Integrated Water Resources Management – A framework for action

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1.0 PROLOGUE

A) THE ETERNAL QUEST FOR WATER

Water is a basic necessity of life. According to our religion and culture, it is one of the *Panchmahabhutas* viz Earth, Sky, Fire, Air and Water. The quest for water must have started along with the evolution of human life. According to our scriptures, the great saint Narada enters the *Durbar* of king Yudhisthira and asks "Are your reservoirs full of water ? Are your farmers happy?". The life starts with water, with the child being given a bath, and it similarly ends with water. So water accompanies us through the journey of life.

Earlier, there was enough water for everybody, say, upto the middle of last century. Then the water shortage started, and now it has assumed alarming proportions, with people talking of water wars and what not.

This concern for water quantity (and, later, for water quality also) led the people to do a lot of brainstorming : Why the water shortage ? Is it due to rise in population ? Or change in lifestyle ? Or both ? Is there enough water for everybody on earth and the problem is due to mismanagement, unequal distribution etc? And thus, the terms like water management, equity etc were coined. Then, there were conflicting demands viz irrigation, hydro power, food control, domestic & industrial water supply etc, to which ecolology was added later. It is understood that all this brainstorming and churning led to the idea (or concept) of Integrated Water resources Development and Management

(IWRDM).

B) IWRDM

Perhaps, the idea of Integrated Water resources Development and Management

(IWRDM) must have been as old as the water use itself. For, IWRDM, at its simplest, is a logical and intuitively appealing concept. Its basis is that the many different uses of finite water resources are interdependent. Integrated management means that all the different uses of water resources are considered together.

1.1 International Conference on and the Water and Environment ICWE), Dublin

However, the concept in its present form and meaning, is understood to have emerged with the International Conference on Water and the Environment (ICWE)held in Dublin, Ireland, on January 26-31, 1992.

The Conference concluded that concerted action is needed to reverse the present trends of overconsumption, pollution, and rising threats from drought and floods. The Conference Report set out recommendations for action at local, national, and international levels, based on four guiding principles :

Principle No. 1 – Fresh water is a finite and vulnerable resource, essential tosustain life, development and the environment

Since water sustains life, effective management of water resources demands a holistic approach, linking social and economic development with protection of natural ecosystems. Effective management links land and water uses across the whole of a catchment area or ground water aquifer.

Principle No. 2 – Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels

The participatory approach involves raising awareness of the importance of water among policy-makers and the general public. It means that decisions are taken at the lowest appropriate level, with full public consultation and involvement of users in the planning and implementation of water projects.

Principle No. 3 - Women play a central part in the provision, management and safeguarding of water

This pivotal role of women as providers and users of water and guardians of the living environment has seldom been reflected in institutional arrangements for the development and management of water resources. Acceptance and implementation of this principle requires positive policies to address women's specific needs and to equip and empower women to participate at all levels in water resources programmes, including decision-making and implementation, in ways defined by them.

Principle No. 4 - Water has an economic value in all its competing uses and should be recognized as an economic good

Within this principle, it is vital to recognize first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognize the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources.

The Action Agenda

Based on these four guiding principles, the Conference participants developed recommendations which would enable countries to tackle their water resources problems on a wide range of fronts. The major benefits to come from implementation of the Dublin recommendations were envisaged as Alleviation of poverty and disease, Protection against natural disasters, water conservation and reuse, Sustainable urban development, Agricultural production and rural water supply, Protecting aquatic ecosystems and Resolving water conflicts

It would be seen that this Conference put together all the relevant issues/aspects related to IWRDM. It, incidentally , provided all major inputs for the RIO Conference, as far as the Water sector is concerned.

1.2 United Nations Conference on Environment & Development, Rio, June 1992

The United Nations Conference on Environment & Development, held in Rio de Janeiro, Brazil during June, 1992 (commonly known as the Earth Summit) is known as a landmark in field of sustainable development

(including that of water resources).The conference proposed the following seven programme areas for the freshwater sector :

(a) Integrated water resources development and management;
(b) Water resources assessment;
(c) Protection of water resources, water quality and aquatic ecosystems;
(d) Drinking-water supply and sanitation;
(e) Water and sustainable urban development;
(f) Water for sustainable food production and rural development;
(g) Impacts of climate change on water resources.

It may be noted that Integrated water resources development and management is the first, and foremost, of the seven programme areas. In fact, the chapter on freshwater in Agenda 21 is titled Protection of the Quality and Supply of Fresh Water Resources: Application of Integrated Approaches to the Development, Management and Use of Water Resources, which again emphasizes use of the term IWRDM. However, under IWRDM, the RIO Conference mainly emphasized the issues and aspects highlighted earlier in Dublin Conference.

2.0 IWRDM : INDIAN EXPERIENCE

The concept of IWRDM and the steps needed for its implementation have been discussed in many forums since ICWE and Rio Conference viz. World Summit on Sustainable Development, the World Water Assessment

Report (prepared by 23 UN agencies), the World Water Forum etc, but hardly anything new has been added. The obvious reason : this aspect was covered so thoroughly in the earlier two forums that it left only one thing to be done – IMPLEMENTATION. The implementation – or the present status of IWRDM – is now discussed.

As mentioned earlier, IWRDM encompasses practically every conceivable aspect related to the development, management and use of water resources. An attempt is, therefore, made to cover all the relevant issues/aspects.

2.1 Background

Though water as an element is abundant on Earth, the pool of annually renewable fresh water is limited and is becoming increasingly scarce relative to needs. The water resources in India are roughly 4% of the World's fresh water resources, whereas the country's population is 16% of the World's population.

This is a basic constraint in meeting the growing requirements and is compounded by rapid increase in population. It is rather a delicate balance, which may get disturbed with serious implications unless managed judiciously. Water needs have to be met through methods and means that are sustainable over time both from the point of view of meeting the developmental needs and preserving the eco-systems. Local water resource development and management would also be an important element of the strategy besides creation of large storages for meeting the water needs of the future particularly in water-scarce regions. There is need to lay emphasis on local water planning, water harvesting at micro level and integrated watershed development. The participatory approach to watershed development would involve all individuals in any watershed area in the process of planning a watershed approach and would secure their commitment to execute, monitor and maintain the project even after completion. The traditional water storage structures, which had gone into disuse, need to be revived at the same time. In other words the success of the future strategies largely hinges on finding an optimum balance between modern engineering interventions like dams, large storage structures etc and the traditional methods of water conservation. With the increase in the activities in industrial sector, the water quality is deteriorating day by day resulting the increase in demand. Wastewater treatment should be given due importance and should be taken as an important element in the water resources development and management endeavourers in its holistic approach. Recharging and storage projects both in surface and ground water should consider the water quality issue. Augmentation and quality assurance in unison is the key for meeting the future challenges in a sustainable manner.

2.2 Challenges in Water Sector and the Reform Agenda

2.2.1 Spatial and temporal variation in water resources availability

The average annual rainfall in India is about 1170 mm, which corresponds to an annual precipitation of 4000 billion cubic metres (BCM) including snowfall. As per latest assessment made by Central Water Commission (1993), the average annual water resources potential of the country is around 1869 BCM. Owing to topographical, hydrological, ecological and other reasons, it has been estimated the average annual utilisable water resource (surface and ground) is 1122 BCM of which about 690 BCM is from surface water and 432 BCM is from ground water. There is also a large variation in rainfall both in space and time leading to considerable variation in water availability from region to region, season to season and year to year. Spatial variations are as high as 11000 mm at some parts in the eastern region to as low as only 100 mm in the western parts of Rajasthan. Temporal variations are evident from the fact that nearly 75% of the total precipitation i.e. 3000 BCM is concentrated during the monsoon season confined to only 3 to 4 months i.e between June and September when most of the rainfall in India occurs under the influence of south-west monsoon, except in Tamil Nadu and parts of Andhra Pradesh where it takes place under the influence of north-east monsoon during October and November. 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.

2.2.2 Declining per capita water availability

On an average, the total water resources availability in the country remains the same. The per capita water availability in the county is reducing progressively due to increase in population and rapid growth in urbanization and industrialization. The average annual per capita availability of water which was around 5200, 2200 and 1820 cubic meter in the years 1951, 1991, 2001 would go down to around 1340 and 1140 cubic meter by the years 2025 & 2050 respectively (It is now generally accepted that countries with annual per capita water availability of less than 1,700 cum are water stressed and less than 1000 cum as water scarce). This reflects the National level scenario, though the average annual per capita water availability figures at the basin level may

vary widely. Due to spatial variability of rain in the country and also because of variation in population density, per capita average annual availability of water in different basins presently varies from 16990 cu.m per year in minor river basins draining into Bangladesh and Myanmar, 13636 cu.m per year in Brahmaputra-Barak basin to 298 cu.m per year in Sabarmati basin. This is likely to further accentuate in future and by 2050 it is likely to vary between 187 to 10653 cu.m per year. Furthermore presently, about 5.5% of the area and 7.6% of the population in the country is under absolute scarcity condition (i.e water availability less than 500 cu.m per year) and 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 will be under absolute scarcity condition.

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

A Standing Sub-Committee for assessment of availability and requirement of water for diverse uses in the country constituted by the Ministry of Water Resources in its report (August 2000) assessed the requirements of water for various sectors as shown in the Table-1 below.

Table-1: Water Requirement for Various Sectors

Sector	**Water Demand in Billion Cubic meter (BCM)**			
	2000	2010	2025	2050
Irrigation	541	688	910	1072
Drinking Water	42	56	73	102
Industry	8	12	23	63
Energy	2	5	15	130
Others	41	52	72	80
Total	634	813	1093	1447

The signal of the dwindling gap between availability and demand is evident from the projections made for water demand in the coming decades. The projection clearly indicate that in 2050, the water demand may be significantly higher in comparison to the utilisable water resources of the country. This deficiency may have to be managed by adopting the twin strategy of improved management practices as well as augmenting the water resources availability through newer concepts like inter-basin transfer of water. Improvement of water use efficiency and using the return flows from various uses which are estimated to be around 80% from domestic uses, 10% from the irrigation sector and 65% from the industrial sector forms the key aspects of the future management strategies. However, besides these water management strategies, the newer concepts like inter-basin transfer of water should also be vigorously pursued for augmenting the water availability. Optimum results can be achieved and the demand supply gap can be reduced to the minimum possible extent only when these two approaches supplement each other by acting in conjunction.

The present food grain production, which is about 200 million tones is expected to increase to 500 million tones by 2050. Assuming reasonable yield level, about 160 Mha of land would have to be put under irrigation while the ultimate irrigation potential is about 140 Mha through conventional means. Though, irrigation potential has increased from 19.5 Mha at the time of independence to about 94Mha at the end of the IX Five Year Plan still it is imperative to bring more and more area under irrigated agriculture. Futhermore the increasing population also predicts a steep rise in the domestic water demand. Regarding hydropower generation, the present installed capacity in the country is about one sixth of the total hydroelectric potential in the country, assessed as 84044 MW at 60% load factor (equivalent to an installed capacity of 1,50,000 MW). Against an ideal hydro-thermal mix of 40:60, the present ratio stands at only 25:75.

2.2.4 Inequitable water distribution

The prime reason for the inequitable water distribution has to do with the design concept of spreading water to the large number of farmers possible. This is responsible for poor water management at the scheme level. Throughout the development period, the excess water available is used by the head end farmers. Thus, during an extended number of years, head end farmers grow commercial crops on the full size of their farms with irrigation intensity much higher than those considered in the designs. But, during the same period, construction of the tail end of the scheme continues as per their initial design concept without taking any account of the actual situation which has developed in the upper reaches. As a result, at times irrigation potential is created in places where water ultimately does not reach. In addition there is lack of operational plan for distribution of irrigation water through the various irrigation systems/projects. In absence of these, and even where these are available and not

being followed in practice, the command area in the head reaches generally gets the water while tail areas of the command are deprived of precious water for irrigation. This in turn leads to two major concerns:

2.2.4.1 Bridging the gap between irrigation potential created and utilized

Out of the irrigation potential of 94 M.Ha. created so far, about 80.0 M.Ha is being utilised, which corresponds to about 85 percent utilisation of the created assets. Some gap between the two is bound to occur when river inflows and consequent irrigation supplies are inadequate. The potential area which can be irrigated in a system depends on several factors including, the availability of distribution networks, the volume and seasonal pattern of water supply, the losses in conveyance, distribution and application, the extent to which the conjunctive use is developed and the crop pattern on ground. In so far as the assumptions in respect of these parameters, underlying the project design, are not realised in full, there is bound to be a divergence between the actual area irrigated and the potential created. Delay in construction of distribution networks, actual cropping pattern being different from the one envisaged during planning, more diversion of water for domestic / industrial water supply than planned, are some of the major reasons for the gap in potential created and utilised.

2.2.4.2 Water Logging and Salinity

Continuous use of excessive water in the field has created the problem of water logging and salinity. In maximum cases of the water resources projects, the construction of head work structure took place early and the command area get developed later. Generally a part of the command area in the vicinity of the headwork gets developed and starts using the water in excess quantity by either growing cash crops or applying larger than needed water doses to crops like paddy. This not only affects crop productivity but also leads to water logging and soil salinity. About 5 to 6 m. ha of irrigated areas in major and medium irrigation commands is estimated to be water logged.

2.2.5 Mitigation of drought-flood-drought syndrome

Co-existence of floods and droughts have been one of the most inexplicable paradox in the water resources sector of this country. Flood protection and drought mitigation are therefore major areas of concern and it is imperative to minimize the recurring losses due to floods and droughts for poverty alleviation and maintaining steady economic growth. On an average, area affected by the floods annually is about 7.52 m.ha, of which the crop area affected is 3.52 m.ha. In a span of 44 years from 1953 to 1996, the floods on an average claimed 1515 lives and 95,285 heads of cattle. On the other hand, certain portions of the country for example the Kalahandi-Bolangir-Koraput districts of Orissa are extremely vulnerable to droughts and the resulting loss in life and property is phenomenal.

Since the country faces high spatial and temporal variability as regards rainfall, floods and droughts are potential threats that will continue to inflict miseries. It is therefore of paramount importance to divert the excess flood water to the water starved zones it through inter-basin water transfer schemes.

2.2.6 Increase in conflicts amongst the users of various sectors as also different regions

One of the characteristic features of the water resources sector in the last few decades have been the frequency and intensity of the Inter-State Water Disputes. Being pushed continuously to meet their rising multi-sectoral demand, majority of the States are increasingly opting for a seemingly rigid stance when it comes to inter-State matters, resulting in not only cropping up of fresh issues but also rejuvenating earlier disputes which were thought to have been settled amicably. One of the most effective solutions to this problem, as also highlighted by the National Water Policy lies in the establishment of River Basin Organisations (RBOs). While several committees constituted from time to time has unanimously suggested the need for setting up of RBOs, its other modalities like functions, powers etc. are yet to agreed by all the State Governments. However, efforts in this direction are being made continuously.

2.2.7 Shift from project specific planning to integrated approach with basin or sub-basin as a unit

In India planning so far has been done to serve specific purposes. Several Boards/Commissions/Authorities have been created but they were established mainly to cater some specific requirement like construction of any particular project (Betwa River Board for construction of Rajghat dam), overseeing the regulation and control as per the agreements between the State Governments (Upper Yamuna River Board implementing the MoU signed in 1994), implementing the decisions of the Tribunal (Narmada Control Authority) and in some cases for preparation of river basin master plan (Sone River Commission).

The objective of sustainable development can be achieved through integrated water resources planning, development and management so that the benefits envisaged can be optimized keeping in view the priorities based on socio-economic & environmental demand. This however, essentially requires that the water resources development planning be done with the basin/sub-basin as unit as also advocated by the National Water Policy.

2.2.8 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. A basin wise study conducted by Dr. A. Vaidyanathan and K. Sivasubramaniam of the Madras Institute of Development Studies reports the overall efficiency of around 38% in the country. The study reveals that the Krishna, Godavari, Cauvery and Mahanadi systems have a very low efficiency as around 27% while the Indus and Ganges systems are doing better with efficiencies in the range of 43-47%.The reason behind this is that the peninsular rivers have large areas under irrigation in delta areas where the water management practices are very poor while the rotational water supply ('Warabandi') is practiced in Indus and Ganga Basin.

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
- Absence of volumetric supply
- Inadequate extension services.

2.2.9 Deteriorating water quality

Water pollution is a major environmental concern in India. Some of the root causes of water quality deterioration are ignorance of the full cause/effect relationships of water pollution; and failure to appreciate that water is a near universal solvent and as it moves through both man-made and natural environment, it picks up and transports in solution and suspension, a wide variety of organic and inorganic substances. The main sources of water pollution are discharge of domestic sewage and industrial effluents, which contain organic pollutants, chemicals and heavy metals, and run-off from land based activities such as agriculture and mining. With the increasing use of fertilizers and pesticides in agriculture; the run-off from irrigated lands has been adding to the water bodies a variety of organic and inorganic pollutants. Further, bathing of animals, washing of cloths and dumping of garbage contribute to water pollution. Over exploitation of ground water in coastal and semi-arid areas causes salinity and depletion of ground water levels. Non-availability of minimum flow in the rivers has reduced natural purification capacity of rivers thus increasing pollution. All these factors have led to pollution of rivers, lakes and coastal area and thus affected the eco-systems.

2.2.10 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 overdraft has resulted in failure of wells, shortage of water supplies necessitating deepening of existing structures thereby increasing pumping lifts and pumping costs. 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. Changes in groundwater quality have been observed in major agricultural and industrial belts and urban complexes. This has been due to over use of fertilizers, pesticides/insecticides in agriculture and haphazard disposal of untreated urban and industrial wastes.

In addition to above problems caused due to man's interference, natural factors also affect the ground water quality. It has been estimated that over two lakh square kilometre area in the States of Haryana, Punjab, Delhi, Rajasthan, Gujarat, Uttar Pradesh, Karnataka and Tamil Nadu is affected by inland salinity in ground water. Further, occurrence of high content of fluoride in groundwater in 13 States, high concentration of arsenic in West Bengal, iron in North-East States, Orissa and other parts of the country are caused by natural process.

Regulating and Control of ground water development should therefore be backed by a suitable legislation. Such legislations, however should also address fundamental issues like ownership of ground water etc. The Government of India has been continuously advising the states on the need for such a legislation, however excepting a few states, the rest are yet to enact the legislation.

2.2.11 Improper Drainage System

Proper drainage system should be taken as an integrated part of the project itself. While the expansion of the irrigation system has been received a lot of attention, the drainage part has been overlooked, especially field drainage. This also plays a larger role in water logging problem.

2.2.12 Land acquisition and Environment and Forests clearance of projects

It has been reported that delay in land acquisition and environment, forest & wildlife clearance are the major reasons for non-completion of on-going irrigation projects. The clearance procedures may be simplified to the extent possible.

2.2.13 Co-ordination among the agencies involved in water sector

The multiplicity of the agencies dealing with different areas of water sector is the prime reason behind the lack of co-ordination. The policies and their implementation pertaining to different subjects under the water sector should be closely interlinked so as to optimize the benefits and therefore, bringing all water related subjects under 'one umbrella' is highly significant. Giving a list of the subjects being presently dealt by the different ministries, the Tenth Plan Document adopted by the National Development Council in its 50th Meeting held on 21.12.2002 clearly recommends a single administrative Ministry for water.

3.0 STRATEGIES FOR ATTENUATING THE CHALLENGES

In the preceding section, various issues that the water sector is encountering, have been discussed. There is urgent need for addressing these issues effectively and timely. Broadly, the approach route for mitigating the issues & challenges can be categorized into three principal heads. Category one is to bridge the gap between availability and utilization through developmental activities. The second one is to adopt improved management practices to fill up the gap between creation and utilization and the third one is to bridge the gap between demand and availability by investigation and planning backed by research and development. It is to be however noted that the proper implementation of all the activities identified under each category is of paramount importance to mitigate or even dilute the potent threats being mounted by those steep challenges. Therefore, co-operation and co-ordination among all the agencies involved in the water sector is a dire requirement under the present circumstances.

The approach route for optimum and judicious utilization of water resources may be categorized into three principal heads:-

3.1 Category I - Developmental activities to bridge the gap between availability and utilization

This would include creation of surface storage, renovation of old tanks and ground water development. 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. The live storage capacity which was only 15.6 BCM at the time of independence has presently gone upto 213 BCM. Projects under construction are likely to add another 76 BCM while 108 BCM is to be contributed by the projects under contemplation.

Even after such relentless persuasion to create more storages, till date, the present level of development on the country in terms of creation of live storages is only just more than 11% 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 like Russia, Australia, Brazil, United States, Turkey, Spain, Mexico, China (1111 m3), South Africa etc. India can store only about 30 days of rainfall compared to 900 days in major river basins in arid areas of developed countries. Therefore, there is an urgent need to vigorously pursue the case for creating storages in India, wherever feasible, given it's projected rise in population, urbanization & industrialization.

3.2 Category II - Improved management practices to fill up the gap between creation and utilization

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.

This category would therefore interalia comprise of several management practices including implementation of restructured command area development, water management programme in States, participatory approach to irrigation management, modernisation of irrigation system and performance improvement, rationalisation of water rates, benchmarking of irrigation systems, conjunctive use of surface and ground water etc.

3.3 Category III - Planning and Investigation backed by Research and Development to bridge the gap between Demand and Availability

This would include constituting a group for technology forecast in water resources sector, sponsoring and coordinating research on development of crops which require minimum water and can sustain poor quality/saline water, technology upgradation like using micro irrigation and new approaches for augmenting water resources availability like inter basin transfer of water, artificial recharge of ground water and desalinization of sea water/brackish water.

However, the suitability of the strategy would be case specific mainly encompassing the factors such as water resources scenario, water demand, level of socio-economic-technological development etc.

4.0 THRUST AREAS

4.1 Policy framework and Economic & technical Mechanisms

4.1.1. Policy Framework

Under India's Constitution, water is a "state subject". The most comprehensive water policy statement by Government of India is the National Water Policy (NWP – 1987), later updated in 2002.. In only a few cases has the national policy been translated into specific state level policies. The NWP is, nevertheless, a significant conceptual document. In fact, India formulated its National Water Policy in 1987, much before the Agenda 21 was brought out during RIO Conference in 1992. However, NWP broadly covers all aspects relating to Freshwater mentioned in Agenda 21. This signifies that NWP is a well thought-out Policy document. The principal problem, however, is that NWP is not supported by enabling legislation.

4.1.2. Economic Mechanisms

The existing incentive structure underlies the paradoxical phenomenon that unlike other goods where scarcity prompts efficiency and conservation, water resources continue to be depleted and misused, even under conditions of scarcity. Key features of India's current water pricing regime are:

- Water charges for surface irrigation that are a fraction of costs of supply, have not been revised for years in most states, resulting in no incentive to conserve water either by farmers as consumers or by irrigation agencies as providers.
- Charges for ground water only through the indirect mechanisms of the prices of diesel fuel or electricity charges.
- Subsidized water charges in the urban and rural water supply and sanitation sector which have resulted in poor water service at high cost.
- An inadequately developed and under-priced system of economic incentives and disincentives to control pollution and encourage water saving or reuse.

4.1.3. Technological Mechanisms

Within the technical field, there is substantial scope to alleviate competing pressures on available water through measures to improve the efficiency of delivery systems and to enhance productivity.

4.2 Future perspectives

4.2.1 Options available

Several options are available for carrying out water resources development. Some of these are discussed as under:

i) Small or big dams – For development of all the utilisable water resources in a basin, a discrete cost-effective combination of mega to micro scale of facilities is necessary. Claims that only small size (or only large) dams be adopted are not correct.

ii) Micro watershed development as an option for dams - Both cater to different functions. The former captures rain in situ and supplements/conserves soil moisture for a longer period, whereas the latter hold the run-off in storages of surface waters and make it available through canals for irrigation.

iii) Run-of-the river Hydropower Stations – They can be built downstream of large storages on perennial rivers for reuse of water released through main power stations. Their reliability in post monsoon season is low, requiring shutdowns. Cost per unit power therefore goes high.

iv) Solar and non conventional energy as alternative to hydro power – Although undoubtedly the ultimate inexhaustible source of the future, these alternative sources at present are still in development stage.

With a number of technological choices available as given above, there are varying options as to which to choose. The options are as under:

i) To continue the mode adopted so far i.e. big and small dams.

ii) To shift the emphasis to small dams (in view of the opposition to big dams)

iii) To shift the emphasis to water harvesting etc., discarding dams.

iv) To use a judicious mix of all i.e. big dams, small dams, watershed development, rain water harvesting etc.

The water needs of the country continue to grow, partly due to rise in population and partly due to change in lifestyle of the people. To achieve this ever growing demand for water, the best course would be to adopt option (iv) above i.e. to use a judicious mix of all available methods. In fact, there is no option but to use all available options, for the growing water needs of the nation.

4.2.2 Areas needing thrust

In order to prepare a strategy that comprehensively deals with the issues, thrust must be given on the following areas:

- The per capita storage in the country is about 210 m3 which is way below the storages achieved in many countries such as Russia (6103 m3), Australia (4733 m3), Brazil (3145 m3), United States (1964 m3), Turkey (1739 m3), Spain (1410 m3), Mexico (1245 m3), China (1111 m3) and South Africa (753 m3). There is dire need for creating more storages to cope up with the temporal & spatial variations in rainfall as well as catering to the rising multi-sectoral water demand. Harnessing of 690 BCM utilizable surface water is possible if storages are built to the maximum possible extent.
- Emphasis has also to be laid on:
  - **Restoration of traditional water bodies** – A 'National Project for Repair, Renovation and Restoration of Water Bodies Directly linked to Agriculture' has been taken up by the Ministry of Water Resources.
  - **Maintaining the water quality standards** - A Water Quality Assessment Authority has been constituted by the Government of India to initiate various steps for improvement of surface and ground water.
  - **Assessment of water resources** – The Hydrology Project was taken up with the assistance from the World Bank for the improvement in the field of water resources, both surface and ground water. Phase – I of the project has already been completed and Phase – II has now been taken up.
  - **Wetlands management** – India is a signatory to the Ramsar Convention (dealing with wetlands of international importance). There are a number of important wetlands and a Central sector programme is under implementation by the Union Ministry of Environment & Forests for conservation and management of wetlands. Similarly, a National lake Conservation programme is under implementation for conservation of lakes (including urban lakes) by this Ministry.

- **Environmental and social aspects** – Various laws and acts have been enacted for protection and improvement of the environment, including water resources. It is mandatory to obtain environmental clearance from the Union Ministry of Environment & Forests before taking up certain specified projects (including river valley projects). In case tribal population is effected by the projects, clearance is also to be given by the Ministry of Tribal Affairs.
- **Coastal protection** – India has a coast line of about 7500 km and many areas face the problem of coastal erosion a National Programme for Coastal Protection is under implementation for protection and improvement of coastal areas.
- **Gender issues** – The role of women in water sector is very important, as highlighted by the Dublin and Rio conferences. The National Water Policy of 2002 states that 'Necessary legal and institutional changes should be made at various levels ------ duly ensuring appropriate role for women'. The Guidelines for 'National Project for Repair, Renovation and Restoration of Water Bodies Directly linked to Agriculture' referred above have also emphasized the participation of women in the implementation of the Project.
- Proper operation & maintenance of water distribution systems.

- The projected gap in demand-availability scenario as per the estimations for 2050 essentially necessitate that the research, development and training should have a more pronounced role in water and related sectors. Therefore, some of the areas that need to be focused upon are:
  - Development of crops which require less water and can sustain on poor quality/saline water;
  - Bio-drainage for waterlogged areas;
  - Improving energy efficiency of water pumps used for irrigation;
  - Technology upgradation like use of sprinkler and micro irrigation techniques etc.;
  - Application of integrated and holistic models for assessing the future water scenario taking into account the interactions between various competing uses;
  - Augmenting water availability through:
    - Inter-basin and Intra-basin transfer of water;
    - Artificial recharge of ground water;
    - Desalination of seawater/brackish water. This, however, is relevant only to supply drinking water. Desalination as a source of water for irrigation does not seem to be viable as of now, or in foreseeable future.
    - Recycling and reuse.

5.0 A FRAMEWORK FOR ACTION

Major constraints

Before deciding on an action framework, it will be prudent to pinpoint the major constraints presently faced in the implementation of IWRDM :

A) Water is a state subject

B) Lack of a co-ordinating mechanism

The solutions

A) There seems to be no possibility of the subject of water being transferred to the Central or Concurrent list. Even the National Commission on Integrated Water Resources Development Plan (NCIWRDP) has discussed this issue and stated that 'The current political trends are towards greater decentralization and debureaucratisation. It does not seem realistic to expect that water can be got included in the concurrent list. There have been proposals, from time to time, to include certain subjects in the in the concurrent list but none could be included so far. It is well to remember that 'Forests' got included in the Concurrent list during the 1975-77 emergency' , indicating how difficult it is to transfer such subjects from the State list. So the logical solution is to plan all actions within the existing framework.

B) 'Water' is being dealt by about ten Ministries/Departments. While the Ministry of Water Resources is entrusted with the multi-purpose, irrigation and flood management projects, the urban and rural drinking water supply is being look after by the Ministries of Urban Affairs & Employment and Rural Development respectively. The Ministry of Environment & Forests is dealing with the environmental and forest clearance of water resources projects. It is also implementing several schemes like the National River Conservation Plan, National Lake Conservation Plan, Conservation and Management of Wetlands, etc. The Ministries of Agriculture and Health and the Deptt of Science & tech also deal with Water. However, there is no empowered mechanism for co-ordination. An empowered mechanism needs to be set up immediately. The Ministry of Water Resources is the obvious choice for this role due the following reasons :

i) There are many expert organizations under the Ministry of Water Resources dealing with various aspects of water resources viz Central Water Commisssion, Central Ground Water Board, National Water Academy, National Institute of Hydrology, CSMRS and CWPRS.

ii) The implementation of IWRDM would require extensive collaboration and co-ordination with the other Ministries which can very well be done by MOWR, given the support and experience of the above organizations.

THE ACTION FRAMEWORK

The action should start with the establishment of an empowered co-ordinating mechanism which role may be assigned to the Ministry of Water Resources. The next step would be the collection of information/data about the water related activities of all Ministries/ Deptts. The areas in which MOWR can work would be then identified as under:

a) Areas in which MOWR should enter viz wetlands conservation, climate change, GHG emissions from reservoirs.

b) Areas in which role of MOWR needs strengthening viz command area development, restoration of water bodies.

c) Areas needing closer co-ordination between MOWR and other organizations viz watershed management.

The above task would be gigantic. Nevertheless, the challenge has to be accepted, if the aspirations of the government, industry, other sections of the society and the people at large are to be met. And the time to start it is : NOW.

It is suggested that, in order to achieve this, a unit may be established in MOWR which may be appropriately termed as Central Management Unit or Project Management Unit. It should be manned by experts from various disciplines such as engineering, sociology, economics, management (as it will be a truly multi-disciplinary work), possessing adequate experience in and exposure to various aspects of water resources and, above all, a commitment to the purpose. This unit will be like a 'Think Tank' of MOWR and endeavor to work for implementation of IWRDM, integrating all as aspects viz technical, social, religious, cultural etc. The unit will also have to ensure the involvement of all sectors and sections of the society in this task, right upto the Panchayati Raj Institutions.

6.0 CONCLUSIONS

The water resources sector of India is presently encountering a series of interlinked issues and challenges which if not dealt in totality may prove to have serious ramifications in the long run. There is the challenge of meeting the aspiration of growth in a manner that development is sustained and the growth process does not destroy the delicately balanced environmental and ecological systems. At the core of all this is the challenge of meeting the water needs of the society. Integrated development and management of water resources should be based on the treatment of water as an integral part of the eco-system and as a natural resource whose quality and quantity determines the nature of its utilization. The multi-sectoral involvement and the rising demand owing to fast pace of developssment and consequently the number of stakeholders concerned with water sector makes the policy making and its implementation even more complex, given the fact that the solutions envisaged through those policies need to cater to all the intended target areas, failing which, the possibility of the benefits being

unduly skewed in favour of one sector or the other cannot be altogether ruled out. Therefore, an articulation of prioritized, sequenced, co-ordinated and concerted efforts lies at the core of timely and effective redressal to the challenges presently encountered by water sector.

The Water sector may be facing tremendous problems. But these are not insurmountable. Various estimates indicate that we are still away from being water stressed (It is now generally accepted that countries with annual per capita water availability of less than 1,700 cum are water stressed and less than 1000 cum as water scarce). So there is certainly light at the end of the tunnel; a silver lining in the dark clouds. The need is to start working in the right earnest, with hope and a determination to provide water in enough quantity and of appropriate quality to every sector and individual of the country by 2050.

1. ional rice Congress, Vietnam, November 2010.