Trust's initiative. Just in the last two years, more than 100 beris (small community wells for drinking water), 10 lakes, 5 wells, 100 acres of agricultural land and 1,200 bighas of common pasture land have been revived. In more than 60 villages, people now have access to water, and are able to produce food and fodder for their livestock. This work has brought many changes with it. Villagers who had to walk 10 km to get water now have water in their village. Communities which never ever did agriculture now have their own lands to do so. People who would migrate to other states for work now live and work in their own villages. What is remarkable is how communities have pooled in their resources to work towards self-reliance. The youth are more attentive towards conserving natural resources and have become active in local governance.

Jaisalmer

Ramgarh area is where it rain scantly, has also become water sufficient due to harvesting every drop of rain water in ponds without any aid from Government or NGOs. The Viprasar pond holds special significance for this region. Villagers still practice community farming to save water and all the people have equal right on water bodies as the collective assets of the entire society. As a result, the area in the heart of desert today has plenty of water, food grains, and fodder and gives employment to the people belonging to areas which receive good rainfall.

3.3.7 WEST-BENGAL

Purulia gets ample rain but the district has a very undulating terrain due to this nearly 50% of this water is wasted in run off making the district prone to droughts. But things started changing in some portions of the district over the past 3 years. A Kolkata-based NGO SAFE with funds from NABARD has taken up rain water harvesting through farmers club. At present there are more than 70 such farmers clubs in 5 blocks of the district. Along with rain water harvesting other innovative measures such as 'collective farming', wherein farmers harvest a single crop over several acres of land instead of growing various crops in their fragmented individual farmlands and 'water budgeting' in which the members of the club decide on what crops to grow according to availability of rain leaving some water for daily use and growing fishes have also helped the farmers. With yields increasing more farmers are now showing interest to form farmers clubs.

3.3.8 JHARKHAND

Ranchi

Simon Oraon, popularly known as Baba in Bero block of Ranchi area has transformed the lives of thousands of villagers in Jharkhand with his massive tree-planting and water conservation efforts, The 84-year-old man, a Padma Shri awardee, has been working in 51 villages of Bero to protect natural flora for decades. The residents of these 51 villages owe him the agricultural prosperity he brought them through simple water conservation efforts. Today, his village is one of the state's agri-produce hubs, supplying more than 25,000 metric tonnes of vegetables to various districts and nearby locations.

3.3.9 ODISHA

Bargarh

In Kharamal village under Jamseth gram panchayat of Paikmal block, which is often hit by drought but farmers Sitaram Majhi & Dambru Majhi, who have created water harvesting models in their agricultural land, using which the farmers have managed to irrigate vegetables and earn profit. In 2005, Water Initiatives Odisha, a group of people working on water issues, motivated villagers to develop an integrated ecological revival plan for the village. Locals then revived a community tank in the village but Sitaram and Dambru dug up small water bodies on their land, locally called ***Muda***. During monsoon, the run-off rain water from the hill range would flow through their land and get collected in the Muda. A few years later, the soil moisture content improved with ground water being recharged due to the Mudas.

3.3.10 UTTARAKHAND

Pauri

In Ufrenkhal village, Sacchidanand Bharti has created a lush, green mountain covered with *deodar*, *banj* and *utees* trees over few decades. The forest has replaced a formerly barren land. The man along with villagers has also revived a local stream with the help of the

Chal-Khal: Under this system small percolation pits on every bit of available land on the slopes of stream were dug by villages. Grass and trees were planted around and in the pits to secure the edge and prevent the soil from being washed away. Once grown, they helped in retaining soil and water. The pits and the trees developed a mutually beneficial relationship, which rejuvenated an entire system. Today, more than 40 villages have adopted chal-khal system. Earlier, this work was carried out by the villagers through shramadaan drives. Today, it is done in the monsoons, for wages of Rs. 50/- per pit. This is an on-going process, having continued for over 30 years now.

3.3.11 PUNJAB

Kapurthala, Moga, Fatehgarh Sahib

Even as concern over declining water table and over exploitation of water in Punjab for paddy continues to grow, some farmers in the state are using innovative techniques to save water. Avtar Singh, a farmer in Phagwara has inter-cropped cotton crop with cucumbers and is practicing capillary action irrigation which also helps in conserving water. He irrigates his fields after every 2 weeks, helping him save a lot of water which would otherwise have been used to flood the land. Paramjit Singh Gill of Moga cultivated red garlic, a crop that is not familiar to Punjab, and has reaped profit of Rs 1 lakh per acre. Another farmer, Sukhvir Singh from Fatehgarh Sahib has grown onions on 7 acres, muskmelon on 5 acres, tomatoes on 2 acres, chillies on 2 acres and pumpkin on 1 acre.

3.3.12 GUJARAT

Kutch

As the state reels under water scarcity this summer staring at empty dams on minor rivers, several areas in Kutch are still satiating their drinking water needs from carefully managed groundwater. A total of 300 villages of four talukas on coastal area ***Abdasa, Mandvi, Mundra and Anjar*** are involved in an aquifer management project for the past 4 years. This summer has showed a marked difference in several, if not all, villages that are part of the network. The mapping of aquifer took place five years ago along with Central Ground Water Board as three of the four talukas were declared 'dark zones' with high TDS and over 50% saline water. It is one of the few projects at aquifer level going on in India, with such a large population base.

The compilation underlines that community driven and local water conservation methods even today, remain viable and cost-effective alternatives to rejuvenate depleted groundwater aquifers. With government support, these structures could be upgraded and productively combined with modern water harvesting & conservation techniques. This may be a far more sustainable approach to alleviating the water scarcity crisis across India. No doubt this drought is exceptional but at the same time it offers a golden chance to draw lessons from local and community driven water conservation initiatives. In this defining moment, it depends on us how we convert this adversity into an opportunity by reinventing time-tested and local water harvesting structures with community participation and by incorporating innovative ideas to keep severe drought like this at bay.

3.4 THE WAY FORWARD

Traditional, Conventional and Modern Techniques of water conservation and management are prevalent, wherein we have plethora of techniques for mitigating water sector challenges. Certainly, a doubt may arise on one's mind which is the appropriate method and how it can be applied in the present day context for extenuating the challenges? After a deep analytical thought we can confer that though many techniques are in place but they have a problem solving tendency at a local scale. In spite of innumerable techniques and methods available for facing the water sector challenges, the country is still facing with untold challenges viz. flood, drought, competing water demands, inter-state water disputes etc. The inference drawn is that though the strategies and methods are in place, it is being implemented in a piecemeal manner by the different agencies/ organizations without any integration and synchronization. Thus, to overcome these challenges and to bridge the gap of demand and supply of water in the near future, there is an immediate need for an integrated robust framework and environment to address these challenges in a holistic and multi-disciplinary manner, the answer to this is "**Integrated River Basin Planning and Management (IRBPM) / Integrated Water Resources Management (IWRM)'.** A broad perspective is needed that unites social, economic and environmental concerns in a **landscape where upland forests and rangeland, wetlands, agricultural and urban areas are integrated**.

A central goal of IWRM at the river basin level is to achieve water security for all purposes, as well as manage risks while responding to, and mitigating disasters. The path towards water security requires trade-offs to maintain a proper balance between meeting various sectors' needs, and establishing adaptable governance mechanisms to cope with evolving environmental, economic and social circumstances. Well-developed, well-tested, scientifically robust, socially acceptable and economically viable approaches to implement IWRM at the river basin level are still not widely available. IWRM strives for effective and reliable delivery of water services by coordinating and balancing the various water-using sectors – this is an important part of sustainable water management.

Let us glimpse through the definition, principles and approach of IRBPM / IWRM

"Integrated Water Resources Management (IWRM) is a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an

equitable manner without compromising the sustainability of vital ecosystems and the environment." (Global Water Partnership)

Above approach of IRBPM/IWRM is suitable for India and other developing countries as it envisages maximizing social & economic benefits in equitable manner ensuring sustainability of freshwater ecosystems. Aforementioned development is concerned with identifying structural and non-structural measures which will ensure availability of water overcoming its spatial & temporal variability to meet development objectives, subject to various technological, social and financial constraints.

The five principles of IWRM are:

I. Water is a finite and vulnerable resource: This principle assigns a river basin or a catchment area to be a water management unit, which is the so-called hydrographical approach to water management.

II. Participatory Approach: Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels. Decentralizing decision making to the lowest level is the only strategy to enhance participation.

III. Role of women: This principle lays emphasis on gender equality at all levels for playing a decision making role of water management can expedite the achievement of sustainability, while integrated and sustainable water resources management

IV. Water has a social and economic value: Recognizing water as an economic good is a key decision-making tool to distribute water among different sectors of the economy and different users within sectors. It is particularly important when water supply cannot be increased.

V. Integration of 3 Es (Economic Efficiency, Equity and Environment Sustainability): Integrated water resources management is based on the equitable and efficient management and sustainable use of water. It recognizes that water is an integral part of the ecosystem, a natural resource, and a social and economic good, whose quantity and quality determine the nature of its utilization.

3.4.1 IRBPM/IWRM: A multidisciplinary Approach

Historically, projects have been undertaken in fragmented manner such as management of individual reservoirs to meet local irrigation demand, abstraction of ground water for drinking water etc. Integration needed at river basin scale (conjunctive use etc) which may further call for integration at regional, national and possibly international scale. It enables a holistic approach for addressing issues related to water resources in a river basin

. The major disciplines for IWRM are as under:

- HYDROLOGY - Concerned with quantifying natural distribution of water in time and space (assessment of water resources)
- HYDRAULIC ENGINEERING - Concerned with design and management of structural measures whereby water can be stored and distributed in time and space
- ENVIRONMENTAL ENGINEERING - Concerned with quantifying water quality in time and space, and with waste water treatment processes whereby this can be altered to accord with water quality standards for river water etc.
- SOCIAL SCIENCES - Concerned with formulating objectives of development, with assessment of water demand and with water governance and public participation
- SYSTEMS ANALYSIS - Interacting roles of above disciplines can best be studied through the medium of systems analysis. Variables describing inputs to, components and states of, and outputs from a system can be defined and relationships between them can be represented through equations in a mathematical model. Constraints can be introduced into the model and operation research techniques of simulation and optimization can be used to maximize objectives, evaluate risk etc

<u>IRBPM/IWRM: A Sequence of Decisions</u>

Success of IRBPM/IWRM depends on right decisions taken at the right time. There can be several kinds of decisions to be taken; some of them are as under:

- PLANNING DECISIONS - Involves deciding on feasibility of a project and further details regarding location and timing of construction of dams, transfer links, power stations, sewerage treatment works etc.
- DESIGN DECISIONS - Involves sizing individual components and setting target yields, consideration of risk etc.
- OPERATION DECISIONS - Long-Term Operating Policies; Short-Term Controls such as real-time monitoring of state of the system, quick decisions based on forecasts etc.

3.4.2 National Water Policy (2012) on IWRM

The National Water Policy-2012, in several provisions, has enumerated the integrated perspective of water resources planning, development and management. One of the basic principles of the policy is that planning, development and management of water resources need to be governed by common integrated perspective considering local, regional, State and national context, having an environmentally sound basis, keeping in view the human, social and economic

The Policy under para 2.3 states that there is a need for *comprehensive legislation for optimum development of inter- State rivers and river valleys to facilitate inter-State coordination ensuring scientific planning of land and water resources taking basin/sub-basin as unit with unified perspectives of water in all its forms (including precipitation, soil moisture, ground and surface water) and ensuring holistic and balanced development of both the catchment and the command areas. Such legislation needs, inter alia, to deal with and enable establishment of basin authorities, comprising party States, with appropriate powers to plan, manage and regulate utilization of water resource in the basins.*

Highlighting the importance of integrated water resources management, the policy under para 12.4 states that *Integrated Water Resources Management (IWRM) taking river basin / sub-basin as a unit should be the main principle for planning, development and management of water resources. The departments / organizations at Centre / State Governments levels should be restructured and made multi-disciplinary accordingly.*

Thus, taking cue from the above, it is clearly evident that Integrated River Basin Planning & Management / Integrated Water Resources Management is an methodology managing the water resources and for bridging the gap between the demand and supply.

The following strategy and framework are proposed:

Space and Scale	An approach should be developed with Natural Hydrologic Spatial Unit i.e. River Basin and its Sub Basins for some design period.
Enabling Environment	• Basin Management Plan and Vision • Participation and Coordination Mechanisms, Fostering Information Sharing and Exchange: Identify and involve stakeholders; Sustained relationship with stakeholders: • Capacity Building • Water Literacy for stakeholders Participation • Water law / water rights in place • Water Pricing • Public-Private-Partnership
Institutional Mechanism and Development	• Setting up of River Basin Organizations clearly defining the role, function and responsibilities. • Setting up of Water Regulatory Bodies to regulate the water supply during the lean period
Policies and Governance	• Convergence of Govt. of India Schemes under one umbrella • National Water Framework Act • Model Ground Water Act • Synergization amongst the various Organizations

Methodology	• Integrated Approach (multiple aspect integration) o Supply – Demand o Water: Surface & Ground Water o Water: Quality and Quantity o Upstream - Downstream o Land- Water- Environment o Multi-disciplinary o Multi-Sectoral Demands with Prioritization o Multi-Stakeholders o Linked with Disaster Management
Tools and Techniques	(i) **Water Resources Assessment** ✓ Data collection networks and assessment techniques ✓ Environmental Impact Assessment (EIA) techniques ✓ Risk management tools for instance of floods and droughts (ii) **Communication and Information** ✓ Raise awareness ✓ Informed stakeholders participation (iii) **Allocation and Conflict Resolution** ✓ Allocation through market instruments ✓ Allocation based on the valuation of costs and benefits ✓ Tools for conflict resolution: upstream vs downstream, sector vs sector, human vs nature (iv) **Regulatory Instruments** ✓ Direct controls –regulations, rights, standards, land use plans, utility regulations, etc. ✓ Economic instruments- prices, tariffs, subsidies, incentives, fees, charges, markets, taxes, etc ✓ Encourage self-regulation- transparent benchmarking, product labelling, etc. (v) **Technology** ✓ Research and Development ✓ Technology Assessment guidelines ✓ Technology Choice guidelines (vi) **Finance**

An example of successful IRBPM is the Murray Darling River Basin in Australia. The box below highlights some of the prominent features in the scheme.

Box 1.2
The Murray-Darling Basin Authority

The Murray-Darling Basin

- Possesses 23 river valleys covering 1 million square km, covering 14 per cent of Australia.
- The riparian five states and territories are New South Wales, Victoria, the Australian Capital Territory, Queensland, and South Australia.
- Provides one-third of Australia's food supply. It serves a population of 2 million inside the basin and 1.2 million outside the basin.
- The total average annual rainfall in the basin is 5,306 km^3: 94 per cent evaporates or transpires through plants, and 2 per cent drains into the ground, leaving only 4 per cent as runoff.
- The total volume of water storage capacity in the basin is around 350 km^3.
- First Murray-Darling Basin Commission was established in January 1988 under the Murray-Darling Basin Agreement to efficiently manage and equitably distribute River Murray water resources.
- The Water Amendment Act, 2008 (amendment to the Water Act, 2007) was introduced to transfer authority from the Murray-Darling Basin Commission to the Murray-Darling Basin Authority (MDBA), creating an independent, expert-based body that would manage the Basin holistically for the first time.
- Institutions involved are MDBA, basin states, the Australian Government Minister for Sustainability, Environment, Water, Population, and Communities.

Main Roles and Responsibilities

Since 2008, MDBA has been planning the integrated management of water resources of the Murray-Darling Basin. The Murray-Darling Basin Authority is an integral element of the Commonwealth Government's programme 'Water for the Future' which has four priorities: (i) tackling climate change, (ii) supporting healthy rivers, (iii) using water wisely, and (iv) securing water supplies.

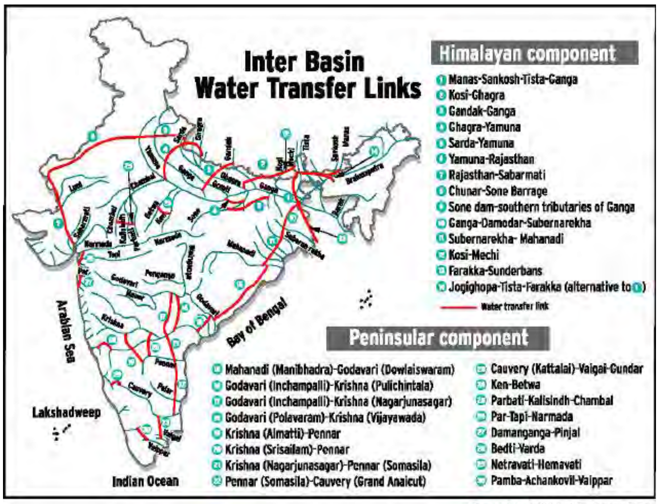
In addition to the commission's former functions, the Authority's role includes:

- Preparing the Basin plan for adoption by the Minister for Sustainability, Environment, Water, Population, and Communities.
- Implementing and enforcing the Basin plan.
- Advising the minister on the accreditation of state water resource plans.
- Developing a water rights information service which facilitates water trading across the Murray-Darling Basin.
- Measuring and monitoring water resources in the Basin.
- Gathering information and undertaking research.
- Educating and engaging the community in the management of the Basin's resources.

Source: Murray–Darling Basin Authority. Available at: http://www.mdba.gov.au/

Perhaps, an excellent example of integrated water resources planning in India is in the form of preparation of integrated plan for water resources development of Damodar Valley which is being implemented through **Damodar Valley Corporation** (1945). The initiative of establishment of **Bhakra Beas Management Board** (1967) is an excellent example of integrated management where the benefits are shared among various States namely Himachal Pradesh, Punjab, Haryana, Rajasthan and Delhi for various purposes namely domestic, hydropower, irrigation through an integrated operation policy. Although in a very limited manner, Tungabhadra Board (1953) for the operation of Tungabhadra reservoir, a project common to two States namely Andhra Pradesh and Karnataka, in a region which is highly sensitive to water demands, is also a classic example of cooperation through integrated plan and operation. An initiative for a systematic planning for Sone River Basin by adopting integrated approach was taken up with the constitution of Sone River Commission (1980). The constitution of Narmada Control Authority (1980) may also be regarded as a step forward towards integrated management of water resources of river Narmada and to ensure proper implementation of decisions and directives of NWDT Award.

3.4.3 Inter Linking of Rivers / Inter Basin Water Transfer



Source: National Water Development Agency

Inter-basin transfer of water in India is a long-term option to partly overcome the spatial and temporal imbalance of availability and demand of water resources. The transfer of water from surplus areas to deficit areas is not a new concept. Many such schemes have been implemented all over the world. In India too, projects like the Periyar–Vaigai system, Indira Gandhi canal and Telugu Ganga canal stand as classic examples of inter-basin water transfer. In the seventies, the Garland Canal proposal of Dastur and the Ganga–Cauvery Canal proposal of Dr. Rao were received with considerable attention. Some of the major benefits expected from inter linking of the rivers are:

- (i) Irrigation potential is to increase from 140 to 175 Mha;
- (ii) Drinking water availability is to increase by about 12 BCM;
- (iii) Peak flood discharge to get reduced by about 30% due to construction of reservoirs;
- (iv) Generation of 34,000 MW of electricity; and
- (v) Possibilities of inland navigation to provide cheap transport.

With IRBPM and IWRM in place this proposition and strategy will definitely see the light of the day.

3.5 CONCLUSION

Efforts were made through various broad-based methodologies viz. traditional, conventional and modern technology oriented techniques to solve the water scarcity problems as well as issues related to **food security**, **environmental protection** and **disaster management**.

On the one hand we found that the traditional practices were able to cater to the limited water uses like drinking and household use, minor irrigated agriculture etc. for a limited population. Interestingly they all were developed in the upper reaches of a river basin, small streams, rivulets, depressions etc. But they were not able to fulfill all the water demands of a developing nation like India including large scale food production, industrial production and energy requirement. Also burgeoning population growth along with urbanization put tremendous pressure on this invaluable resource.

Therefore, the large scale conventional methods were resorted upon and to a greater extent such water resource development and augmentation projects stood the test of time. These were developed mostly in the major rivers and the natural depressions en route formed the reservoirs. It must be borne in mind that we have not yet been able to tap and harness the total utilizable water in the country because of lack of feasible and appropriate storage spaces and other concomitant issues like Rehabilitation & Resettlement, Land Acquisition, Environment and Forest Clearances etc. as well.

Interestingly, newer adversities cropped up making the scenario further complex and challenging viz. environmental degradation, climate change, over-exploitation of ground water resources, water use inefficiency, operation and maintenance issues etc. which could not be handled by large scale supply based conventional methods alone. This paved the way for demand side management techniques and application of technology through various modern methods like micro irrigation, waste water treatment and reuse, use of water saving appliances, piped irrigation etc.

There has been a plethora of innovative techniques and management practices both large scale and small scale evolving since then like that of production of desalinated water, water market, participatory irrigation management, benchmarking techniques of irrigation projects and many others. Mostly the application of such methods was sporadic, disintegrated and localized.

In the light of further complicated challenges like water conflicts, social and environmental activism, strained external relationship with neighbouring countries, frequent occurrences of extreme events like droughts and floods etc. all the time-tested water conservation and management practices yielded little results. This does not mean that those traditional-conventional methods and innovative ideas have outlived their impact and edge. It only indicates that the strategy followed was not correct, in fact we had no strategy as such.

Also, it must be appreciated that such methods may be at conflicting terms with each other for e.g. haphazard developments in traditional practices will affect the upstream catchment area and may lead to reduced water collection and storage in the downstream reservoir created through conventional methods. Therefore, at the end the pressing need for an Integrated River Basin Planning and Management has been stressed wherein the best of all the past and upcoming practices need to be amalgamated.

The only way to cater effectively to the future challenges of water sector lies in an appropriate Master Plan for a River Basin which must be robust enough to absorb the more likely spatial and temporal variations of precipitation events (due to climate change) in such a large hydro-meteorological scale to effectively address the floods and droughts within the unit. Various scenario based modeling need to be developed for the river basin along with its sub-basins for which the relevant data collection, collation, analysis, interpretation and dissemination need to be dynamic, real time and accurate. This would support in informed and effective decision making.

Further, the inter basin transfer of water would be more feasible and realistic in such an era of River Basin Approach/Framework through which the regional or inter basin fluctuations could be managed by scientifically identifying the surplus and deficit basins taking into consideration the water requirements and future needs as well.

Of course for that we need proper water governance mechanism in place, effective water policy in vogue, clear constitutional mandate for different institutions, stakeholder participation in decision and action, integrated approach at all levels and a very essential enabling environment for thriving of such system. Undoubtedly, for smooth and sustainable running of such machinery, constant research and development need to supplement the process.

Before concluding it must be emphasized that the role of Private Sector is also going to be very crucial in the coming era and Public-Private-Partnership in water sector holds tremendous potential and promise. Simultaneously, the significance of hydrological, demographical, meteorological and other relevant data for modeling purpose at river basin level (event based or continuous) cannot be over-emphasized as it can definitely be linked to prediction of precipitation events and help us in preparedness and resilience towards disaster management like floods and droughts.

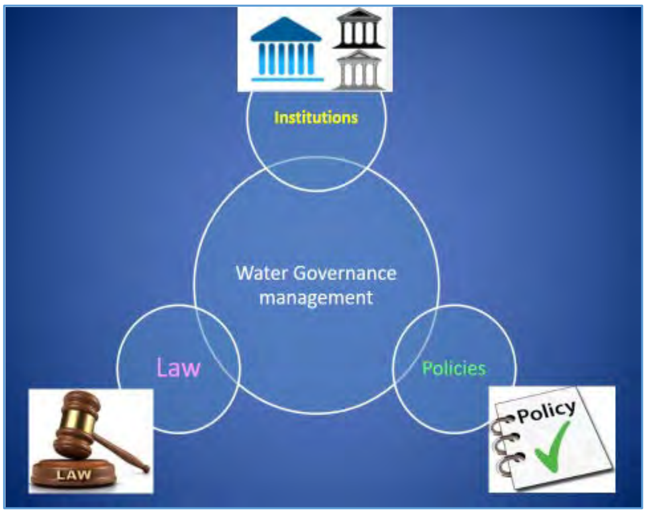
To bridge the gap between supply and demand of water in coming future, integrated water resource management (IWRM) seems to be the only way out as a prudent strategy of water conservation and management, in which different river basins will have different master plans integrating the various traditional, conventional and modern innovative methods applicable in that basin. Concerted and deliberate attempt need to be taken in that direction as early as possible for heading towards **Water Security from Water Scarcity**.

Chapter 4

Water Conservation and Management in India: Governance Issues in Water Management

4.0 INTRODUCTION

The Water Resources Management & Governance scenario in India is undergoing structural changes for at least three reasons. **Firstly**, in the case of surface water, allocation equals or exceeds available water; in case of groundwater, extraction exceeds recharge. This makes the allocation of water in space& time, and over different regions, sectors and social groups increasingly inter-linked and complex. "Complexity" has two meanings in this regard. The first is that the interdependencies in water management are intensifying, creating more externalities and factors which influence decisions. The second meaning is that, partly as a result of this, that water management is increasingly becoming a contest between competing ideologies. Interests of burgeoning population are required to be weighed against the increasing concerns of social, environmental & ecological issues connected with water resources development. **Secondly**, India is changing through rapid urbanization and industrialization, giving rise to new priorities and demands in water use, and a changing economic and political role of agricultural water allocation. Because agriculture in India is the dominant freshwater user (about 80-84 % of total utilizable water), it is a safe prediction that the agriculture water sector will have to accept lower allocations in the future. This puts new emphasis, both on the efficiency of water use in agricultural cultivation, and on the equity dimensions of its distribution.



Thirdly, though water resources management is inherently a localized phenomenon, global ideas and concerns are increasingly entering Indian water policy and politics(e.g Integrated Water Resources Management (IWRM) concepts, Irrigation Management Transfer(IMT), Right to water & sanitation etc.), and appropriated and embedded in domestic discourse and practice in a variety of ways.

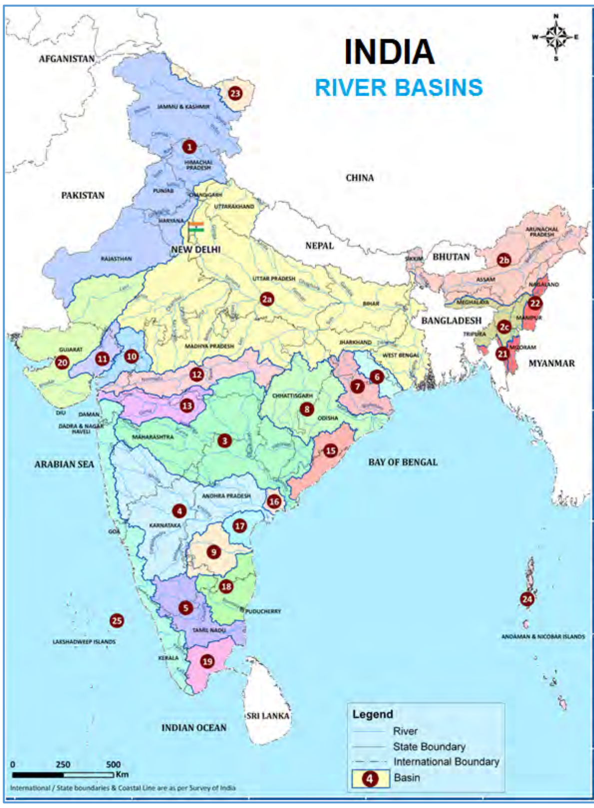
Water Governance in India must be responsive to the changes happening in the water sector. It should adapt itself to face the upcoming challenges & respond to the governance issues which are hampering the development & management of this precious resource.

Water Governance in general encompasses the legal & policy framework along with Institutional mechanism, implementation tools & strategies. The current legal framework pertaining to water in India is fragmented and spread across a variety of instruments, legislation, legal principles, both from the colonial and post-colonial times, as well as customary mechanisms, and a number of judicial precedents, not necessarily in harmony with each other.

4.1 CONSTITUTIONAL PROVISIONS AND EXISTING LAWS IN INDIA WITH RESPECT TO WATER

The water resources development & management during post-independence era has thrown up many important legal issues, starting from the provisions in the constitution to inadequacies in central and state laws and need for new law. India, a union of states, is a sovereign, secular, socialist, democratic republic with a parliamentary form of government. Indian Constitution provides power to the states to develop the water resources within their boundaries subject to parliament empowering union government to regulate and develop inter-state rivers to the extent to which such regulations and development is declared by the parliament by law to be expedient in the public interest.

All the major river basins, covering about 78% of the geographical area of the country and some among the forty six medium river basins are inter-state having their drainage area lying in more than one state or union territory. So the constitutional provisions pertaining to Inter State Rivers have wider and far reaching ramifications.



Code	Basin Name
1	Indus (Up to border) Basin
2a	Ganga Basin
2b	Brahmaputra Basin
2c	Barak and others Basin
3	Godavari Basin
4	Krishna Basin
5	Cauvery Basin
6	Subarnarekha Basin
7	Brahmani and Baitarni Basin
8	Mahanadi Basin
9	Pennar Basin
10	Mahi Basin
11	Sabarmati Basin
12	Narmada Basin
13	Tapi Basin
14	West flowing rivers South of Tapi Basin
15	East flowing rivers between Mahanadi and Godavari Basin
16	East flowing rivers between Godavari and Krishna Basin
17	East flowing rivers between Krishna and Pennar Basin
18	East flowing rivers between Pennar and Cauvery Basin
19	East flowing rivers South of Cauvery Basin
20	West flowing rivers of Kutch and Saurashtra including Luni Basin
21	Minor rivers draining into Bangladesh Basin
22	Minor rivers draining into Myanmar Basin
23	Area of North Ladakh not draining into Indus Basin
24	Drainage Area of Andaman and Nicobar Islands Basin
25	Drainage Area of Lakshadweep Islands Basin
26	Island Basin

Constitutional provisions pertaining to the water are the main basis of legislative and executive framework which governs the use, development & management of India's water resource. Laws relating to water in India have diverse origins, including ancient local customs and the British Common Law and GOI Act 1935. The major constitutional provisions pertaining to water are as follows:

- ***Article 263*** of the Constitution of India provides for coordination between the States and therefore establishment of Inter-State Council. But Article 263 is a general provision and Article 262 is a special provision dealing with disputes regarding water of the inter-state rivers and river valleys. Special provision overrides the general provision and therefore Article 262 is important for inter State water disputes resolution and overall water sector development of Inter State Rivers.
- ***Article 262***
  Disputes relating to Water– Adjudication of disputes relating to waters of inter-State rivers or river valleys:
  1. Parliament may by law provide for the adjudication of any dispute or complaint with respect to the use, distribution or control of the waters of, or in, any inter-State river or river valley.
  2. Notwithstanding anything in this Constitution, Parliament may by law provide that neither the Supreme Court nor any other court shall exercise jurisdiction in respect of any such dispute or complaint as is referred to in clause (1)
- **Entry No. 56 (List I), Entry No. 17 (List II)**
  - ✓ *Entry 17 of List II (State List) of the Seventh Schedule*
    Water, that is to say, water supplies, irrigation and canals, drainage and embankments, water storage and water power subject to provisions of entry 56 of List I.
  - ✓ *Entry 56 of List I (Union List) of the Seventh Schedule*
    Regulation and development of inter-state rivers and river valleys to the extent to which such regulation and development under the control of the Union is declared by Parliament by law to be expedient in the public interest.

Entry No. 56 of the Union List of the Union list, is preferentially applicable to the Inter-state River and river valleys. It is also pertinent to note that the land and the water within the state are under the exclusive jurisdiction of the State. But the rivers which flow from one state to other state or states are inter-state rivers because of the flowing nature of the water.

4.1.1 Other Water Related provisions in the Constitution of India

- *Fundamental Rights*
  - ✓ There is no direct mention of "Right to water" in our constitution, however Right to potable drinking water is being interpreted by Courts as

part of "Right to life and personal liberty" guaranteed under **Article 21** of the Constitution.

- ✓ Right to equality before the law and equal protection of the laws guaranteed under ***Article 14*** would require non-discrimination and absence of arbitrariness in the matter of access to water. ***Article 15(2)(b)*** prohibits the State of discrimination, on grounds only of religion, race, caste, sex, place of birth or any of them, subject to any disability, liability, restriction or condition with regard to the use of wells, tanks, bathing ghats maintained wholly or partly out of State funds or dedicated to the use of the general public.

- o *Directive Principles of State Policy*
  - ✓ **Article 39(b)** directs the State to adopt policies with a view to secure that the ownership and control of the material resources of the community are so distributed as best to sub serve the common good.
- o *Fundamental Duties*
  - ✓ ***Article 51A*** imposes the duty on every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for all living creatures.
- o *Eleventh Schedule (Powers of Panchayats: **Article243G**)*
  - ✓ 3. Minor irrigation, water management and water-shed development
  - ✓ 11. Drinking water
  - ✓ 13. Roads, culverts, bridges, ferries, waterways and other means of communication
  - ✓ 29. Maintenance of community assets
- o *Twelfth Schedule (Powers of Municipalities: **Article 243W**)*

  5. Water supply for domestic, industrial and commercial purposes

- o *Centre's control over State Legislation*

  Though States are free to legislate on matters in the State List, the Centre can exercise control on State legislation. Thus, ***Article 200*** empowers the Governor of the State to reserve any Bill passed by the Legislature of the State, for consideration of the President. There are other provisions also (***Article 288(2)*** and ***304(b)*** where laws passed by State would become law only if assented to by the President.)

- *Administrative Relations between the Union and the States:*

  Article 256*: Obligations of States and Unions:*

  The executive power of every State shall be so exercised as to ensure compliance with the laws made by Parliament and any existing laws which apply in that state and the executive power of the Union shall extend to the giving of such directions to a State as may appear to the Government of India to be necessary for that purpose.

4.1.2 Other Constitutional provisions for enacting laws relating to Water

- ***Article 252:*** Power of Parliament to legislate (on state subjects) for two or more States by consent and adoption of such legislation by any other State.
- ***Article 253:*** Parliament has power to make any law for the whole or any part of the territory of India for implementing any treaty, agreement or convention with any other country or countries or any decision made at any international conference, association or other body.

Indian Constitution is our fundamental law. All other laws passed by the Central or State legislative authorities as well as all subordinate legislations have to conform to the constitutional provisions. Whichever legislation or part of it falls outside the ambit of the constitutional provision, becomes unconstitutional and hence can be declared as illegal and inoperative.

4.2 EXISTING CENTRAL LEGISLATIONS

Some of the Acts enacted by the Parliament, under specific provisions related to water as well as under other constitutional provisions, are described below:

4.2.1 River Board Act, 1956:

This act has been enacted in pursuance of the Article 246, entry No. 56 of the constitution. The Government of India in 1956, just six years after the adoption of Constitution, enacted the River Boards Act, which made provisions for establishment of river boards for regulation and development of inter-state rivers and river valleys. However, the power to do so has been limited due to the following provision:

> *'Provided that no such notification shall be issued except after consultation with the Governments interested with respect to the proposal to establish the Board, the persons to be appointed as members thereof and the functions which the Board may be empowered to perform"*

The River Boards Act provides for the establishment of River Board, one or more, by the Central Government, either on request by the State or otherwise, by notification in the

Official Gazette, for advising the Government concerning the regulation and/or development of Inter-State Rivers and River Valleys.

No single River Board has been constituted yet under this Act. A new act namely, River Basin Management Bill, 2012, which will overcome some of the weaknesses of this act is under active consideration of the Union Government. Details of this bill are given in Para 10.2.

4.2.2 Inter-State Water Dispute Act, 1956:

This act has been enacted under the Article 262 of the constitution. The Preamble of this Act states that,

> *"This is an Act to provide for the adjudication of disputes relating to waters of Inter State Rivers or River Valleys."*

Inter-State River is a river which flows through more than one state and the river which starts and ends by itself in one state only is a State River.

Under this Act, water dispute means any dispute or difference between two or more state governments with respect to:-

- The use, distribution or control of the waters of, or in, any inter-state river or river valley; or
- The interpretation of the terms of any agreement relating to use, distribution or control of such waters or the implementation of such agreement; or
- The levy of any water-rate in contravention of the prohibition contained in Section 7 of this Act.

If such a dispute arises between two or more States then, any of the State or States may request the Central Government to refer the water dispute to a Tribunal for adjudication. Such complaints can be made by State or States, if it is likely to be affected prejudicially by:

i) Any executive action or legislation taken or passed, or proposed to be taken or passed, by the other State; or

ii) The failure of the other State or any authority therein to exercise any of their powers with respect to the use, distribution or control of such waters; or

iii) The failure of the other State to implement the terms of any agreement relating to the use, distribution or control of such waters.

On receipt of any such complaint, if the centre feels that such dispute cannot be settled by negotiation with the disputing states then Central Government shall constitute a Water Disputes Tribunal for adjudication of the water dispute; by a notification in the Official Gazette. Such a Tribunal consists of a chairman and two other members, nominated by the Chief Justice of India, who, at the time of nomination, are judges of the Supreme Court or of a High Court. Such a Tribunal may appoint two or more persons as assessors to advice in the proceedings before it. So also the Central Government, is given the power to make Rules after consultation with State Government and by notification in the official Gazette, to carry out the purposes of this Act. Such Rules are required to be laid before each house of the parliament to get their sanction.

The Tribunal has to investigate into the matters referred to it by the Central Government and the concerned States are to cooperate with the Tribunal in the matters of investigation.

The Tribunal has to submit its report to the Central Government giving its decision on the points of facts found by it in the investigation. The Central Government shall publish the decision of the Tribunal in the Official Gazette and then the decision shall be final and binding on the parties thereto and shall be given effect to by them.

The Central Government may also frame a Scheme/s for all matters necessary to give effect to the decision of the Tribunal. There is also provision to establish an authority with special rights to implement the decision of the tribunal. (e.g. Narmada Control Authority.)

After the finalization of the report and decision of the Tribunal, the Central Government shall dissolve the Tribunal.

As per the authority of clause (2) of Article 262 of the Constitution, the parliament has provided in this Act for the exclusion jurisdiction of Supreme Court(SC) and all other courts regarding water disputes which may be referred to a Tribunal in the following words. Section 11 of the said Act states as follows:

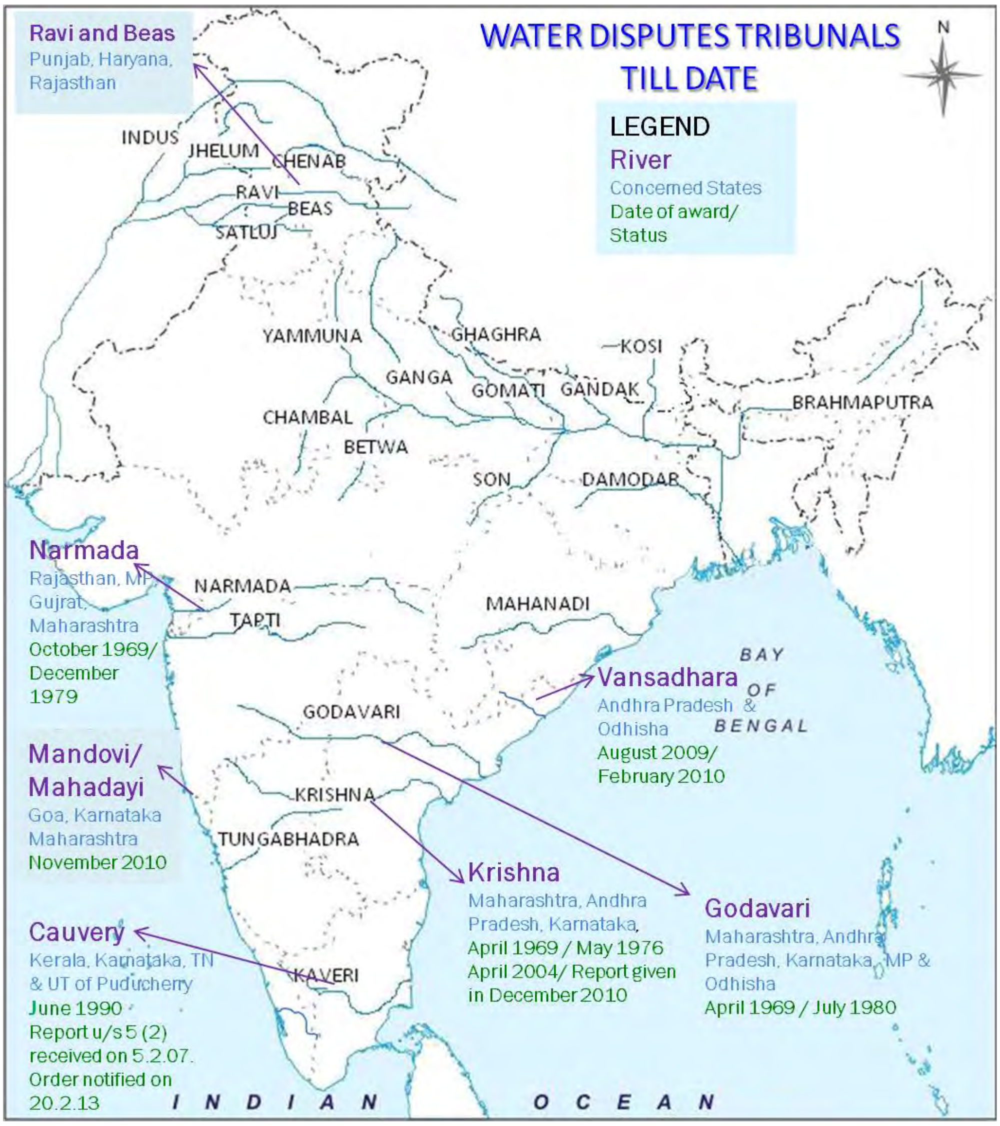
> ***Bar of Jurisdiction of Supreme Court and other Courts:*** *"Notwithstanding anything contained in any other law, neither the Supreme Court nor any other Court shall have or exercise jurisdiction in respect of any water dispute which may be referred to a Tribunal under this Act"*

In-spite of this, States approach SC and SC also admits the SLPs. The routes adopted are Article 131 & Article 136. The Observations of SC in this regard are:

- This Court has the jurisdiction to decide the scope of the powers of the Tribunal under the Act and in case the Tribunal has wrongly refused to exercise jurisdiction under the Act, then this Court is competent to set it right and direct the Tribunal to entertain such application and to decide the same on merits.
- The Tribunal is a statutory authority constituted under an Act made by the Parliament and this Court has jurisdiction to decide the parameters, scope, authority and jurisdiction of the Tribunal. It is the judiciary i.e. the courts alone

have the function of determining authoritatively the meaning of a statutory enactment and to lay down the frontiers of jurisdiction of anybody or Tribunal constituted under the Statute.

Various Inter-State Water Disputes Tribunals have been constituted by the Union Govt. under this act for resolution of specific river basin disputes. The details of these Tribunals are as follows.



4.2.3 Amendments of the Inter State Water DisputeAct

- ✓ The Act was amended in 1980 and Section 6A was inserted to accommodate directions of NWDT. This Section provides for framing a scheme for giving effect to a Tribunal's award.
- ✓ The Act was amended in April, 1986 to set up a Tribunal known as "Ravi Beas Waters Tribunal", suo moto, or on the request of concerned State Government and Section 14 was inserted.

- ✓ The Act was further amended in August, 2002 as a follow up to the Recommendations of **Sarkaria Commission on Centre State relations**.
  - The tribunal has to be now constituted within a period of one year from the date of receipt of request.
  - The Tribunal has to submit report within a period of three years which could be extended for a further period not exceeding two years.
  - The Tribunal has to submit further report within a period of one year(On the clarifications sought by States) which can be extended for a further period as it considers necessary.
- ✓ As per Section 6 (2), the decision of the Tribunal, after its publication in the Official Gazette, shall have the same force as an order or decree of the Supreme Court.
- ✓ Central Government is also required to maintain a data bank and information system.
- ✓ The Act was renamed as Inter-State River Water Disputes (ISRWD) Act, 1956.
- ✓ The amendment to the ISRWD Act, 1956 made so far are essentially to meet specific situation.

4.2.4 The Water (Prevention and Control of Pollution) Act 1974

The Water (Prevention and Control of Pollution) Act, 1974 was enacted as per Article 252 of the constitution for prevention of pollution of water due to discharge of liquid effluents from industries. Subsequently, another Act namely **Water (Prevention and Control of Pollution) Cess Act 1977** was also enacted as per Article 252 for enabling the effective implementation of the earlier Act. The Act incorporates provisions for creating Central and State Pollution Control Boards. All the states adopted the Act by 1990 and *State Pollution Control Boards of the respective states were inter-alia set up under the Act.* Central and state Pollution Control Boards adopted the environmental norms for water discharge from different types of sources. This Act contains specific provision for prohibiting the use of stream or well for disposal of polluting matter, prescribing restrictions on new outlets and new discharges, laying down rules regarding existing discharge of sewerage or trade effluents, emergency measures in case of pollution of stream or well and power of the Board to make application to courts for restraining apprehended pollution of water in streams or wells. The said Act also prescribes powers and functions of the Pollution Control Boards to take various steps and measures for regulating the prohibition, prevention and control of water pollution. Some states have also enacted separate water pollution Acts e.g. Orissa River Pollution Prevention Act, 1953 and Maharashtra Prevention of Water Pollution Act, 1969.

The Water (Prevention and Control of Pollution) Act, 1974, as amended in 1978, makes even the companies and the Heads of the Government Departments punishable under the said Act, if the offences under that Act are found to have been committed by a company or a Government Department, as the case may be. Moreover, if the State Government, after consultation with, or on the recommendation of the State Boards, is of the opinion that the provisions of this Act need not apply to the entire State, it may, by notification in the Official Gazette restrict the application of this Act to such area or areas as may be declared therein. The provisions of this Act shall apply only to such control area or areas.

4.2.5 The Environment (Protection) Act (EPA), 1986

The Environmental (Protection) Act (EPA), 1986 was passed by the Union Parliament in 1986under article 253 of the constitution and was notified by the Union Ministry of Environment and Forests. The act was passed in the wake of Bhopal Gas Tragedy, to implement Stockholm Declaration of UN conference on Human Environments, to which India is a signatory. This Act covers different facets of "environment" including water as well as items interrelated to water.

In exercise of the powers conferred by this act, the Central Government has constituted an authority known as "**Water Quality Assessment Authority (WQAA)**". It consists of members drawn from the concerned ministries like Ministry of Environment and Forests and Ministry of Water Resources.

The **Central Ground Water Authority (CGWA)**, constituted under Environment (Protection) Act of 1986 has been a major institution created for regulating over-exploitation of ground water. In view of its importance, its salient features and activities would be discussed in a separate section in this chapter.

For the protection of coastal environment in India, including ground water resources, a Coastal Regulation Zone Notification (CRZ), 1991 has been issued. National Coastal Zone Management Authority and State Coastal Management Authorities constituted under the Environment Protection Act (1986) are other legal bodies for overall protection of costal environment including ground water.

4.3 GROUND WATER REGULATION

Governing the groundwater has become a growing challenge in large parts of the country where the water table is steadily sinking. The pressure on the available groundwater resources necessitates sound, scientifically based regulations to prescribe behaviour relating to use and abuse. Legal frameworks play a crucial role for efficient governance, for turning policy decisions into rights and obligations, and as a democratic basis for control and accountability. In practice Groundwater is usually treated as a state subject as the Constitution of India does not empower Central Government to directly deal with its management.

4.3.1 Legal Position

Unlike several countries, India does not have any separate and exclusive ground water law dealing with various water resources and covering all aspects. Instead the water related legal provisions are dispersed across various irrigation acts, central and state laws, orders/decrees of the courts, customary laws, case laws and various penal and criminal procedure codes. As a result, understanding of the exact legal position with respect to ground water becomes rather cumbersome.

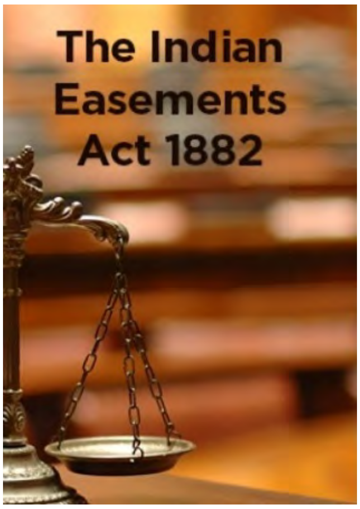
Moreover, India does not have any explicit legal framework specifying water rights. The Supreme Court of India has, however, interpreted Article 21 of the Constitution of India to include the right to water as a fundamental right to life. The Easement Act of 1882 made all rivers and lakes the absolute right of the state. But as per the provisions of the Easement Act 1882 as usually understood and the Transfer of the Property Act of 1882, a land owner is supposed to have a right to ground water beneath his land as it is considered as an easement of the land. So, the land owners own the ground water on their lands. Ground water was considered an easement connected to land: he/she who owns the land, owns the ground water beneath the land. Ownership of ground water is transferred along with the transfer of ownership of land. Thus, ground water is viewed as an appendage to land. This absolute ownership concept has allowed unlimited withdrawals of ground water beneath the land by the owners. There is no limitation on how much ground water a particular land owner may draw. As a result, a person is free to draw water more than his/her personal requirement and sell the same in the market. Moreover, the landless have no right on ground water. Similarly the tribal who have no ownership right over land have no right on ground water.

The legal aspects governing ground water resources have continued to remain the same despite substantial changes in ground water scenario that have taken place since then. Rapid expansion in the exploitation of ground water resources in India for irrigation and other uses has led to an over-exploitation of ground water in several parts of the country. As a result, the above law is no longer in harmony with resource sustainability and economic requirement.

It may, however, be mentioned that the Directive Principles of State Policy [Article 39 (b)] of the Indian Constitution has made it incumbent on the state to ensure that the ownership and control of the material resources of the community are so distributed as to sub-serve the common good in the best possible manner.

Moreover as already pointed out, since the Constitution does not have an entry relating to 'Environment', using the residual powers, the Union has enacted laws on environment and control of pollution, which have effects on water use, including ground water and its exploitation. Moreover, a correct understanding of the Easement Act 1882 implies that it does not give unlimited power to the land owner to exploit ground water regardless of the adverse effects on other users.

4.3.2 The Indian Easement Act 1882



Though this act is of British times, it remains in force after Independence as per the article 372 of the constitution. An easement is a right which the owner or occupier of certain land possesses as such for the beneficial enjoyment of that land, to do and continue to do something or to prevent and continue to prevent something being done, in or upon, or in respect of, certain other land not his own.

In the first and second clauses of this section, the expression "land" includes also things permanently attached to the earth, the expression "beneficial enjoyment" includes also possible convenience, remote advantage, and even a mere amenity, and the expression "to do something" includes removal and appropriation by the dominant owner, for the beneficial enjoyment of the dominant heritage, of any part of the soil of the servant heritage, or anything growing or subsisting thereon.

Section 7(g) the Indian Easement Act, 1882 which came into force in July 1882, states that (a) "The right of every owner of land to collect and dispose within his own limits of all water under the land which does not pass in a defined channel and all water on its surface which does not pass in a defined channel". This clause explicitly relates to ground water and is the basis for prevailing thinking that land owners have absolute rights over water underneath their land. The provision has been based on the common English law under which ground water is viewed as an easement connected to land. (b) The Act also contains several provisions regarding natural streams which include underground streams also as per explanation provided in the Act which states that "a natural stream is a stream whether permanent or intermittent, tide or tideless, on the surface of land or underground, which flows by the operation of nature only and in a natural and known course".

A close reading of the above clauses shows that, the Easement Act does not permit land owners ownership of ground water if it is passing in a defined channel. As much of ground water is a dynamic resource which flows through defined channels, owners of land cannot claim absolute ownership over water under their land. A proper implementation of this Act would require authorities to provide information whether ground water in an area is passing through a defined channel. This is not done presumably because most parts of ground water pass through defined channels with the result that the more one person withdraws ground water from his/her land, the less ground water becomes available to the person owning the neighbouring land.

4.3.3 Central Ground Water Authority

CGWA was set up on 14th January, 1997 by the Ministry of Environment and Forests, Government of India in pursuance of an order of the Hon'ble Supreme Court of India dated 10th December, 1996 on a PIL. Authority has been established under sub-section (3) of Section 3 of the Environment (Protection) Act, 1986. The authority is headed by a Chairman, has eight members and a member secretary.

The Authority has been empowered to exercise the powers and perform the following functions:- (i) Exercise powers under Section 5 of the Environment (Protection) Act, 1986. The Authority can issue directions in writing to any person, officer or any Authority and such persons, officer or Authority shall be bound to comply with such directions. For example – The Authority has power to direct the closure, prohibition or regulation of any industry or process and also the stoppage or regulation of the supply of electricity or water or any other service. (ii) To resort to the penal provisions contained in Section 15 to 21 of the Environment (Protection) Act, 1986. In Sections from 15 to 21 of the Act, it has been summarized that penalty should be levied in avoidance of the rules, orders and directions of the Act, if it is by companies or Government Departments &every person, who at the time the offence was committed, was responsible for avoidance. (iii) To regulate indiscriminate boring and withdrawal of ground water in the country and to issue necessary directions with a view to preserve and protect the ground water.

Areas of Activities of CGWA To achieve the mandate, the Authority has divided its functions into following mentioned four sub-heads. These are detailed as follows.

(a) Regulation of ground water.

- i) Extraction of ground water development
- ii) Construction of wells
- iii) Registration of ground water abstraction structures
- iv) Performance of business of drilling wells
- v) Sale of ground water

(b) Conservation of ground Water Conservation and artificial recharge of ground water including roof-top run-off harvesting storm water recharge and by other means etc.

(c) Protection of Ground Water

- (i) Protection of ground water quality deterioration from disposal of urban and industrial wastes.
- (ii) Management of ground water in coastal aquifers.
- (iii) Clearance of solid & liquid waste disposals sites.

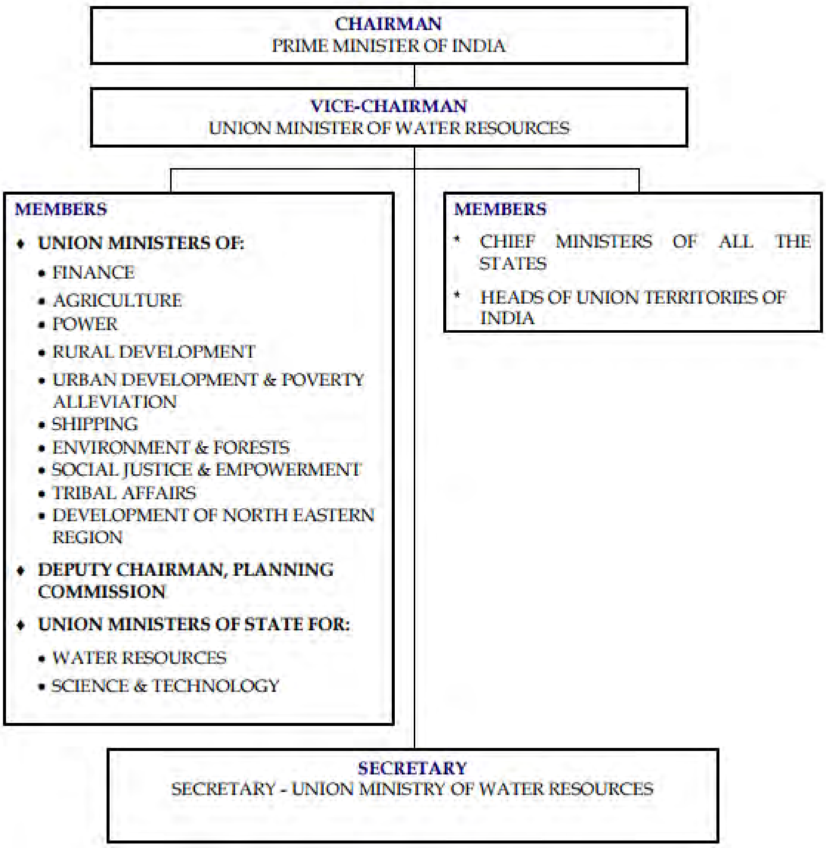
(iv) Clearance for setting up of ground water based industries.

(d) Mass Awareness

4.4 NATIONAL WATER POLICY

Water, which is vital for sustenance of all forms of life and economic development, is becoming an increasingly scarce resource in the country. The planning and execution of water resources development projects have by and large been carried out by individual states. As the major rivers in our country are inter-State in nature, it has not been possible for individual States to prepare Master Plans in respect of these rivers. It was felt that planning at national level for utilization of water resources should be undertaken so that the greatest good is achieved and optimum benefits derived from the available water resources.

The necessity for an apex body to evolve national policies for development and use of water resources in conformity with the highest national interests was emphasized by various authorities including the Irrigation Commission, National Commission on Agriculture and Rashtriya Barh Ayog. The **National Development Council** at its meeting held on 14th March, 1982 also discussed the matter and the Council observed that a climate should be created in which National Water Plans are prepared keeping in view the National Perspective as well as State and Regional needs. In that context, the Council welcomed the proposal of the Government of India for setting up of **National Water Resources Council** (NWRC).Accordingly, NWRC was set up on 10th March, 1983 under the Chairpersonship of Prime Minister of India with following composition:



A National Water Board, chaired by Secretary, Ministry of water Resources was also constituted to provide support to the NWRC.

The functions of the National Water Resources Council are as follows:

(a) To lay down the National Water Policy and to review it from time to time.
(b) To consider and review water development plans submitted to it (including alternative plans) by the National Water Development Agency, the River Basin Commissions, etc.
(c) To recommend acceptance of water plans with such modifications as may be considered appropriate and necessary.
(d) To direct carrying out such further studies as may be necessary for fuller consideration of the plans or components thereof.
(e) To advise on the modalities of resolving inter-State differences with regard to specific elements of water plans and such other issues that may arise during planning or implementation of the projects.
(f) To advise practices and procedures, administrative arrangements and regulations for the fair distribution and utilization of water resources by different beneficiaries keeping in view optimum development and the maximum benefits to the people.
(g) To make such other recommendations as would foster expeditious and environmentally sound and economic development of water resources in various regions.

4.4.1 National Water Policy, 1987

The NWRC adopted the first National Water Policy in its 2nd meeting held in September, 1987.

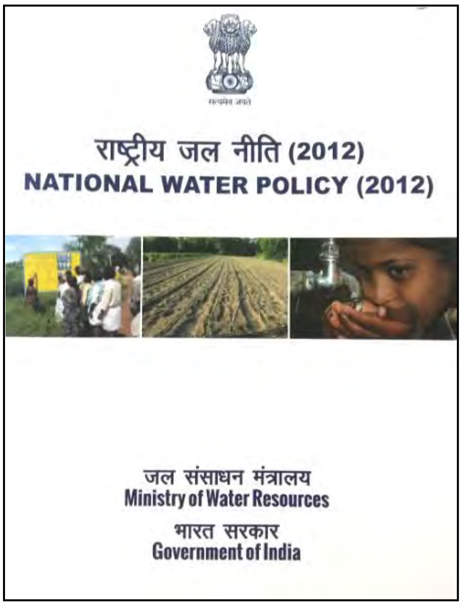
4.4.2 National Water Policy, 2002

After adoption of NWP 1987, new challenges emerged in the water resources sector, which necessitated review of the National Water Policy. Accordingly, the revised National Water Policy 2002 was adopted by the National Water Resources Council in its 5th meeting held on 1st April 2002.

4.4.3 National Water Policy, 2012

India is faced with the challenge of sustaining its rapid economic growth while dealing with the global threat of climate change. While engaged with the international community to collectively and cooperatively deal with this threat, India needed a national strategy to firstly, adapt to climate change and secondly, to further enhance the ecological sustainability of India's development path.

In pursuance to the strategy identified in National Water Mission Document as well as deliberations in National Water Board, Ministry of Water Resources had initiated the process of review of National Water Policy, 2002. A series of consultation meetings were held with all stakeholders.



A Drafting Committee Chaired by Dr. S.R. Hashim, former Member, Planning Commission and Chairman, UPSC drafted the National Water Policy. More than 600 comments were received on the Draft National Water Policy (2012). These comments along with newspaper reports, etc., were considered by the Drafting Committee and accordingly, Revised Draft National Water Policy (2012) was recommended.

Revised Draft National Water Policy (2012) was considered by the National Water Board (NWB), wherein modifications were suggested and modified Draft National Water Policy (2012) was recommended to National Water Resources Council (NWRC) for adoption and finalization.

Modified Draft National Water Policy (2012) recommended by NWB was considered by the NWRC in its 6th meeting Chaired by the Hon'ble Prime Minister on 28.12.2012. The NWRC adopted the National Water Policy (2012) as per the deliberations at the Council Meeting. The adopted National Water Policy (2012) was released during India Water Week, 2013.

4.4.4 Objective of NWP-2012

The objective of the National Water Policy is to take cognizance of the existing situation, to propose a framework for creation of a system of laws and institutions and for a plan of action with a unified national perspective.

4.4.5 Concerns on the present scenario of water resources and their management in India

- Issues related to water governance have not been addressed adequately.
- Wide temporal and spatial variation in water availability may increase further due to climate change.
- Climate change may also increase sea levels which may lead to salinity intrusion in GW aquifers/ SW and inundate coastal regions.
- Groundwater, though part of hydrological cycle and a community resource, is still perceived as an individual property and is exploited inequitably and without any consideration to its sustainability leading to its over-exploitation in several areas.
- Access to safe water for drinking and other domestic needs still continues to be a problem in many areas. Skewed availability of water between different regions and different people in the same region and also the intermittent and unreliable water supply system has the potential of causing social unrest.
- Inter-regional, inter-State, intra-State, as also inter-sectoral disputes in sharing of water, strain relationships hamper the optimal utilization of water through scientific planning on basin/sub-basin level.

- Inadequate sanitation and lack of sewage and effluent treatment are polluting the water sources.
- The public agencies in charge of taking water related decisions tend to take these on their own without consultation with stakeholders, often resulting in poor and unreliable service characterized by inequities of various kinds.

4.4.6 Basic principles for WRPD&M

- Integrated perspective considering local, regional, state & national contexts
- Equity and social justice must be factored in use and allocation of water
- Meaningful, intensive participation, transparency and accountability should guide decision making and regulation of water
- Water as common pool community resources held by the state under public trust doctrine
- Planning on the basis of Hydrological unit
- Due consideration to Minimum Ecological needs
- Safe drinking water, sanitation needs defined as pre-emptive need for water; high priority allocation for other domestic needs (including needs of animals), achieving food security, supporting sustenance agriculture and minimum eco-system needs; thereafter water as an economic good to promote its conservation and efficient use.
- More emphasis on demand management through maximum efficiency in use of water and avoiding wastages
- Water quality and quantity inter-related.
- Climate changes need to be factored into water management related decisions.

Highlights of the important provisions contained in the NWP-2012 on various aspects of water resources planning, development and management are given below:

- **Water Framework Law** : Need to evolve a National Framework Law as an umbrella statement of general principles; Comprehensive legislation for establishment of basin authorities, comprising party States, with appropriate powers to plan, manage and regulate utilization of water resource in the basins.
- **Uses of Water**: Governance institutions must ensure access to a minimum quantity of potable water for essential health and hygiene to all its citizens, E-flow to meet ecological needs based on scientific study.
- **Adaptation to Climate Change:** Through increasing water storage in its various forms, namely, soil moisture, ponds, ground water, small and large reservoirs and their combination. Also through enhancing the capabilities of the community to adopt climate resilient technologies.
- **Enhancing Water Available for Use :** Periodical assessment of water resource on scientific basis, need for aquifers mapping, introducing improved technologies of water use, incentivizing efficient water use, artificial recharging and encouraging community based management of aquifers. Inter-basin transfers of water should be considered on the basis of merits of each case after evaluating the environmental, economic and social impacts of such transfers.

- **Demand Management and Water Use Efficiency :**An institutional arrangement for promotion, regulation and evolving mechanisms for efficient use of water; Recycle and reuse of water, water-conserving crop patterns, Water saving in irrigation use be of paramount importance, advanced irrigation to be encouraged and incentivized.
- **Water Pricing :**Pricing of water should ensure its efficient use and reward conservation. Allocation & pricing should be through independent statutory Water Regulatory Authority (WRA), to be set up by each State; water charges should be on volumetric basis; Recycle and reuse of water should also be incentivized through a proper tariff system. Differential pricing may be retained for the pre-emptive uses of water for drinking and sanitation; and high priority allocation for ensuring food security and supporting livelihood for the poor. Balance water to be subjected to allocation and pricing on economic principles. Electricity regulation to be implemented for ground water extraction.
- **Conservation of River Corridors, Water Bodies and Infrastructure :**Encroachments and diversion of water bodies and drainage channels must not be allowed, developmental activities in the protected upstream areas of reservoirs/water bodies, key aquifer recharge areas should be strictly regulated. It needs to be ensured that industrial effluents, local cesspools, residues of fertilizers and chemicals etc. do not reach ground water. The water resources infrastructure should be maintained properly through water charges collected for repair and maintenance.
- **Project Planning and Implementation :** Water resources projects should be planned considering social, environmental and techno-economic considerations in consultation with stakeholders; All clearances, including environmental and investment clearances, be made time bound; Pari-passu execution of all components of a project. Reduction of the gap between irrigation potential created and potential utilized; All water resources projects, should be planned as multi-purpose projects to the extent feasible with maximum benefits.
- **Management of Flood and Drought:** Structural and non-structural measures for flood protection; emphasis on preparedness for flood / drought with coping mechanisms as an option. Greater emphasis should be placed on rehabilitation of natural drainage system; Improvement of soil and water productivity to manage droughts; Modernization of real time data acquisition system & flood forecasting system; Preparation and periodic updating of emergency action plans / disaster management plans.
- **Water Supply and Sanitation:** Need to remove large disparity between stipulations for water supply in urban and in rural areas. Proper sewerage facilities in rural areas too; Conjunctive use of surface, groundwater and rainwater; Water accounts and water audit for urban supply systems. Encouragement to rainwater harvesting and desalination, wherever techno-economically feasible; Urban water supply and sewage treatment schemes should be integrated and executed simultaneously.

- **Institutional Arrangements :** Need of a forum at the national & state level to deliberate upon issues relating to water and evolve consensus, co-operation and reconciliation amongst stakeholders; A permanent Water Disputes Tribunal at the Centre for expeditious resolution of disputes, Public private partnership mode can be adopted with suitable safeguards; IWRM taking river basin / sub-basin as a unit should be the main principle for WRPDM; Appropriate institutional arrangements for collecting river basin & aquifers data with water budgets and water accounts based on the hydrologic balances.
- **Trans-boundary Rivers :** Efforts should be made to enter into international agreements with neighboring countries on bilateral basis for exchange of hydrological data of international rivers. Negotiations about sharing and management of water of international rivers should be done on bilateral basis in consultation with riparian States, keeping paramount the national interest.
- **Database and Information System :** All hydrological data, other than those classified on national security consideration, should be in public domain. A National Water Informatics Center should be established to collect, collate and process hydrologic data regularly from all over the country, conduct the preliminary processing, and maintain the database in open and transparent manner on a GIS platform.
- **Research and Training Needs**: Continuing research and advancement in technology, Establishment of autonomous center for research in water policy to evaluate impacts of policy decisions and to evolve policy directives for changing scenario of water resources. Regular training and academic courses for professionals in water management.

4.5 POLICIES RELATED TO WATER QUALITY MANAGEMENT IN INDIA

4.5.1 Pollution of Rivers

Water Quality data generated through National Water Monitoring Programme and River Basin Studies carried out since 1980 clearly indicate Water Quality deterioration in various river segments. Many water bodies do not meet the desired WQ criteria and hence are designated as polluted river stretches/water bodies.

4.5.2 Policies of Government of India

The Government of India has articulated four policy statements namely, "Policy Statement for abatement of pollution, 1992", "National Conservation Strategy and Policy Statement on Environment & Development, 1992" as well as the "National Environment Policy of 2006" by Ministry of Environment and Forests and National Water Policy 2002 (revised in 2012) by the Ministry of Water Resources. A brief description on main issues dealt by these policies is summarized as follows:

4.5.3 Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision making.

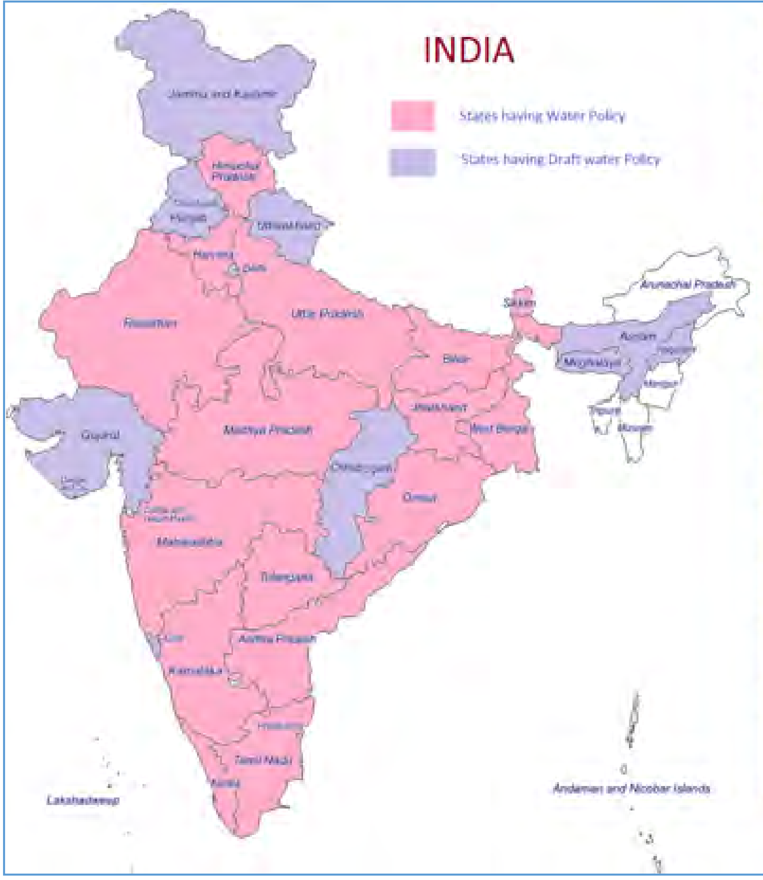
4.5.4 The National Conservation Strategy and Policy Statement on Environment and Development, 1992 aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The primary purpose of the strategy and the policy statement is to include & reinforce our traditional ethos and to build up a conservation society living in harmony with Nature and making frugal and efficient use of resources guided by the best available scientific knowledge. The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

4.5.5 The National Environment Policy, 2006 highlights key environment challenges, regulatory reforms, use of economic principles in environment decision making, conservation of natural resources, abatement of pollution, promotion of clean technologies and capacity building. It also stresses on the principles of right to development, economic efficiency, polluter pays, cost minimization, equity, legal liability, decentralization of power, integration and preventive actions. With respect to water resources and rivers, the Policy emphasizes the need for integrated water resources development in view of ever increasing pollution load exceeding the assimilation capacity of the natural water bodies.

4.5.6 The National Water Policy, 2012 stipulates that both surface and ground water should be regularly monitored for quality; a phased programme should be undertaken for improving water quality; the efficiency of utilization in all the diverse use of water should be improved; awareness of water as a scarce resource should be fostered; and conservation consciousness should be promoted.

4.6 STATE WATER POLICIES

Water sector in India is governed by several policies like NWP, state water policies and policies of local bodies governing rural and urban regions. Too many policies have implementing issues because of overlap and contradictions. As in 2017, in addition to NWP, most of the state water policies have been formulated, with few more in the draft stage. Table 1 shows the states in India that have formulated their own policies and those in the draft stage. In addition, several state governments have enacted legislative acts that are applicable within their administrative jurisdiction. The Ganges River Basin, the largest river basin in India, is guided by the NWP, in addition to the Uttar Pradesh, Madhya Pradesh Bihar and west Bengal State Water Policy. The Godavari River Basin is governed by NWP, along with Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh and Orissa State Water Policies. Similarly, the Krishna River Basin is divided policy-wise among Maharashtra, Karnataka and Andhra Pradesh. Ever since the NWP–1987 and 2012, more states have come up with their own water policies.



States having their own Policy	Year
Andhra Pradesh	2008
Assam (Draft)	2007
Bihar	2014
Himachal Pradesh	2005
Karnataka	2002
Kerala	2008
Madhya Pradesh	2003
Maharashtra	2003
Odisha	2007
Punjab (Draft)	2008
Rajasthan	2010
Uttar Pradesh	1999
Uttarakhand (Draft)	2014
Jharkhand	2011
Chhattisgarh (Draft)	2012
Telangana	2008
TamilNadu	1994
Haryana	2012
Goa(Draft)	2015
Gujrat(Draft)	2015
West Bengal	2011
Meghalaya(Draft)	2013
Nagaland (Draft)	2016
Jammu & Kashmir(Draft)	2016
Sikkim	2009
Delhi(Draft)	2015

4.7 PARTICIPATORY IRRIGATION MANAGEMENT

The National Water Policy 2012 stipulates involving Water Users Associations in decision making and participation from inception and planning stage of the project, advocating WUAs to be entrusted with statutory powers to collect and retain a portion of water charges, management of volumetric quantum of water allotted to them and maintain the distribution system in their jurisdiction. The concept of PIM though exists in the country for, quite some time now but has not yet blossomed to the level required.

Ministry of Water Resources has been making efforts to promote farmers participation under CADWM programme since 1987. The Ministry recognized the need for a legal framework in the country and during 1998 circulated a Model Act to be adopted by the State Legislature for enacting New Irrigation Acts/ amending existing Irrigation Acts. The legal framework provides for creation of farmers organizations at different levels of irrigation systems. In accordance with Model Act, 18 States have enacted/ adopted Legislation for involvement of farmers in irrigation management at different levels i.e. Water User Associations covering cluster of outlets or a minor, Distributary Level Committee and Project Level Committee.

4.8 WATER ADMINISTRATION AND INSTITUTIONS IN INDIA

As we have seen in the earlier paragraphs, constitutionally water is a state subject. Presently water is being dealt by more than 10 Ministries in the Government of India and various States and Union Territories who are enacting laws and legal provisions governing the use and development of this resource. The general organization framework of the Indian water sector can be briefly described by highlighting the key actors playing different roles at the Centre, State and role of District Administration.

4.8.1 Apex Institutions

At present, the roles of various institutions in the matter of the evolution of water policies by the Union government are as follows:

1.	The National Water Resource Council	The council performs the function of approving water-related policies through the evolution of a consensus.
2.	The National Water Board	The Board assists the National Water Resources Council

4.8.2 Central Ministries &Organizations: Role In Water Management

There are more than 10 ministries having a role in WRPD&M with different, sometimes overlapping jurisdiction & mandate. Their functions cover some part of water sector but at the same time also restrict their jurisdiction in other related field. These are brought out in the following figures or each of the concerned Ministry at the Union Government level.

Ministry	√	×
Ministry of Water Resource, RD &GR	√ Principle agency responsible for water in India	× Water pollution, Industrial use of water
Ministry of Commerce & Industry	√ Planning and development of water resources for industrial use	× Control or regulate the water use by industries
Ministry of Power	√ Development of hydroelectricity	× Water consumption or water pollution by the thermal power plants
Ministry of Environment , Forests & Climate Change	√ Quality of surface and ground water	× Control on use of water, water scarcity, resolving water conflicts
Ministry of Rural Development	√ Intregrated Watershed Management / Integrated Drought Prone Management/DPAP	× Control on use of water, water scarcity
Ministry of Urban Development	√ Drinking water in urban areas	× Monitor, regulate or charge water used by industries
Ministry of Agriculture	√Water Use Efficiency, National Watershed Development of Rainfed Area; PMKSY	× Control on use of water, water scarcity
Ministry of Drinking Water & Sanitation	√Rural Water Supply, Sewage, Million Wells Scheme, Rajiv Gandhi National Drinking Water Mission	× Availability of water, Testing for water contamination
Ministry of Earth Science	√Meteorology, Evaporation, Rainfall data, Climate, Temperature, Integrated Coastal Area & Marine Zone Management	× Water pollution, Industrial use of water
Ministry of Science & Technology	√National Natural Resources Managment :WRIS/RS & GIS	× Monitor, regulate, measure of water resource
Ministry of Shipping	√Inland Waterway, Navigation, National Waterways	× Control on flow of water
Ministry of New and Renewable Energy	√All matters to small/mini/micro hydel projects of & below 25 MW capacity	× Availability of Water

In addition, there are other major central institutions under respective ministry, that addresses specific issues related to water. The main roles of these institutions are summarized below:

- *Central Water Commission (CWC)*

CWC is a premier Technical Organization of India in the field of Water Resources and is presently functioning as an attached office of the Ministry of Water Resources, River Development and Ganga Rejuvenation. The Commission is entrusted with the general responsibilities of initiating, coordinating and furthering in consultation of the State Governments concerned, schemes for control, conservation and utilization of water resources throughout the country, for purpose of Flood Control, Irrigation, Navigation, Drinking Water Supply and Water Power Development. It also undertakes the investigations, construction and execution of any such schemes as require. The work of the Commission is divided among 3 wings namely, Designs and Research (D&R) Wing, River Management (RM) Wing and Water Planning and Projects (WP&P). A separate Human Resources Management Unit deals with Human Resources Management or Development, Financial Management, Training and Administrative matters of the CWC. National Water Academy, Pune which is a part of CWC is responsible for capacity building &training of Central and State in-service engineers& other stakeholders in water sector. Other important functions of CWC includes, survey & investigations, planning, design, appraisal & monitoring of irrigation & flood management projects. This D&R wing is responsible for, providing guidance in the planning, preparation of lay-out studies, specifications, detailed designs and drawings and standardization of designs of river valley projects in the country including hydrological studies for the projects, advising state Governments/Dam owning agencies on safety aspects of dams, taking policy decisions on design and research activities, conducting site inspection at all critical stages of construction of projects for which CWC provides design consultancy for advising the adequacy of foundation conditions and foundation treatment, adherence to design specifications etc. and providing advices on landslide/dam break disaster management issues.

This RM wing is responsible for, collection, compilation, storage and retrieval of hydrological and hydro-meteorological data including water quality monitoring, formulation and issue of flood forecast on all major flood prone rivers and inflow forecasts for selected important reservoirs, providing guidance to States in technical matters on different aspects of river and flood management in the country and regulation of multipurpose reservoirs, river morphology studies, techno-economic appraisal of various flood management schemes received from the State Governments, providing advice to coastal states on issues related to coastal erosion problems including preparation of National Coastal Protection Project (NCPP) for Coastal Protection works, survey and investigation of water resources development projects in India and neighbouring countries, monitoring of schemes under Centrally Sponsored Command Area Development (CAD) Programme, Accelerated Irrigation Benefit Programme (AIBP), Revival and Restoration of Water Bodies etc. through field units of

RM Wing and international co-operation with neighbouring countries in the field of flood forecasting.

This WP&P wing is responsible for dealing with matters related to National Water policy; overall planning and development of river basins including integrated river basin planning and development, monitoring of storage position of the important reservoirs; techno-economic appraisal of Water Resources Projects including projects for assistance from external agencies and assistance to the States in the formulation and implementation of projects; monitoring of on-going major, medium & Extension Renovation & Modernisation (ERM) irrigation projects for identification of bottlenecks to achieve the targeted benefits; environmental issues related to water resources projects; irrigation planning; soil conservation, anti-water logging measures, reclamation of alkaline and saline soils; application of remote sensing technologies in water resources and related activities; water rights and inter-state disputes among different states for the conservation and utilisation of water resources; issues related to construction machinery planning, evaluation and manpower planning aspects and silting of reservoirs.

- *Central Ground Water Board (CGWB)*

A Subordinate organisation of MoWR, RD & GR, CGWB is entrusted with developing and disseminating technology related to sustainable use of ground water; monitoring and implementing policies for the sustainable management of ground water resources; estimating ground water resources, aquifer mapping etc.

- *Central Ground Water Authority (CGWA)*

Constituted under Section 3(3) of the Environment (Protection) Act, 1986 to regulate and control development and management of ground water resources; can resort to penal actions and issue necessary regulatory directives

- *Water Quality Assessment Authority (WQAA)*

Frustrated with the multiplicity of agencies MoEF& MoWR decided to set up this apex body to compile information on water quality and monitor the function of the agencies. But since its constitution, WQAA has only met twice and no progress has been made on its agenda.

- *Central and State Pollution Control Board (CPCB) & (SPCB)*

Implementation of the Water (Prevention and Control of Pollution) Act, 1974 which seeks to restore water quality Sources. These organisations regulate industrial water pollution and charge water cess based on the amount of wastewater discharged by the companies. But they have no mandate to control sourcing of water from various sources.

In addition there are few other organisations under MoWR, RD & GR like Central water and power Research Station (CWPRS), Pune, Central Soil and Material Research Station

(CSMRS), New Delhi, National Institute of hydrology Roorkee which are providing research, simulation, modelling and other related vital services for water sector.

4.8.3 River Basin Organizations (RBOs)

RBOs support the integrated and physical and technical management of water resources, and if developed adequately, can respond to the growing competition for water among agricultural, industrial, urban, and in-stream uses within the basins. RBOs can help recognize the environmental impacts of water uses and water development at the basin scale. Their importance with regard to future uncertainties of water supply and demand can be seen in their being described as an adaptation measure to climate change in the Third Inter-Governmental Panel on Climate Change.

Without integrated river basin management through the RBOs, there would be limited collaboration between departments related to water (irrigation, agriculture, industries and environment). Water related data and information would remain fragmented, consequently reducing the possibilities to conserve water. Given the limited possibilities to increase water supply or decrease demand, water resources would continue to move to those uses where the value of water is highest (e.g. to industry rather than to irrigated agriculture) and water would continue to be allocated in an ad-hoc, suboptimal manner (from a social and environmental point of view). Broadly defined, RBOs offer a mechanism to achieve such integrated management by providing the framework for water allocation following efficiency and equity principles.

Majority of the current river basin management organizations are for specific functions, such as flood planning or reservoir construction, water allocation, water pollution mitigation, etc. The adopted approach is demand oriented and focuses on resolving specific problems in the river basin. The main functions of RBOs are given in the figure below.

Beyond functional cooperation there is integrated approach to river basin management that focusing on the river basin as a whole and try to resolve the existing hydrologic, ecologic and socioeconomic problems through holistic policies. The integrated approach is widely endorsed and promoted by international organizations as well as by NGOs and scientists though there are few examples of truly integrated RBOs.

The type of RBO for a basin is a function of the political and institutional situation and overall objective of the organization. For instance, an authority is usually given independent powers and is responsible for infrastructure planning. Examples of this include the Tennessee valley Authority in US and Damodar valley Authority in India. However, the description of the different types of RBOs overlaps significantly. While the type of organization is important, it is even more important to match the structure that supports basin-level management with the objectives that the organization aims to achieve.

4.8.4 Setting up of Boards for Specific Purposes

In India, river basin management Boards / Authorities / Commission are constituted from time to time are mainly for carrying out specific purpose. Indian basin organizations have been established mainly through:

1. Specific Acts- e.g. Damodar Valley Corporation, Brahmaputra Board
2. On the orders of Tribunals, as a result of existing inter-state river water disputes- e.g. Narmada Control Authority
3. Notifications- e.g. Tungabhadra Board
4. Memorandum of Understanding between States- e.g. Upper Yamuna River Board

A selected list of basin organizations constituted in India from time to time including their mode of constitution and role is given in the table below:

Basin Organisation	*Mode of Constitution*	*Role*
The Damodar Valley Corporation	Damodar Valley Corporation Act, 1948 (AS per article 372 of the constitution)	Promotion and operation of river system for irrigation, water supply, drainage, hydro-electric and thermal power generation, flood control, navigation, afforestation, control of soil erosion, public health, agricultural, industrial, economic and general well being of people.
Tungabhadra Board	Notification by the Government of India in exercise of the powers vested under Section 66(4) of Andhra Pradesh State Act	Completion of the Tungabhadra project, maintenance and operation
Bhakra Beas Management Board	Constituted by the Government of India under Section 79 of Punjab Reorganisation Act, 1966	Administration, maintenance and operation of Bhakra-Nangal project
Cauvery River	River Cauvery Water	Implementation of the Cauvery

Authority	Disputes Tribunal	Water Disputes Tribunal
Ganga Flood Control Commission	Government of India resolution as secretariat and executive wing of Ganga Flood Control Board	To deal with floods and its management in Ganga Basin States
Bansagar Control Board	Government of India resolution in accordance with an agreement between Govts of MP, UP and Bihar	Ensuring efficient, economical and early execution of Bansagar dam and connected works
Brahmaputra Board	Brahmaputra Board Act, 1980	Master plan for the control of floods in the Brahmaputra Valley giving due regard to the overall development and utilisation of the water resources of the valley for irrigation, hydropower, navigation and other beneficial purposes.
Narmada Control Authority	Narmada Water Disputes Tribunal	Proper implementation of the decisions of the Tribunal
Upper Yamuna River Board	MoU signed by the Chief Ministers of the riparian States (H.P, Haryana, UP, Rajasthan and Delhi)	Distribution of the available flows among co-basin states within the overall framework of the MoU
Betwa River Board	Constituted under the Betwa River Board Act, 1976	Efficient, economical and early execution of Rajghat dam project
Sone River Commission (closed)	Set up by the Government of India in 1989 in pursuance of the agreement of Bansagar Project between the states of Bihar, Madhya Pradesh and Uttar Pradesh.	Compiling and analysing hydrological and hydro-meteorological data, consumptive use data and to carryout investigations and studies for the preparation of basin and regional plans for optimum use of Sone river waters for irrigation and multipurpose uses.

4.8.5 Role of State Governments & Union Territories in Water Resources Development and Management

Water being State subject, the role of State Government is paramount for Water Resources Development and Management. All Water Resources schemes are planned, initiated, coordinated, and managed by State Governments. The state government is responsible for implementing various water supply schemes for cities, towns and villages. They are also responsible for watershed development activities, Command Area Development, Water conservation activities, and for implementation of State Schemes as well as Central Schemes for which funding is given by Central Government. The State Governments also play a pivotal role in rescue and relief operations during the water related disasters like occurrence of flood, droughts etc. All the issues pertaining to water like controlling water borne diseases; maintaining water quality etc. is primarily the responsibility of State Government. The various organizations /department in state government responsible for water development and management are as shown in the figure.

4.8.6 Role of District & Local Administration

The District is the Principal Administrative unit below the state level. It is a unit of administration covering most of the departments of Government. The block and village level bodies are generally executive in nature, while the district level body mostly has a coordinating and supervisory role. The functions of the district administration can be summarized as follows:

- Law and order and magisterial matters
- Land Revenue
- Development Activities
- Regulatory Functions
- Municipal Administration Matters
- Emergency Relief
- Land Acquisition matters and Land Reforms
- Residuary functions etc.

In pursuance of the above, District Administrative Officer has a pivotal role in providing water & sanitation facilities; implementing water conservation measures like watershed development, CAD; regulatory activities like controlling regulation of Surface and Ground Water Resources. In the case of natural calamities like flood & drought, District Administration plays an important role. They are the first to act in providing rescue and relief operations, rehabilitation etc. Implementation of various legislations in respect of Water Sector for e.g. extraction of ground water; Participatory Irrigation Management; drinking water supply; rural water supply; urban water supply etc are also within the ambit of District Administration. The local bodies which support district administration in discharging the responsibilities are shown in figure

4.8.7 Water Regulatory Authority

In the last few decades many high level Committee/Commissions have been set up by the government to formulate a guidelines for the water rates. The National Water Policy and State Water Policies also provided the guiding principles for rationalization of the water rates; however, implementation has not taken off in real terms. It is basically because, in a country like India, water is considered more as social good than an economic good. Charging of water by the water service providers is invariably opposed by the people at large; media; activists; NGOs on various grounds. The administrative issue of recovery of water rates gets transformed into sensitive political issue. As a result, the water rate remains very low across all sectors; without any incentive or disincentive for efficient water use. There has to be an independent institution for regulating and fixing water charges for all sectors. This institution would be entrusted with the responsibility of fixing and regulating water tariff for various sectors based on factors like water availability; direct costs involved; priorities; allocation of water to each sector;

MAHARASHTRA WATER RESOURCES REGULATORY AUTHORITY (MWRRA)

MWRRA has formulated a methodology in consultation with the stakeholders for deciding water rates for bulk users. The principles that have been adopted by MWRRA are:

- *Only O&M cost to be considered for recovery. No capital cost interest on investment or depreciation is to be considered. This is in line with the mandate given to MWRRA by Govt. of Maharashtra*
- *Calculation are based on actual cost and not on marginal cost combination of crop, technology, season and irrigation methods;*
- *It has adopted volumetric system of pricing for WUAs, domestic and industrial sector;*
- *The share of each sector in the cost is decided on the basis of matrix constructed by allocating weightages representing the relative importance of each of the following parameters to each of the water use sector;(i) affordability; (ii) accessibility: (iii) quantity & timeliness; and (iv) water use efficiency*
- *The tariff is decided by computing annual likely use of water by each sector. The annual projected O&M cost including the cost of the establishment is derived. The apportionment of the projected O&M cost among the all category of users is done as per finalized criteria and basic rate for each category of use is worked out.*
- *Then within each category of user, tariff is fixed based on the incentive, disincentive, policy of the government etc.*
- *The volumetric pricing for agriculture is derived based on average cropping pattern and crop- wise tariff;*
- *The gap between revenue likely to be earned through water rates and O&M cost is then subsidized by the state government through budgetary support;*
- *As per the policy of Government of Maharashtra, marginal farmers having up to 1 ha land are charged 50% of the basic rate. Small farmers with 1-2 ha holdings are charged 75% of the basic rate. No tariff is charged from the tribal farmers. The gap in revenue generation due to this social concession is made up through government subsidy.*
- *The MWRRA also encourages the farmers to adopt advanced irrigation technologies by charging them only50% of the basic rates.*
- *Farmer family having more than two children is charged 1.5 times the basic rate. This is a classic example how water rate can be used as a tool for water use efficiency and also as a tool for social interventions;*
- *The Gram-Panchayats, using up to 40 LPCD is charged 75% of the basic rate; ULBs using upto70 LPCD are charged 90% of the basic rate; ULBs drawing more than 130 LPCD are charged 1.25 times of the basic rates; corporations are given further concession of 50% on volume of sewage treated.*
- *For industries, discharging untreated sewerage and effluents in violation of MPCB norms are charged twice the basic rates.*

It is seen that the MWRRA has used the water rates as a tool to achieve multiple objectives.

affordability; accessibility; quantity; quality; timeliness etc. The independent institution can consult all stakeholders and formulate a methodology for arriving at applicable water rate to each sector. Factors considered and data used for arriving at a particular water rate should be kept in public domain, so that all stakeholders are well informed about these. The 13th Finance Commission has incentivized formation of Water Regulatory Authority by keeping aside a conditional grant of Rs.5000 Crores, which has been linked with the water charges recovery rate and formation of Water Regulatory Authority by the respective states. The minimum mandate for the Water Regulatory Authorities has also been fixed by the 13th Finance Commission. This incentive had good effect and states have started establishing Water Regulatory Authorities. Maharashtra is the first state that has established Maharashtra Water Resources Regulatory Authority (MWRRA) in 2005 followed by other states like Andhra Pradesh, Karnataka, Gujarat, etc.

4.9 CURRENT ISSUES IN WATER GOVERNANCE

From the above paragraphs, it can be seen that there is well structured legal, policy and institutional framework in place for water governance. However, there are many water governance issues that are still impacting the progress in water management in adverse way. There are many areas where there is lot of scope for improvement. There is an urgent need to evolve an effective implementation mechanism for water management and water use efficiency to see the encouraging results on ground. The key issues of water governance are briefly enumerated in the following heads below.

- **Implementation of Existing Laws:**
  - ✓ Encroachment upon water bodies, flood plains etc. is impacting the natural course of rivers and water bodies. There is an urgent need for proper enforcement of Flood Plain Zone Mapping.
  - ✓ Enforcement of Groundwater Law is weak, resulting in Overexploitation and unsustainable ground water extraction practices in many regions of the country
  - ✓ Enforcement of Waste Water Quality Standards from users such as industries, municipal corporations, townships, etc. needs stricter implementation.
  - ✓ There should be proper enforcement of law regarding various designated land uses and cropping pattern followed by the farmers.
- **Legal Frameworks**

- ✓ Governance of the water sector is complex, involving actors beyond the water sector. They frequently have contradicting interests and responsibilities, culminating in sub optimal choices from sustainability and efficiency perspective. The actors include national governments, local governments, river basin authorities, representatives of indigenous people, consumer bodies, farmer bodies, energy companies, other private companies, etc. A sound regulatory framework is essential for effective stake holder coordination. Legal provisions like National Water Framework Law as an umbrella policy must be adopted and implemented effectively. The proper enforcement of various laws should be ensured.
- ✓ Integrated Water Resources Management (IWRM) is only talked about, however the actual implementation is in piecemeal manner.
- ✓ Leadership at Local Level should be encouraged for achieving best results in Water Management.

- **Participatory Approach and Capacity Building**
  - ✓ Participatory Management is being encouraged for quite some time. There are acts for PIM in many states but the on-ground situation is not at all encouraging. Participatory Management should be fostered, recognizing the social, economic and cultural characteristics of the community. The Administrative system has to play a role of catalyst in this regard.
  - ✓ With increased use of advanced technology, promotion of participatory approach, low level of awareness of the society and other challenges it is high time to build the capacity of various stakeholders and also sensitize all of them about the current water scenario and level of water security and quality. Water Literacy is the need of the hour to prepare the common people for changing approach in Water Resources Management.
  - ✓ E-Governance in water sector needs to be implemented with wide coverage in Govt. schemes, information systems, water data, mass awareness, public services with transparency and citizen centric approach.

- **Managing Water Organisations**
  - ✓ *Rationalisation of water allocation & water pricing*: Indiscriminate use of water by stakeholders is attributable to distorted sectoral policies, such as irrigation subsidies and low water tariffs. Since most key sectors are water dependent, inter-sectoral policy implications has a lot of significance. For instance, energy subsidies and improper pricing could lead to over exploitation of ground water for irrigation. The Water Resources Regulatory Authorities should be given the sole responsibility of water allocation among water use sectors and water pricing to resolve the issue of inequitable distribution of water. Pricing of water is one of the key components of good governance and water resource management and should be handled in a most rational way.
  - ✓ *Finance:*
    - o There is need for increased investments in the water infrastructure. The government alone has limited capability for resources. The private

investment in the sector must be encouraged with Public-Private-Partnership (PPP) model, wherever it is feasible.
  - Provision of giving incentives to the stakeholders for practicing water conservation measures is necessary for increasing Water Use Efficiencies. There must be tangible benefits to the user for saving water in terms of lower water tariff or assured & timely water supply.

- ✓ *Wastage and Overexploitation:* Every water use sector has a lot of wastages and overuse of water. The Water Use Efficiency is one of the lowest in the world. There is overall lack of awareness amongst the stakeholders towards increasing water use efficiency.
- ✓ *Project Implementation:*
  - Thin spreading of resources, hampers the project implementation thereby causing cost & time overruns. The projects in hand should be completed first and then new projects should be started.
  - The application of Information Technology in Water Resources Projects Planning, Design, Construction, Operation and Maintenance is very poor in our country. Various remote sensing, satellite technologies, SCADA, online monitoring and measurements, modelling tools, latest technologies in the field of Agriculture and different industries need to be promoted for effective and sustainability of WR Projects.

The issue of governance is multidimensional, encompassing social, economic, political, and legal institutions. Effective enforcement is the key to successful governance and the administrative system of the country should have adequate capacity to enforce laws, legislations and acts. Ideally, water management should work through voluntary cooperation among users, but the competing agendas of water users can lead to conflicts, requiring formal rules, regulations, controls and incentives to define user rights and responsibilities.

4.10 LEGISLATIVE INITIATIVES BY MOWR, RD & GR

On the basis of the experience of the existing legislations and also to provide effective legal framework for WRPD&M in the changing paradigm of water sector, MoWR, RD & GR has taken initiatives in formulating few bills as given below :

4.10.1 National Water Framework Bill

The National Water Policy (2012) emphasizes the need to evolve a National Water Framework Law as an umbrella statement of general principles governing the exercise of legislative/ executive powers by the Centre, the States and the local governing bodies. The Draft aims towards legislative reforms for sustainable management of water resources.

Why a Central Law?

- States have the competence to make laws, formulate and implement plans and schemes for development of water resources for water supply, irrigation, hydropower etc.
- Several States have enacted different laws also. There are more than 300 Acts on water. But, most of these laws do not address the present concerns in a holistic manner.
- During water policy consultation process, most of the States have indicated that they need a greater push from the Centre to carry forward water sector reforms.
- Considering its critical importance in national development, water needs to be managed with a national perspective based on the acceptance of a few common fundamental principles.

The draft national water framework bill 2013 was prepared by a committee headed by Shri. Y.K. Alagh. The Draft National Water Framework Law (May 2013) prepared by the Drafting Committee headed by Dr. Y.K. Alagh was Placed before the National Forum of Irrigation and Water Resources Ministers of States on 29.05.2013 and was also circulated amongst all States/Union Territories/related Union Ministries and also hosted on Ministry's website.

A committee under the chairmanship of Dr. Mihir Shah, Former Member, Planning Commission was constituted to review the draft Bill on National Water Framework Law. Dr. Mihir Shah Committee has submitted its Final Report to the Ministry on 18th July, 2016. The Report of the Committee contains a National Water Framework Bill, 2016. The National Water Framework Bill, 2016 has been circulated to all the States/UTs and concerned Central Ministries for inviting their comments. Comments of some States / Departments / Ministries have been received.

Salient features of draft national water framework bill 2016 prepared by a committee headed by Dr. Mihir Shah are as follows:-

- The Bill provides an overarching national legal framework based on principles for protection, conservation, regulation and management of water as a vital and stressed natural resource, under which legislation and executive action on water at all levels of governance can take place.
- Every person has a right to sufficient quantity of safe water for life within easy reach based on the principles of integrated river basin management.
- The States shall hold water as a Common Heritage and Resource Public Trust.
- The appropriate government shall strive towards rejuvenating river systems with community participation, ensuring:
    (i) 'Aviral Dhara' – continuous flow in time and space including maintenance of connectivity of flow in each river system;
    (ii) 'Nirmal Dhara' – unpolluted flow so that the quality of river waters is not adversely affected by human activities; and
    (iii) 'Swachh Kinara' – clean and aesthetic river banks.

- The appropriate government should adopt people-centric decentralized water management, for both surface and ground water, including local rainwater harvesting, watershed development and participatory irrigation management, shall be prioritized, while recognizing, encouraging and empowering local initiatives.
- The appropriate Government shall take into consideration the following :
    - Water use and land use
    - Appropriate Treatment and Use of Wastewater
    - Standards for Water Quality and Water Footprints
    - Water Use Prioritization.
- The draft Bill lays high priority to Integrated River Basin Development and Management, wherein a river basin, including associated aquifers, shall be considered as the basis hydrological unit for planning, development and management of water. Each State Government shall develop, manage and regulate basins of inter-State rivers through a River Basin Master Plan to be implemented by an appropriate institutional mechanism.
- The Central Government shall provide for establishment of a River Basin Authority for each inter-State river basin, or for a sub-basin for sub inter-State river basin wherever appropriate for optimum and sustainable development of the inter-State rivers and river valleys, with active participating and cooperation by all basin States to ensure equitable, sustainable and efficient utilization of water resources with emphasis on demand management through conjunctive and integrated use of resources. Each River Basin Authority shall prepare a Master Plan for the River Basin.

The draft framework Bill also provides that the appropriate Government shall prepare and oversee the implementation of a Water Security Plan for (a) attainment of sufficient quantity of safe water for life and sustainable livelihoods by every person; and (b) ensuring water security even in times of emergencies like droughts and floods.

So far (as on April 2017) State Governments of Madhya Pradesh, Rajasthan and Tamil Nadu have forwarded their comments on the Bill. Tamil Nadu has opposed the Draft NWFL. Ministry of Agriculture & Farmers Welfare, Ministry of Urban Development, Ministry of Commerce & Industry and Niti Aayog have forwarded their comments so far. These comments / suggestions are yet to be incorporated in Draft NWFL

Path Ahead:

- Consultations with stakeholders :
    - Discussions in National Water Board (Chairman- Secretary (WR, RD & GR), Representative/ Member Secretary – Member (WP&P), CWC) with all States and concerned Union Ministries.
    - Political consensus be obtained through National Water Resources Council with Prime Minister as the Chairman and all Chief Ministers and related Union Ministers as Member and Secretary (WR, RD & GR) being the Member Secretary.
    - NITI Aayog may hold consultations with States as it was done in the case of ISWDA.

- Central govt. has requested States' Assemblies to resolve to empower Parliament to enact National Water Framework Law under Art.252 (as per Dr. Mihir Shah's report), or under Art.253, particularly in view of Sustainable Development Goal No.6 adopted by the United Nations and concurred by India). The state of Uttar Pradesh has agreed for such resolution in its assembly. The states of Madhya Pradesh and Rajasthan too has agreed but with some comments for modification. Kerala Tamilnadu, Odisha has opposed this bill.
- In case of enactment under Art.252 – after resolution by at least 2 States, preparation of cabinet note and circulation for inter-ministerial consultation
- In case of enactment under Art.253, preparation of cabinet note and circulation for inter-ministerial consultation.
- After obtaining the Cabinet approval, the draft legislation to be laid in the Parliament.

4.10.2 River Basin Management Bill, 2012

4.10.2.1 Need for fresh Legislation for Inter-State River Basins

- ✓ The River Boards Act, 1956 does not provide for any river basin planning on the principles of integrated water resources management
- ✓ The term 'Basin' does not figure under the River Boards Act, 1956 while the word 'basin' is important as it is the hydrological unit that underpins the institution
- ✓ No single River Board has been constituted under this Act, as the States have not responded to legal space for River Boards to be created under the River Boards Act, 1956. Consequently, this Act has fallen into disuse.
- ✓ A legal foundation for River Basin Development and Management Plan for Inter–State River Basins is needed which will provide the institutional legal framework

MoWR constituted a Committee under the Chairmanship of Justice Tejinder Singh Doabia to study the activities that are required for optimal development of a river basin and changes required in the existing River Board Act, 1956 for achievement of the same. The report of the Committee containing the River Basin Management Bill, 2012 was submitted in November, 2012.

The River Basin Management Bill, 2012 proposes to establish a River Basin Authority for regulation and development of waters of an Inter-State River Basin or any specified part thereof and further makes it clear that different Authorities shall be established for different Inter-State River Basin. The Bill also makes provision for creation of a separate River Basin Authority for a sub-basin within an Inter-State River Basin.

Some of the salient features of the Bill are:

- ➢ The Central Government shall, by notification in the Official Gazette, establish a River Basin Authority for development, management and regulation of waters of an inter-State river basin or any specified part thereof and different Authorities shall be established for different inter-State river basin(s).
- ➢ Basin States shall have the right to participate in the development, management and regulation of waters of an inter–State river basin in an equitable and

sustainable manner. In case any basin State fails to participate in the regulation, development and management then the decision of the remaining States shall be binding on all participating and non-participating States.

- Basin States shall participate and cooperate in best interest of the nation, in the development, management and regulation of waters of inter –State river basin for the mutual benefit of the basin States and the Indian Union.
- Every River Basin Authority shall consist of a Governing Council and an Executive Board.
- The Governing Council shall consist of Chief Ministers, Minister in charge of Water Resources, One Member of Parliament from the House of the People, One Member of the State Legislature, Two representatives of District Panchayat / Zilla Parishad, Chief Secretary to the State Government or the Administrator to the Government of the Union Territory, One representative from the Water User Associations, One representative from the Urban Local Bodies / Municipalities, Two persons to be nominated by the State Government from each of the basin States from amongst eminent citizens having knowledge and experience from each of the basin states. Further three independent experts to be nominated by the Central Government from amongst eminent citizens having requisite knowledge and experience in water resources development, management and regulation.
- The Chairperson of the Governing Council shall be from amongst the Chief Ministers of the basin States, by rotation. Member-Secretary of the Governing Council would be the Chief Executive Officer of Board, nominated by the Central Government from amongst the officials of the rank of the Member of the Central Water Commission of the Government of India
- The Executive Board apart from the Chief Executive Officer would comprise of Secretary to the State Government in charge of water resources / irrigation / flood control , Agriculture Department, Power Department, Environment Department, Engineer in Chief in charge of water resources / irrigation / flood control, Member-Secretary of the State Pollution Control Boards, A Representative of the State Groundwater Board, Managing Director / Member Secretary of the State Water Supply and Sewerage Board, Member Secretary of the State Disaster Management Authority, One person to represent non-government organizations dealing with river basin and water resources management, One expert to be nominated by the State Government having relevant knowledge and experience in water resources development, management and regulation from each of the basin states. Further, Regional Director(s), Central Groundwater Board within the territorial jurisdiction of the concerned River Basin Authority will also be a member.
- Member-Secretary of the Executive Board would be nominated by the Central Government from amongst the officials of the rank of the Chief Engineer of the Central Water Commission of the Government of India

- A River Basin Authority shall ensure that a River Basin Master Plan for river basin development, management and regulation is prepared for the inter-State river basin under its jurisdiction.
- The River Basin Master Plan shall, inter-alia, include
  - All the results of the analysis of the River Basin Characteristics
  - A comprehensive review of the impact of anthropogenic interventions on the status of surface water and ground water, including an estimation of pollution, point as well as diffused, in water uses
  - Identification of protected areas, social and cultural flow needs and duration
  - Environmental needs
  - Ground water and protected aquifers, if any
  - A summary survey of existing pricing policies and an economic analysis
  - A fair assessment of the effects of existing legislations
  - An economic analysis for optimal allocation and the notional cost of deviation from optimal
- All the basin States shall ensure coordination with the aim of producing a single inter-State river basin master plan.
- River Basin Master Plan shall be coordinated with the plans for national economic and social development, the general plans for land use and general urban plans and plans for environmental protection, and at the same time the needs of various regions and industries shall be taken into consideration.
- The River Basin Master Plan shall be made through an inclusive consultative process in the manner prescribed.
- The Governing Council approve the river basin master plan so as to ensure sustainable river basin development, management and regulation within the parameters laid down by the National Water Policy, as amended from time to time
- The Executive Board will formulate a River Basin Master Plan for the inter-State river basin including river valley under its jurisdiction so as to ensure sustainable river basin management and will ensure compliance of the decisions taken in the Governing Council in respect of River Basin Master Plan.
- Any recommendations made by a River Basin Authority in exercise of its powers and functions under this Act shall be binding upon the Governments interested.
- The Central Water Commission would provide technical support in the matter of preparation of River Basin Master Plan in close coordination with Governments interested.

4.10.3 Dam Safety Bill

Mostly, dams are owned by the State Governments. Hence the responsibility of maintenance and safety of dams also rests with the owners of dam. Each State Government is entrusted with safety assurance of dams in their jurisdiction.

Constitutionally, too “Water” is a state subject. It is within the purview of State legislatures to provide appropriate legal framework for the Dam Safety aspects. In 1982, GOI constituted a Standing Committee (under Chairman, CWC) to review existing practices & evolve unified procedures of dam safety for all dams in India. This committee recommended enactment of Dam Safety Legislation by all states. To have unified practices and procedures across all states, a draft *Dam Safety Bill* had been prepared by MoWR, RD & GR. The current draft went through many iterations and consultations before it could get the present form.

The current version of the proposed legislation seeks to enjoin responsibility on Central Government, State Governments and owners of specified dams to set up an institutional mechanism for ensuring safety of such dams and reporting the action taken. It defines the duties and functions of these institutions in relation to perpetual surveillance, routine inspections, operation and maintenance, maintenance of log books, instructions, funds for maintenance and repairs, technical documentation, reporting, qualifications and trainings of concerned manpower etc. Provisions have been made concerning the necessities of periodical inspections, instrumentations and establishment of hydrological and seismological stations. The Bill addresses the issues of emergency action plan and disaster management, and also enlists the requirements of **comprehensive dam safety evaluation.**

4.10.4 The Model Ground Water Bill

With a view to protect GW regime and take safeguards against overexploitation, Govt. of India, in 1970, framed a Model Groundwater (Control and Regulation) Bill for adoption by the states. It was revised in 1972, 1996 and 2005, the Bill provides the framework to regulate indiscriminate extraction of GW. In 2005, new chapter on rainwater harvesting was introduced which provide for implementation of GW recharge measures. It provides for constitution of State Ground Water Authority for regulation of groundwater development. The Regulation is limited to areas notified by the Authority.

Salient features of Model Bill, 2005

The Model Bill, 2005 proposes following actions in notified areas:-

- ✓ Grant of permit for sinking a new bore well.
- ✓ Registration of existing borewell-owners.
- ✓ Registration of Drilling Agencies
- ✓ Restrictions on the depth and diameter of borewells.
- ✓ Restriction on purpose of use of groundwater.
- ✓ Registration of new users in non-notified areas.
- ✓ Adoption of rainwater harvesting.

Status of implementation

- ✓ Implementation in general is yet to be satisfactory.
- ✓ In some of states, enactment made but SGWA still to be constituted.

- ✓ After creation of SGWA, suitable infrastructure not provided and duties are being performed additionally by irrigation, PHED etc. departments where domain experts are few or non-existent.
- ✓ Database required for regulation is also not available/created.

In view of the unsatisfactory implementation a new Model Bill for the Conservation, Protection and Regulation of GW, 2011 was prepared by Planning Commission, with following Mandatory principals..

- ✓ *Non-discrimination and Equity*
  - o Every person to have access to water, ensure equitable distribution and sustainable use.
- ✓ *Subsidiarity and Decentralisation*
  - o Decentralisation of powers and functions in urban and rural areas and different regulation measures in different parts of the state based on availability.
- ✓ *Protection, Precaution and Prior Assessment*
  - o Aquifers to be protected from such impacts that affect the equity of access and sustainability of the resource, from depletion, deterioration in quality etc.
  - o Plan management measures to conserve, replenish and recharge GW.
- ✓ *Integrated approach for management of water resources*
  - o Protection, conservation and regulation of GW integrated with surface water resources on a watershed basis, land and forest.

Institutional framework proposed in the Model Bill, 2011 is based on the principle of subsidiarity and framed around existing administrative units of village/panchayat.

Institutional Framework

- ✓ Rural Areas
  - o Gram Panchayat Groundwater Committee.
  - o Block Panchayat Groundwater Committee
- ✓ Urban Areas
  - o Ward Groundwater Committee
  - o Municipal Groundwater Committee
- ✓ At District level
  - o District Groundwater Council
- ✓ At State level
  - o State Groundwater Advisory Council
- ✓ Ground Water Grievance Redressal Officer to be nodal officer for implementation of Act.

4.10.4.1 Review of Model Bill, 2011 by Expert Committee

MoWR, RD & GR constituted an Expert Committee under Sh. Sushil Gupta, Ex. Chairman, CGWB to review the provisions of Model Bill, 2011. The Committee was of the view that the provisions of this Model Bill are in general more relevant.

4.10.4.2 Re-drafting of Model Bill, 2011 by MoWR, RD & GR

MoWR, RD & GR has further constituted a committee under Dr. Mihir Shah, Ex. Member, and Planning Commission to redraft the Model Bill on the basis of principals given in the National water Policy 2012 and also to bring harmony with National Water Framework Law, River Basin Management Bill and other State Acts.

Ministry of Water Resources, River Development and Ganga Rejuvenation has uploaded the Draft model bill (May 2016) based on the recommendations of the above committee, on its website (http://mowr.gov.in). The comments/ suggestions/views from all Individuals/ Experts /Organizations/ Institutions on the above bills have been invited.

4.10.5 Amendment to Inter State River Water Dispute Act 1956

As per the provision of NWP 2012, the Union Government has decided to set up a single, permanent Tribunal to adjudicate all inter-state river water disputes subsuming existing tribunals, a step which is aimed at resolving grievances of states in a speedy manner. This will require amendment to the **Inter State River Water Dispute Act 1956.** Besides the Tribunal, the act will be amended to enable to float some benches to look into disputes as and when required. The Tribunal will be permanent, however the benches will cease to exist once the disputes are resolved. The amendment is likely to be introduced in Parliament in its next session.

As per the amendment, there will be only one permanent Tribunal with retired Supreme Court judge as its chairperson. There will be benches formed as and when required. The benches though will be wound up once a dispute is resolved. In present system, it used to take lot of time for the Tribunals to deliver its judgement. Now Tribunal is expected to deliver its verdict during a span of three years.

Along with the Tribunal, the amendment proposes to set up Dispute Resolution Committee (DRC). The DRC, comprising experts and policy-makers, is proposed to handle disputes prior to the Tribunal. In order to give more teeth to the Tribunal, it is proposed that whenever it gives order, the verdict gets notified automatically. Until now, the government required to notify the awards, causing delay in its implementation.

4.10.6 Integrated Water Resources Management (IWRM)

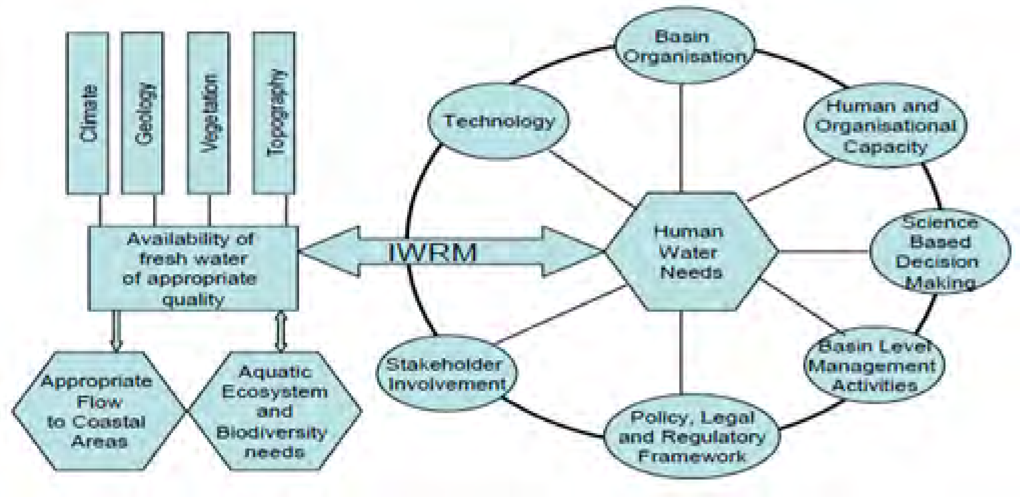
4.10.6.1 Concept of IWRM

Under the most recent paradigm, IWRM can be defined as a process which promotes coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. IWRM is therefore in essence, a conceptual framework that river basin managers should strive forward.

Unlike traditional water management that is supply driven, the integrated framework is broader in that it involves both supply and demand side responses along with a strong emphasis of stakeholder participation. It encourages the integration of water management across sectors, and places the responsibility of providing an enabling environment. The concept of IWRM is as broad as one defines it, and could consist of integrating water and land use practices; coastal and freshwater use; green, blue and grey water; ground and surface water; water quantity and quality; and upstream and downstream uses.

The main arguments in favour of an integrated water management framework are the interrelationship between land and water use and the large seasonal and annual variations in water availability in most tropical and subtropical regions of the world. Such variability increases the demand for infrastructure development and the need to manage water demand and supply. In the future, the increased variability in precipitation and temperature as a consequence of global climate change may further affect the demand and supply of water resources, and an integrated framework that includes demand and supply side measures along with stakeholder participation may be one of the ways to address the challenge.

The traditional approach to water management disaggregates the various uses of water resources, and manages each use independently of the other. Hence, water in a basin that is used for irrigation, hydropower, domestic purposes, or industry is managed separately by the irrigation department, the electricity department, the municipalities or the industries department. This approach is largely supply driven as each department aims to meet the demands of the sectors without focusing on the demand management aspects of water resources leading to fragmented and uncoordinated development and management of the resource. Further, the environmental and ecological aspects of the water resource also need to be adequately represented and need to be given due priority because of their importance in sustaining water resources.



The IWRM framework is therefore a response to the competing demands for water resource across sectors and in response to the declining water quality and ecological and equity concerns within a river basin. In a nutshell, IWRM therefore means that all the different uses of water resources are considered together. Water allocations and management decisions consider the effects of each use on the others.

They are able to take account of overall social and economic goals, including the achievement of sustainable development. This also means ensuring coherent policy making related to all sectors.

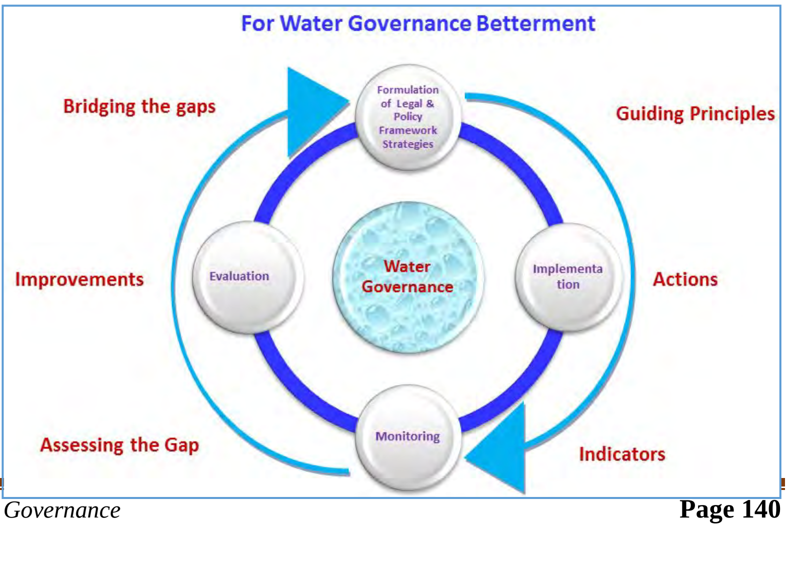
The basic IWRM concept can be extended to incorporate participatory decision-making. Different user groups (farmers, communities, environmentalists) can influence strategies for water resource development and management. That brings additional benefits, as informed users apply local self-regulation in relation to issues such as water conservation and catchment protection far more effectively than central regulation and surveillance can achieve.

Hence in accordance with the principle of demand-driven development, a River Basin Organisation (RBO) needs to be established in response to a perceived and expressed demand for a concerted effort in water management that is expressed by multiple users.

4.11 CONCLUSION

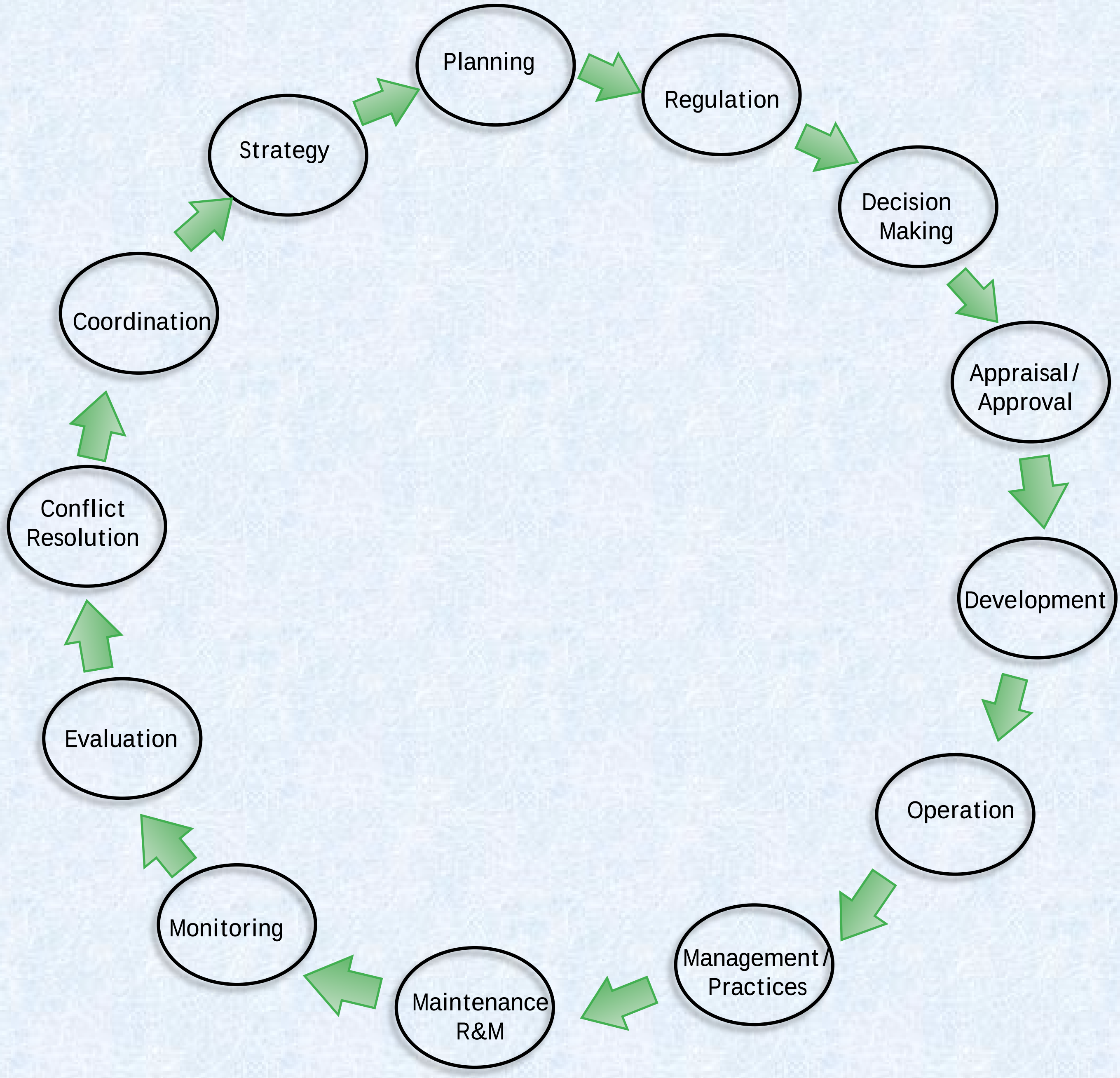
Water Governance in India continues to remain non-uniform, inconsistent, and somewhat inadequate to deal with today's complex water situation characterized by scarcity and depletion of this renewable but limited resource, and increased demand. A business-as-usual approach will not be able to plug the gap between water supply and demand. Good national water management requires a paradigm shift, comprising at least the following: Clear and comprehensive science-based Water Resource Policy at Central and State levels for Integrated River Basin Planning and Management, which focuses on both supply and demand side dimensions of water use. IWRM has been highlighted in the National Water Policy, NWM, NMCG mandate, draft NWFA and River Basin Management Bill and in many national and international forums. Other pre-requisites for successful water governance are:

- ✓ A Water Framework Law at Central level laying out the architecture for planning and regulation and technical institutional support.
- ✓ Effective legislation at State level (based on the Central Model Law) for regulation of ground water and surface water providing an explicit and



increasing role for Municipal and Panchayati Raj Bodies in planning, management, and regulation.

- ✓ Restructuring, strengthening, and empowerment of the existing institutions (Central, State, and local) involved in different aspects of service delivery so as to improve efficiency in management and sustainability of the resource. Also involvement of Private Parties in the form of PPP Model for improvement of the Water Sector.
- ✓ Shift in approach in water resource management from purely engineering works to systems that incorporate traditional practices, local materials and are manageable and maintainable by local communities. The Gram Panchayat as well as the local community needs to be involved at all stages of discussion, planning, implementation, management and maintenance.
- ✓ Funding for R&D to bring in innovation towards resource use efficiency and sustainability.
- ✓ Water Portal with full disclosure of all the data in usable formats, accessible to Government institutions, policy makers, society, and regulatory institutions.
- ✓ Another strategy, which needs consideration, is changes in water pricing structures. Mostly water rates are based only on a small fraction of what it costs to obtain, develop, transport, treat and deliver water to the consumer.
- ✓ Scientific and reliable estimation of surface water resources in river basins and assessment of ground water resources in aquifers.
- ✓ Integration of modern practices and traditional methods of water conservation and management.
- ✓ Capacity Building and sensitization of all the stakeholders regarding Water Rights, Water Use, Water Ethics, Water Security, Water Literacy, Water Laws, Water Science.



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