Vision 2020 Document for INCSW
In Research & Development in Water Resources & Other Activities

[2013 to 2020 : 3 years Course]

INCSW

Indian National Committee on Surface Water

CWC, MoWR,RD&GR

Contents

Vision 2025 for Research & Development in Water Resources

0 Summary

Research is an essential element of support to the working executives. The outsourced research to the professionals will bring best results. There is an urgent need to integrate the sponsorship efforts of research in water sector amongst ICAR, DST and within MoWR among various institutes. The various emerging research subjects in the water sector need to be prioritized for timely solution to the Minister of water Resources. There is an urgent need to store and disseminate knowledge as per international standards to utilize the investments on the research.

1 Introduction

Water is a basic need for sustaining life on earth. It is vital human beings for survival, sustenance and economic development including day-to-day chores. Water is imperative for domestic use, agriculture, industrial activity, power generation including thermal and nuclear power generation, inland navigation, environment and other socio-economic development.

It is now well recognized that the development and management of water resources need to be carried out in an integrated manner. However, such integrated approach is complex and requires much more than only integration within the water domain itself. The new concepts bring with them a call for unified policies, participatory processes, integrated information and a greater emphasis on social and environmental concerns. For sustaining efficient water resources development and management, sustained research and development is necessary. The R&D efforts should not be limited to merely technological aspect but also cover the action research, policy analysis and research and human resources development (HRD). In general, research and development activities are required to discharge two important functions. The first is to effectively solve the problem and second is to give a continuous feedback to the policy makers for changing water policies towards improved water development and management.

2 Water R&D Setup in India

Most of the research and development activities in water sector at present are funded by the Government and are undertaken in Central or State Government institutions. Several academic institutions have also played a significant role. In recent times, some NGOs have also taken up some studies and research projects, mostly related to social issues of water resources development and management.

Institutes under the Ministry of Water Resources and under ICAR in the Ministry of Agriculture in the Central Government and the Departments of Water Resources/Irrigation/Command Area Development and the attached institutes in the State Governments are the major contributors to the research in water resources. The National Environmental Engineering Research Institute under Central Government and other institutes conduct important water related research concerning health and environment.

A number of agricultural universities also conduct research on water management. Funds are funneled to these universities through the coordinated water management projects by the Indian Council of Agriculture Research. Engineering Institutions also do considerable water related research either through their own funds or through sponsored projects. The IITs; the Indian Institute of Sciences, Bangalore; Anna University, Chennai; Patna University; Jadavpur University, Kolkata; M.S. University, Vadodara; JNTU & Osmania University, Hyderabad; National Institute of Technology, Surathkal; Punjab Agricultural University, Ludhiana; Andhra University, Vishakhapatnam; BHU, Varanasi and many others do notable research in water related problems. Similarly, the National Remote Sensing Agency has a water resources division dedicated to remote sensing applications to water resources.

In the state governments, water related research is done mainly through Irrigation Research Institutes/ River Research Institutes which were established on the pattern of Central Water and Power Research Station, Pune. These

institutes are at different stages of development. In particular, the U.P. Irrigation Research Institute, Roorkee; Irrigation and Power Research Institute, Punjab, Amritsar; the Gujarat Engineering Research Institute, Vadodara; Karnataka Engineering Research Institute, K.R. Sagar; Maharashtra Engineering Research Institute, Nasik and Hydraulic Research Laboratory, Poondy (Tamil Nadu) are conducting noteworthy research. Apart from these, twelve Water and Land Management Institutes (WALMIs) / Irrigation Management and Training Institutes (IMTI) have also been set up. Among the existing WALMIs, those at Aurangabad (Maharashtra), Anand (Gujarat) and IMTI, Trichi (Tamil Nadu) and the Centre for Water Resources Development and Management, Calicut, have been very active in conducting multi-disciplinary research on irrigation management with focus on action research.

The Ministry of Water Resources has three organizations, CWPRS, CSMRS and NIH fully devoted to R&D in water sector. CWPRS is the premier national institute for research in the area of hydraulics of water resources structure related to irrigation, hydropower, navigation, coastal works and related instrumentation. CSMRS is involved in the research related to construction materials, concrete technology, geophysics, rock mechanics, soil mechanics and rockfill testing technology. NIH is devoted to systematic and scientific studies in all aspects of Hydrology with the objective of improving the present practices in planning, design and operation of water resources projects.

The Central Ground Water Board (CGWB) is also a scientific department with a scientific cadre and most of its activities are research oriented. Other organisations of the Ministry namely Central Water Commission (CWC), Ganga Flood Control Commission (GFCC), Brahmputra Board and National Water Development Agency (NWDA) are also very actively associated with studies in the field of water resources development. North Eastern Hydraulic and Allied Research Institute (NEHARI) under Brahmaputra Board also carries out hydraulic model studies and soil/material research.

In addition to the research and development activities in the above organizations, the MoWR operates an R&D Programme under which it provides

fund to promote research in the field of water resources. This financial assistance is provided by way of grants to academicians/ experts in the Universities, IITs, recognized R&D Laboratories/Institutes, Water Resources/ Irrigation Research Institutes of the Central and State governments. Under the existing arrangements, the R&D activities on surface water in the Ministry of Water Resources are planned and monitored through the following committees.

S.No	Activities	Committee
1	Finalization of Research Programme of various Research Institutes of the Ministry and its monitoring.	Indian national Committee on Surface water, Headed by Chairman, CWC
2	Support to National Committees for taking up research schemes.	Standing Advisory Committee (SAC) under the Chairmanship of Secretary(WR)

The coordination of the R&D activities of MoWR related to support to outside organizations has been entrusted to the R&D Division of the Ministry under PP Wing. Indian National Committees on Surface Water covers the wide range of topics under Water Resources Management. The subject domain of the INCSW is as below:

	Subject Domain
1	Management of Floods, Hydraulic Structures (including masonry and concrete structures), River and Estuarine Hydraulics, River Mo rphology, Ground Water Hydraulics, Instrumentation for Seismic and Geophysical Measurements, Open Channel Flow, Pipe Flow, Hydraulic Machinery, City Water Supply and Ports and Harbours
2	Meteorology, Surface Water Hydrology, Evaporation Control, Ground Water Hydrology and Management (Excluding Ground Water Hydraulics), Instrumentation, Real Time Systems, Application of GIS and Remote Sensing
3	Irrigation, Drainage, Agronomy, Water Management, Environmental Impact and Socio-Economic Aspect of Water Resources Projects, Plasticulture Development, Geo-textiles
4	Rock Mechanics, Application of High Technology and Instrumentation and Measurement Techniques
5	Soil and Materials, Structures
6	Water Conflicts, Water Law, Water Policy, Water Economics, Water Management
7	River Water Quality, Liquid Pollution prevention, Sewerage control

3 Results of R&D so far

The existing R&D programme in the country has been able to address many major concerns and issues in the water sector. The research and development work on hydraulic analysis of barrages on permeable foundations conducted by Khosla and his team, design of unlined channels in alluvial soils by Kennedy, Lacey and several other irrigation engineers have found international acceptability. The Volute Syphon design by Karnataka Engineers was an important step in the development of shaft spillways which have got international acceptability particularly for earth and rockfill dams. Local solutions suited to Indian social milieu in regard to irrigation, water management such as Warabandi of the north west, Kudi marammat system of Tamil Nadu, phad and block irrigation of Maharashtra are important innovations. A system of oxidation ponds for sewage treatment and fisheries development as experimented in Calcutta is another innovation. Certain watershed models developed in Maharashtra, Rajasthan, Madhya Pradesh, Punjab etc. are again worthwhile local innovations.

The details of the completed research are available on the web site with the following links:

- http://cwc.gov.in/incsw
- http://wrmin.nic.in/R&D

4 Water Resources Sector – Challenges Ahead

Due to burgeoning population, growing economy and improving standard of living, the country faces a number of challenges in the water resources sector.

These challenges can be classified into three broad categories. The first is to develop the unutilized water resources. The second is to improve the efficiency of present utilization and bridge the gap between the requirement and supply through R&D efforts and increase water productivity. The enhancement of the level of utilizable resource from the present estimate of 1122 BCM towards a

higher potential may be considered as the third challenge. Ultimately economy, safety, durability, productivity, efficiency and equity has to be realized.

Average annual water resource potential of the country has been estimated as 1869 BCM. However, in view of hydrology, topography and geological limitations, only 690 BCM of surface water can be utilized. The average replenishable ground water has been assessed as 432 BCM. Thus the total utilizable water resources are about 1122 BCM. The availability of resources in the country is very skewed. Ganga, Brahmaputra and Meghna basins cover only 33.5% of land area but command 62% of water resources. The Western Ghats cover only 3.5% of land area but account for 10% of water resources. Thus 37% of the land has 72% of water resources while the remaining 63% has to only 28% of resources.

As a result of vast irrigation development during the past 50 years, the country has not only become self-sufficient in food grain production which has increased to more than 200 m tones but is also in a position to export it. However, the population of the country is increasing and is expected to stabilize by 2050 at 1640 million, requiring 380 million tons to 450 million tons of flood grains. Keeping in view the above projections and other related factors, it is estimated that the total irrigated area will have to be increased to 113 mha (low demand) to 146 mha (high demand) for which water requirement will be of the order of 628 BCM and 807 BCM respectively.

As per the present estimate of MoWR, total water utilization for all use is 605 BCM. The demand pattern is also changing with increase in population, urbanization and fast industrialization. The NCIWRD has estimated water requirements for different uses such as irrigation, domestic, industry, power, navigation and environment etc. for low & high demand scenarios, which indicates a total requirement of 843 BCM in 2025 and 1180 BCM in 2050 for high demand scenarios. Thus it is seen that the demand in 2050 is expected to outstrip the availability of 1122 BCM. However, there is scope for increasing the estimated utilizable water through measures like inter basin water transfers,

proper regulation of reservoirs, recycling and reuse of water, desalination of saline water, artificial recharge of ground water etc.

5 Vision for R&D in Water Sector

The Vision for R&D is an integral part of the overall vision for the water resources development. Most of the elements identified in the Vision Document for Integrated Water Resources Development and Management require sustained R&D efforts. The key elements of the above vision have been given in the preceding para: Water Resources Sector - Challenges Ahead. In order to realize the vision for water sector, knowledge gaps are required to be filled up through focused R&D efforts.

5.1 Objectives of R&D Programme of MoWR

1. To find practical solutions to the country's water resources related problems, to improve available technology and engineering methods and procedures.
2. To maintain a lead in the latest technology so as to enable export of expertise from India, in competition with other developed nations, to countries that import such expertise, in order to earn foreign exchange, increase GDP and provide employment opportunities for Indians abroad.
3. To review the state of the art in the country in different branches of the subject area by collecting relevant information from national and international organizations and publish "State of the art Report". To prepare and maintain a comprehensive documentation, preferably using IT, of R&D done so far at national as well as international level.
4. To prepare, co-ordinate and recommend funding of research programmes to be taken up by the institutions in the country on basic and applied research, action research, and other areas related to research in the subject field.
5. To review the R&D programme in the subject area: identify topics which need immediate attention and encourage the national institutions to take up research on these topics.

6. To disseminate information and stimulate thinking related to the subject field by publishing journals, research news/digests; arranging and conducting seminars/ conferences/ workshops; supporting mass awareness programmes.
7. To provide support for the infrastructure development of research institutions working in the water resources sector.
8. To encourage indigenous industry to take up technology development in the subject area.
9. To promote and co-ordinate effective participation of India in the International programmes related to the water resources.
10. To promote educational, training and Human Resources Development programmes in the subject area.

5.2 Policy Focus of R&D

1. The problems requiring R&D efforts in a region should be dealt by the institutions/ organization located in that particular region. For example, the flood problem to be handled by institution in Bihar & Assam and drought issue by organization in Rajasthan/ Gujarat.
2. The determination of hierarchy of priority areas for R&D and its adherence is essential for achieving the optimum benefits.
3. It is necessary to build systematically a body of data and information system. Scientific in approach and comprehensive in coverage together with a system of data exchange and information dissemination in order to address our concerns in the water sector effectively through R&D.
4. Consolidation of past experience and innovation and building up them are required to further develop technologies and systems to address our present and future concerns.
5. Highest standard of R&D activity is essential for ensuring rapid sustainable development of water resources and optimal utilization of the full resource.

6. Effective coordination is to be maintained to avoid overlaps in the research programmes of different institutions.
7. The research and development of new technology and methods in water resources and related areas in the country should be funded in a continued and sustained manner.
8. The trained and motivated manpower is one of the most crucial inputs for deriving maximum sustained benefits from the water resources of the country. Only the best available talent supported by an intellectually invigorating environment, resources for R&D; and freedom of action can cope up with the emerging challenges in the planning and development of water resources.
9. The links between academic institutions engaged in R&D in water resources and the technical personnel in the water needs to be strengthened so that the academicians could realize the gravity of practical problems and issues in order to better appreciate the crux of the issue so as to address and find solutions for them.
10. The implementation of the findings of research will be ensured to realize the ultimate objectives.

5.3 Research Needs

An attempt has been made to identify the knowledge gaps and research needs in the water resources, the areas / topics where the research is required to be carried has been identified and the same has been presented at annexure 1.

6 Challenges for R&D in Water Sector

The challenges for R&D emerge from the challenges in the water sector. It is seen that the country's total water requirement barely matches the estimated utilizable water resources. The balance between the requirement and availability can be struck only if utmost efficiency is introduced in water use. R&D for the improvement of efficiency in irrigation and other uses is very important. Average availability at national level does not imply that all basins are capable of meeting their full requirement from internal resources. Therefore, a realistic assessment

of availability of water its time distribution and long term changes in its characteristic is required. With global warming, the study of climate changes and its impact on the quantum and distribution of water resources is required. Similarly, improvement in productively per unit of water is another important challenge for R&D.

As mentioned earlier, to enhance utilizable flows, it is imperative to explore the possibilities as enumerated at Annexure 1 which require R&D efforts.

7 Strategy for Implementation

To achieve the objectives of R&D Vision for INCSW , the research and development efforts should be focused on the priority areas. There are several Central/ State research institutions and Universities including private Universities which are carrying out important research work in water sector. These institutions have very good infrastructure and manpower to carry out research and development activities. With proper monitoring, the huge infrastructure and manpower available with them can be better utilized. These institutions may, therefore, be encouraged to carry out research works in the priority areas. Similarly, academic institutions, such as IITs, NITs, etc. need proper nurturing to provide excellent infrastructure and environment for research and should be encouraged to take up R&D schemes in priority areas. During the early Plan era a number of research institutes/ organizations were established by various State Govts. in the field of irrigation/ water resources. These institutions carried out important R&D works and contributed significantly in the development of water sector. However, in course of time some of these institutions have fallen into bad shape. These are either not able to function properly due to shortage of financial resources or suffer due to lack of proper research personnel. WALMIs and Irrigation Research Institutes in many states are glaring example of such malaise. These research institutions need to be strengthened both financially and with proper and trained manpower to carry out the tasks assigned/ envisaged for these institutions.

The stakeholder/user participation in the implementation of R&D scheme would be effective in efficient and meaningful implementation of R&D schemes.

7.1 Methodology of Work

Timely funding to the research schemes shall have to be ensured for realizing envisaged objectives. The funds need to be routed through Chairman, CWC for timely release, proper monitoring and implementation of the R&D works in time-bound manner. The Work Powers shall be required to be delegated to Director, INCSW Dte. for taking up the activities of the web site, events, publishing of research abstracts and to work as the Member Secy. INC-SW has to co-ordinate with Director, R&D who is the Member secretary of SAC for ease of Business.

7.2 Effective Dissemination of Research Results

One of the most important task in the research programme is proper documentation and the dissemination of the findings of the research to the probable end users. Based upon the nature of research, various media should be used to disseminate the findings. This can be done through traditional means like publishing of research reports, dissemination of results through technical journals/ periodicals, foras such as seminars, symposiums and workshops. The electronic media should be extensively used for this purpose. A dedicated website for R&D is a must in this regard which should provide details about the R&D programme, findings of completed research schemes and brief details about the ongoing research projects. The knowledge dissemination may also be revenue generating platform. The involvement of likely end users in the implementation of the research scheme, thus making them an integral part of the research programme would be an effective way of dissemination of research results to the end users.

8 Innovative and Collaborative activities:

INCSW is actively engaged in the collaborative activities of various networks in water sector. Being a National Committee of ICID in India it is actively engaged

at International platform. At national level it is planning to collaborate with Indian Institute of Public Health Engineers [IIPHE], Indian Water Resources Society[IWRS], Institution of Engineers [IE], The Energy Research Institute [TERI] and International Bodies like IWMI, WWC, GWP, IWA, World Bank, FAO, ADB. INCSW is also working with other inline Ministries and Departments like DST, Drinking Water, Rural Development, Power, Urban development etc. for creating common portal on R&D of water sector.

Work is underway to steer the success for 9th International Micro Irrigation Conference to be held in India in January, 2019 with Industry partners and to bid for hosting International level event in the year 2020

9 **Awards:**

Water Flow Awards is a new concept to reward the water sector work. Following fields are identified for the awards :

- Breakthrough Water Technology of the Year
- Smart Water Company of the Year
- Water Project / Wastewater of the Year
- Best Irrigation Project of the year
- Best Water State of the year
- Water Leaders Award

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Annexure-1

Research Needs in Water Resources 2017 and ahead

1. Hydraulics Domain

- The impact of flood control marginal embankments on river regime, the possibility of aggradation, drainage congestion on the land side of the embankments.
- River control and management, prevention of bank erosion, hydraulics of alluvial river mechanics of meandering.
- Hydraulic roughness of sediment transporting channels subject to changing bed formations.
- Real time simulation, flood plain zoning and hazard mitigation
- Use of ANN for risk based analysis.
- Design of less costly sedimentation chambers for hydro stations.
- Evaluation of plunge pools cascades ramps with friction elements for energy dissipation.
- Evaluation of three-dimensional seepage under relatively narrow long structures.
- Three dimensional dynamic analysis for rigid and embankment dams for earthquake conditions. Other problems which cannot be foreseen may emerge while designing a project and will then require specific research effort.
- Uncertainties and risk based design of hydraulic structures
- Research in the field of plugging of tunnels under high head
- Quantum of minimum flows in rivers from environmental considerations and right of water users on the banks
- Hydraulic roughness of sediment transporting channels subject to changing bed formations.
- Siltation of estuaries and the quantum of flow or other measures needed to flush them.
- Computation fluid dynamics such as one dimensional and two dimensional flows in rivers and flood plains respectively.
- Integration of scale effect between hydrology and hydraulic phenomena
- Soil erosion in catchment area under sediment yield of river
- Decision support systems for morphological behavior of rivers
- Development of water level sensor for measurement of river stages and design of installation structure

2. Hydrology Domain

- E-Flows
- Modification in basic concepts, objectives, evaluation criteria and development approach for sustainable development of water
- Development of computer oriented decision support system in view of uncertainties, non-linear interlinkages and differences about valuations.
- Reassessment of water availability (representation of the hydrological cycle and of the utilizable quantity and its quantification through the modelling of the hydrological cycle)
- Impact of human interventions on quantity and quality of water
- Contribution from snowmelt and glaciers
- Assessment of the return flows
- Study of climatic change on the hydrological cycle
- Desalination of saline and sea water (improvements in membrane technology)
- Estimate of habitat demand
- Estimate of the demand in the long term
- System studies for each river basin to determine the sustainable development policy
- Improvement in development policy to account for Climate Change
- Forest hydrology – impact of tree cover on peak flows, low season flows.
- Assessment of groundwater and its interlinkage with surface water
- Research for Basic concepts, local application, adaptation and upgradation in respect of:
    - Promoting water infiltration and reducing soil erosion by watershed treatment
    - Ground water recharge by ponds, recharge wells and through unlined khariff irrigation channels
    - Rainwater harvesting and watershed development
    - Revival of traditional systems of water harvesting and storage
- Rights on ground water
- A realistic assessment of availability of water, its time distribution and long term changes in its characteristic
- Assessment of groundwater and its interlinkage with surface water
- Assessment of the return flows
- Ground water recharge by ponds, recharge wells and through unlined Khariff irrigation channels
- Rainwater harvesting and watershed development
- Assessment of the potential of traditional systems of water harvesting and storage
- Study of Climate Change with regard to its impact on water resources
- Inflow forecasting

3. Irrigation & Drainage Domain

- Impact of Automation in the operation of existing and new canal systems.
- Deficit irrigation
- Lining of canals under running water conditions
- Various techniques for prevention and relief of water logging, reclamation of saline lands.
- Bio-drainage System for maintenance of salt and water balance on long-term sustainability
- Soil nutrient management with a balanced use fertilizer
- Genetic engineering (to produce transgenic material of traits pertaining to shorter growing season, resistance to pests and viral infections, improved nutritional or flavor characteristics, longer shelf life etc.
- Estimation of water demand and its implications on water quantity and quality
- Management of water demand, through technology, policy and specifications
- Rationalization and optimization of demands in Agriculture Sector
- Improvement in productivity per unit of water
- Research to provide guidance to the farmers for Crop planning
- The equity aspect of water (Do the disparities in income really increase in an irrigated area?)
- System of operation and management of large canal system
- Participatory Irrigation Management
- Crops and Crop Planning for Flooded and Flood Prone Areas
- Pilot demonstration of growing paddy with less irrigation water
- Improvement of efficiency in Irrigation System
- Development of indigenous technology for automated irrigation under controlled environment using modern methods, Drip and Micro Sprinkler
- Rainwater harvesting, conservation in command area for use in supplementing canal waters
- Improvement in water use efficiency through effective water management technologies and human resources development through Participatory Irrigation Management (PIM)
- Comprehensive integrated and multi-disciplinary planning for disposal of large quantity of saline water effluents, sewerage and industrial waste, its reuse and impact on soil health and environment
- Actual observed impact of existing high dams and other irrigation systems on the environment
- Assess the impact of large scale inter basin transfers on donor and donee basins
- Assessment of impact on income, employment and acquisition of household goods due water resources development and management
- The impact on the workload and status of women of farming families and the changes in their quality of life
- Regular post evaluation studies for major and medium Irrigation projects including primary, secondary and tertiary benefits
- Integrated Control of aquatic weeds
- R&D Strategy in Dams regarding Green House Gases – rotting vegetation in Dams – Global Warming

4. Geo-technical Engineering Domain

- Comparison of DEM technique with FEM technique for analysis of various underground structure
- Fracture mechanism in rocks.
- Well foundation analysis of tilting foundations
- Field evaluation of blasting patterns
- Software development for rock mechanics problem
- Strength Behavior of weakly cemented rock
- Blast induced Damage to rocks
- Long term measure for solution to land slide problem
- Centrifuge modeling of problems related to water resources development projects
- Use of GIS software for sub-surface data collection.

5. Construction Materials & Structures Domain

- Cost effective canal linings including materials and techniques.
- New materials/coatings to resist cavitation and abrasion.
- Prestressed concrete technology including stress corrosion.
- Durability of construction materials/concrete.
- Non-destructive techniques: Applications/reliability.
- Micropiles: Materials/techniques.
- Polymers: Materials and application techniques.
- Chemical grouts: Materials and application techniques.
- Admixtures for concrete: Materials and efficacy.
- Alkali-aggregate reaction.
- Corrosion of reinforcement
- Roller Compacted Concrete (RCC) technology: Materials and techniques.
- Fibre Reinforced Concrete for hydraulic structures: Materials/techniques.
- Ferrocement: Materials/techniques.
- High Strength Concrete: Materials/techniques and performance monitoring
- Evaluation and research on emerging construction technologies and new construction materials.
- Safety of water resources structures: Instrumentation and performance monitoring.
- Repairs/rehabilitation strategies for hydraulic structures: Materials compatibility and techniques.
- Design, construction, inspection, repairs and safety of Concrete & Masonry Dams:
    - Analysis and design: Defining and reviewing parameters like factors of safety, allowable stresses for analysis, reviewing models for dynamic analysis etc.
    - Construction practices: Improvement of existing practices and the development of new techniques for the economical heightening of concrete/ masonry dams and assessment of the performance of dams constructed, using new techniques like RCC and new composites.
    - Inspection & monitoring: Improving underwater inspection techniques and to evolve a quantified rating system for preliminary inspections.
    - Repair & maintenance: Evaluation of commercial polymer systems and the development of a rating system for their performance and the development of better abrasion resistant composite materials.
    - Earthquake Consideration
        - The influence of construction joints
        - The concrete rock contact
        - Pressurized cracks
        - Fracture mechanics for triaxial structures and loads
        - Fracture Mechanics for dynamic loads (speed, fatigue)
        - Numerical analysis
- Colcrete & Colgrout Masonry construction

6. Water Law, Conflicts

- Water Administration in Federal setup
- Water Law
- Water Sector Conflict & Governance.

7. Water Management, Economics

- Innovative Financing in water sector
- Water harvesting, watershed development and revival of traditional water storage structure.

8. Water Quality, Reusability

- Recycling of treated sewage/ wastes water for industrial use and irrigation
- Estimate of demand and return flows of water in respect of Industrial and thermal energy requirements
- Impact on water quality and environmental conservation. in respect of Industrial and thermal energy requirements
- Recycling and reuse of waste water
- Desalination of saline water

9. Miscellaneous

- History of Water Resources Projects/Dams