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MANPOWER REQUIREMENT AND EMPLOYMENT IN INDIA

Dr. Satish Chandra
Chief Hydrology Consultant
Consulting Engineering Services(India) Ltd.,
New Delhi

ABSTRACT

India is basically an agricultural country, where water is the single most important element for development. Other important users of water are domestic and industrial water use besides hydropower and recreation. The available water resources are limited and unevenly distributed in time and space. The data system is poor, with inappropriate storage and retrieval, processing and analysis and planning systems.

The present institutional arrangement for development, control and management of the limited water resources, quality of available manpower, facilities and training programmes are too inadequate for the requirement. There is a need to analyse and develop the proper system and need for qualified and adequate manpower assessed and requirement arrived at. Also, the steps taken to train the required manpower and arrangement for placement and employment worked out and implemented.

This paper discusses the water availability, present level of development and future needs; observation network, data systems, and institutions engaged; type and number of personnel required; present status and shortfalls; employment opportunities and actions required.

1.0 INTRODUCTION

The increasing population and the growth of economic activity has resulted in greater demand for water. The available water resources are limited and this water scarcity is the limiting factor for development. The problem is further aggrevated by the uneven distribution of water in time and space.

With the increasing need of water resources development, it has become necessary to have an improved system for scientific planning and management of water resources. Reliable data has to be compiled and analysed for proper assessment of quantity and quality of available water resources to prepare plans for appropriate and optimal use of the limited water resources. At present water resources development projects of irrigation, hydropower, water supply for domestic and industrial use, navigation and recreation are frequently executed without adequate investigations and hydrological data needed for preparing scientific, systematic and practical plans and designs of the projects. Therefore, regular and systematic collection of data has to be promoted, accompanied by a system of processing quantitative and qualitative data for the assessment of water resources potential. These water resources have to be planned in an integrated and rational manner for optimal and scientific development. This calls for modernisation and strengthening the existing organisations with a proper and adequate manpower competent to handle the situation appropriately and scientifically. If necessary, new organisations be created which could help in achieving the objectives of required economic development, minimise the uncertainty of water input and maximise the benefits in the socio-economic framework.

2.0 WATER AVAILABILITY, PRESENT LEVEL OF DEVELOPMENT AND FUTURE NEEDS

2.1 Water Availability

The rainfall is the main source of water resources of India. It takes place under the influence of South West Monsoon between June to September except in Tamil Nadu where it is under the influence of North-East Monsoon during October and November. The northern Himalayan region received precipitation in the form of snowfall which amounts to....mham annually mainly in the western region. The average annual precipitation over India is of the order of 1170 mm depth which totals 400 mham. This exhibit great variation in time and space and frequent departures from normal in different years.

The average flow resulting from this precipitation has been estimated at 188 mham. 90% of annual runoff in pennisular rivers and over 80% of annual runoff in Himalayan rivers occur during the monsoon months of June to September. But the actual amount of water that can be utilised is much less as major part of river flow occur as flood flows during two to three months. The recent estimates made by Central Water Commission puts the utilisable water resources at 69 mham. By inter-basin transfer an additional water to the extent of 25 mham will also be available.

Groundwater resources are estimated by CGWB at 61 mham, out of which the utilisable ground water is put at 45.34 mham. Through inter-basin transfer an additional 10 mham of ground water will be available.

2.2 Present level of water development

Major user of water is irrigation. In 1950-51 although the net sown area was 110 Mha but only 21 Mha were provided irrigation water in 1990, the net sown area increased to 140 Mha (42 by surface water and 35 by groundwater). But the irrigation potential created has not been fully utilised, and the actual utilisation has been 69 Mha. The actual water used for irrigation is 42.8 Mham (30 from S.W. and 12.8 from 6 W).

The water used for other purposes is far less. The total urban and rural population of the country at present may be taken as 23 crores urban and 67 crores a rural population. Under the International Drinking Water Supply and Sanitation Decade programme launched in 1981, it has been aimed at providing adequate drinking water facilities to 90% of the urban population and 85% of the rural population, and sanitation facilities to 50% of urban and 5% of rural population. Actual and projected decadewise urban and rural population in India is given in Table 1. It is estimated that about 2.5 Mham (0.7 from SW and 1.8 from 6 W) are being used for community water supply in urban and rural areas, out of which 1.0 Mham of water is used for urban communities.

Water use for industries has not been precisely estimated rough estimates for water use for industrial purposes is put at 1.5 Mham, almost entirely from surface water. The present water use for thermal and nuclear power plants has been estimated at 0.4 Mham. The consumptive use of water as evaporation from reservoirs is estimated at 2.0 Mham.

2.3 Future Needs

The country's population has been growing steadily and is at present stands at 900 million and is expected to approach 1000 million by the turn of the century. If family planning programmes are effectively pursued the population as per an estimate of Planning Commission can be contained at 1230 million. The food grain production stands at 175 million tonnes which is expected to reach 210 million tonnes by 2000 A.D. and 240 million tonnes by 2025 A.D. This would call for creating additional irrigation potential. During the eighth plan it is proposed to add 20 Mha (10 from SW and 10 from GW), creating total irrigation population of 97 Mha. It is estimated that by the year 2000 A.D Irrigation water use will increase to 63.0 Mham (42 from SW and 21 from GW). By the year 2025 AD it may reach 77.0 Mham (51 from SW and 26 from GW).

As per the International Drinking Water Supply and Sanitation Decade Programme 90% or urban and 85% of rural population has to be covered for the entire country. The table gives the projections of domestic water supply - percentage of urban and rural population covered and the per capita rate of water use in 2000 AD and 2025 AD, including sanitation requirement. It has been estimated that by the year 2000 AD, the domestic water supply demand may increase from 2.5 Mham to 3.0 Mham and will increase to

Table 1: ACTUAL AND PROJECTED DECADEWISE URBAN AND RURAL POPULATION OF INDIA (Population in million)

Year	Total population	Total number of towns	Break up of Population	% Population	population	%
1951	363.13	2044	298.85	82.76	62.28	17.24
1961	438.01	2330	359.77	82.03	78.24	17.97
1971	458.16	2531	439.10	81.10	109.10	19.90
1981	685.17	3245	524.46	76..69	159.73	23.30
1991	843.93	4100	604.00	71.75	230.00	28.20
2000+	1000.00	5100	680.00	68.00	320.00	32.00

+ -Projected

5.3 Mham by 2025, whereas the industrial demand will go upto 3.0 Mham and 12.0 Mham by 2000 AD and 2025 AD respectively. The consumptive requirement for Thermal and Nuclear power will rise to 0.6 and 1.5 Mham respectively. The status of Annual requirement of fresh water estimated by CWC is given in Table 2.0.

At the ultimate stage, entire potential of hydropower of 84000 MW will be achieved through additional 260 storage schemes and 460 run of the river schemes. This would involve total storage of the order of 37.5 Mham which will have a total evaporation loss of 7.5 Mham.

Thus, the total requirement of water in the year 2025 would be around 105 Mham whereas the available utilisable potential of 114.0 Mham (69 of SW and 45 of GW). The available water resources will be further increased by 10 Mham by Interbasin making a total of 19 Mham for further exploitation.

3.0 HYDROLOGICAL AND HYDROMETEOROLOGICAL NETWORK

Different types of hydrological and hydrometeorological data are being collected and stored by various central and state government

Table 2: ANNUAL REQUIREMENT OF FRESH WATER (Estimates by CWC)

Unit: mham

	1985 AD		2000 AD		2025 AD	
	Surface Water	Ground Water	Surface Water	Ground Water	Surface Water	Ground Water
1. Irrigation	32.0	15.0	42.0	21.0	51.0	26.0
2. Other uses	4.0	3.0	8.0	4.0	19.0	9.0
i) Domestic & Live Stock*	1.67		2.42		4.0	
ii) Industries	1.0		3.0		12.0	
iii) Thermal Power*	0.43		0.58		1.5	
iv) Misc.*	3.9		6.0		10.5	
Sub-Total	36.0	18.0	50.0	25.0	70.0	35.0
Total	54.0		75.0		105.0	

* Approximate

organisations. The principal types of the data and the concerned data collecting agencies in India are given in table-9. The status of the hydrological and hydrometeorological network is summarized hereunder.

3.1 Network of Hydrometeorological Stations

In view of wide variations in the rainfall data, it is necessary to have a suitably designed network of the raingauges and other hydrometeorological observation station in the country. Keeping in view the importance of rainfall data its observation began since 1891 and daily rainfall data are available for about 3000 stations, since then. For the measurements of other climatological variables such as temperature, humidity, radiations, wind speed, pan evaporation etc., some meteorological observatories have also been established at a few locations by various central and state government agencies. The status of network of the meteorological stations maintained by the various organisations including the India Meteorological Department in the country is as follows:

i)	Ordinary rain gauges maintained by IMD	5500
ii)	Self recording rain gauges maintained by IMD	1000
iii)	Rain gauges maintained by State Governments	4500
iv)	Pan evaporation stations	320
v)	Agromet observations maintained by agricultural universities	130
vi)	Lysimeter stations maintained by agricultural universities	40
vii)	Climatological & hydro-meteorological observatories maintained by IMD	650

In addition more than 5000 non-reporting raingauge stations are being maintained by specific agencies like railways, forest departments, and river valley projects etc. and these data remain with the concerned authorities and do not find place in the published records of rainfall. Some meteorological observatories are maintained by IMD in the Himalayas where snow gauges on snow poles have been installed to measure the quantity of snowfall.

At the instance of Central Water Commission, IMD reviewed that there should be at least one ordinary rain gauge for at least every 500 sq.km. Accordingly there is a plan to install 1200 additional gauges. The ultimate aim is to have one gauge for every 250 sq.km. The recording gauges network is also inadequate, and it is proposed too have one self recording raingauge for every 2500 sq.km. The present network of snow gauges is too poor and it is necessary too augment the network, conduct snow surveys, snow depth measurement including glaciological studies.

For the measurement of evaporation and evapo-transpiration, there is a poor network of pan evaporation measurement and lysimeters. The requirement is one station for every 13000 sq.km. and the density could decrease as one station for every 3000 sq.km. for arid regions as recommended by WMO.

3.2 Network of Gauge and Discharge Sites

The wide variations of very high order in the water resources availability, both in time and space calls for a properly designed network of hydrological observation stations which are properly equipped. Initially, most of the hydrological observation stations were established to meet the specific requirements such as project planning, flood warning etc. However, subsequently the importance of properly designed network was duly recognised and systematic effort was initiated too establish network in all the major river systems in the country. At present, the Central Water Commission maintains about 550 hydrological observation sites. In addition the state governments also maintain a large number of sites of different categories. In India, the sites are generally categorised as follows:

a) G D S & W Q Sites : Sites where observations for gauge, dis-charge, silt as well as water quality are made on regular basis.

b) G D S Sites : Sites where observations for gauge, discharge and silt are made on regular basis.

c) G D Sites : Sites where observations for gauge and discharge are made on regular basis.

d) Gauge Sites : Sites where observations for gauge are made on regular basis.

Table 3: Hydrologic Data for Water Resources

Particulars	Data				
	IMD	CWC	CGWB	GSI	State Govt.Deptts.
Storms	✓		✓	✓	✓
Precipitation	✓	✓		✓	✓
snowfall	✓	✓		✓	✓
Ice	✓				✓
Air Temperature	✓	✓			✓
Soil temperature	✓				✓
Water temperature	✓	✓			✓
Evaporation	✓	✓			✓
Solar radiation	✓				
Wind	✓				
Humidity	✓	✓			
snowfall					✓
(i) Gauge		✓			✓
(ii) C & D		✓			✓
River, lake, reservoir stage		✓			✓
Sedimentation		✓			✓
Suspended load		✓			✓
Reservoir sedimentation		✓			✓
Chemical quality of water		✓	✓		✓
Soil moisture					✓
Density currents					✓
Tides					✓
Floods		✓			✓
Drought		✓			✓
Water use and waste disposal					✓
Drainage					✓
Sewage and waste disposal					✓
Industrial use			✓		✓
Infiltration					✓
Interception			✓	✓	✓
Ground Water			✓	✓	✓

***(Source:** Report of the Task Force on water Resources, 1985)*

Majority of the sites are regular where observations are taken throughout the year on all the working days. Some of the sites are categorised as permanent sites where observations are made on a long term basis while a few other on lesser important tributaries are identified for observations for limited period of about 20 years or so. Once sufficient data are available for establishing a suitable relationship, such sites are closed and sites are established at some other location or on some other tributary.

In addition some of the sites are established for observation during the monsoon season only. Such sites are generally used for the limited purpose of flood forecasting and flood control operations. At most of such seasonal sites, hourly water level is observed and at some of the sites discharge measurements are also made on daily or weekly basis.

For the purpose of establishment and operation of hydrological observation stations Central Water Commission has divided the country into three zones viz., North, East and South. In all there are about 540 gauge & discharge stations presently under operation by the Central Water Commission basinwise details of which are presented in table-10. In addition to above, a number of sites have been established by state government agencies.

With a view to ensure accuracy in observations, considerable steps have been take to equip the sites with modern equipments. Quite a good number of sites have been provided with automatic water level recorders. The discharge observation is generally taken by current meters. Earlier at most of the places cup type current meters were used but recently they have been replaced by propeller type current meters at a number of sites. The conventional navigational equipments such as ordinary boats or boat with OB-engines or motor launches are gradually being replaced by catamaran and moving boats.

The state departments are observing stage and discharge of rivers at nearly 1000 stations. This network is far below the standards laid down by WMO, and steps are being taken to gradually expand the existing network.

3.3 Network of Water Quality Data

For the study of the environmental aspects of the water resources projects the monitoring of the various water quality data is essential. While collecting the water quality data the following aspects are generally taken into consideration:

i) to have an overview of the spatial variation of the water quality parameters;

ii) to determine the temporal trend of water quality, if any;

iii) to detect violations over prescribed water quality standards; and

iv) to identify the polluted stretches (places) for planning the pollution control programme.

Table 4: Statement Showing Basinwise Hydrological and Sediment Observation Stations of Central Water Commission

S. No.	River Basin	No. of Stations G&D	GDS /WQ	Total
1.	Indus	8	10	18
2.	(a) Ganga	113	114	227
	(b) Brahamputra & Meghna	11	20	31
	(c) Barak	9	10	19
3.	Godavari	29	20	49
4.	Krishna	23	25	48
5.	Cauvery	3	19	22
6.	Pennar	-	4	4
7.	East flowing rivers	8	10	18
8.	Mahanadi	4	13	17
9.	Brahmani & Baitarani	-	7	7
	10. Subarnarekha	-	3	3
11.	Sabarmati	1	-	1
12.	Mahi	-	5	5
13.	West flowing rivers of Kutch SaurashtraIncl . Luni	4	10	14
14.	Narmada	7	12	19
15.	Tapi	4	12	16
16.	West flowing rivers from Tapi to Tadri	-	3	3
17.	West flowing rivers from Tadri to Kanya Kumari	-	21	21
	Total	224	318	542

G&D : Gauge & Discharge Observations
GDS/WQ : Gauge Discharge Sediment/Water Quality Observations

***(Source:** Water Resources of India, CWC Publication No.30/88 Central Water Commission, New Delhi, April 1988)*

The Central Pollution Control Boards monitors monitor the various water quality parameters through a well organized national water quality monitoring network of about 450 sampling stations on 14 major, 8 medium and 5 minor river basis including the tributaries. The State Pollution Control Boards are also involved in the monitoring of the water quality data in the respective states. Central Water Commission collects the data pertaining to the sediment and water quality at about 318 GDS/WQ sites (table-10). The ground water quality is being monitored by Central as well as State Ground Water Boards for the observations wells to investigate the ground water pollution.

3.4 Network of Ground Water Observation Stations

The Geological Survey of India (GSI) set up for the first time in 1969, a basic network of 410 ground water stations in various hydrogeological settings. The Central Ground Water Board (CGWB) was constituted as a national apex organisation in 1972 by the merger of Ground Water Wing of Geological Survey of India with the erstwhile Exploratory Tubewells Organisation (ETO). The Central Ground Water Board has since increased this number to about 8000 (Water Resources of India, 1988); water levels are monitored five times a year and water samples are collected twice a year once before and once after the monsoon, for analysis of the chemical quality. The Central Ground Water Board keeps the account replenishable ground water recharge and utilisable water resources on an annual basis. The board has established 15,972 national hydrograph network stations by March, 1993. Most of the states have also set up ground water departments and they have their own network of monitoring stations. Controlled pumping tests and test borings have also too be extended to determine the hydrogeological parameters of the aquifers.

3.5 Data Storage

At present, the data are being stored by the organisations who make the hydrological observation. The Central Water Commission has a central data bank where all the data observed by the different units of the CWC are stored on computers in the standard formats. Some of the data observed by the state govt. departments are also procured and stored in the data bank. The non-availability of the sufficient data of desired quality at short notice has always remained one of the major hurdle which has been reported time and again. This aspect was also considered by the Rashtriya Barh Ayog and the RBA have made specific recommendations for collection of various data by the different agencies. The recommendations in respect of establishment of Central Data Bank and the publishing of the data need to be properly implemented without any further delay. No doubt, considerable work has been carried out by the Central Water Commission and other agencies towards the modernisation and strengthening of existing hydrological network, there is need for serious efforts to be made by the various state governments and other departments in this direction.

It is hoped that the proposed National Hydrology Project will go a long way in improving exploration, assessment and regulation of the shortcomings in respect of data availability and its quality. The project has three important components viz. Surface water, Ground Water and the Water Quality and aims at the establishment of National Hydromet Data Centre (NHDC), National Surface Water Data Centre (NSWDC), the State Water Data Centres (SWDC) National Ground Water Data Centres (BGWDC), and State Ground Water Data Centres (SGWDC). The Central Water Commission, IMD, CGWB, NIH and a number of states will be participating in the above project.

4.0 INSTITUTIONS ENGAGED IN WATER RESOURCES FIELD

Practically all water resources development activities, barring dug wells and private shallow tubewells, are carried out by the government or government supported organisations. Most part of these developments are managed by State governments which are responsible for planning construction management and maintenance of dams and reservoirs, canal system, lift irrigation schemes and deep tubewells. Water supply works for domestic and industrial needs are managed by Water Supply Organisations and Local bodies in urban and rural sectors.

The state governments carryout detailed surveys and investigations and prepare project reports. In respect of minor irrigation schemes the states are fully empowered to sanction and implement the schemes, whereas in respect of medium and major schemes, the approval and clearance of central government is required before the project can be executed. After the technical scutiny of the project by Central Water Commission, an interdepartmental committee consisting of Departments of water Resources, Agriculture, Planning commission and Industries, the clearance by planning commission is accorded.

At the centre, whereas the overall planning of water use is looked after the planning wing of CWC in accordance with the National Water Policy, and coordinates the irrigation and flood control activities of the states. It also deals with the interstate and international problems of water use. The Central Ground Water Board of Ministry of Water Resources has the responsibility of groundwater exploitation. It also acts as Liasson between state groundwater organisations and central government. The Ministry of Water Resources is also responsible for minor irrigation, command area development and National Water Development Agency to prepare plans for interbasin transfer. Central Flood Control Board lays down the policies of flood control and frame and recommend guidelines to state flood control boards. It has three R&D organisation known as National Institute of Hydrology, Central Water and Power Research Station and Central Soil and Materials Research station.

The Ministry of Agriculture and Cooperation to responsible for rural water supply and sanitation, soil and water conservation, soil and land use survey and research under ICAR institutions.

The national programme of water supply and sanitation is the responsibility of Ministry of urban development including industrial use of water. The water quality aspects are looked after and monitored by Central Pollution Control Board. There are river water quality stations of CWC at the river gauging stations and groundwater quality stations are maintained by CGWB at some of their hydrographic stations.

The Central Electricity Authority under the Ministry of Energy provides all necessary technical advice and assistance and coordinates the hydropower development of the country. Besides these the Department of Science and Technology has India Meteorological Department, Survey of India and Wadia Institute of Himalayan Geology; and there are other organisations such as Rural Electrification Corporation, NABARD and CSIR laboratories such as National Environmental Engineering Research Institute and Geological Survey of India who have important interest in water resources.

The states have Irrigation and Water Resources Departments, Groundwater departments, water supply and sewerage departments, Agriculture and soil conservation departments, State electricity boards, and research centres dealing with different aspects of water resources and its development and management. The different data observation and collection systems in the states are maintained by these and revenue departments.

Coordination on important specific problems is achieved through various adhoc groups and committees, National committee on specific subject areas of different Ministries provide research funds for specific research projects to central and state research organisations, educational institutes and autonomous NGOs.

Since the water resources and power are state subjects, the states have been facing difficulty in planning of water resources for interstate rivers passing through them. For an efficient and optimal water resources development, the development plans should be prepared in a comprehensive manner for the river basin as a whole. To achieve this objective for various river basins River Valley Authorities have to be created to collect, coordinate, publish and analyse data, prepare comprehensive basin plans for optimal development and coordinate and plan with states. In 1956 River Board Act was promulgated so far only one statuary body-Damodar Valley Corporation has been created in 1948 for development of Damodar Valley. Similar effort is needed for other basins. Although the Nation Water Policy come into being in 1987; its implementation has not been effective. There is a need to create a statuary body as National Water Resources council which should have adequate manpower to look into implementation of National Water Policy and working of River Valley Authorities.

In order to achieve these requirements effectively, the data status of water for various elements has to be collected, analysed for water availability, project design and planning for needs of conflicting demands for various uses, design and construct projects and efficiently manage them. This will require a band of competent trained manpower for which existing institutions and programmes will have to be strengthened and enlarged.

5.0 PERSONNEL REQUIRED AND TYPE OF PERSONNEL

In order to meet the needs of short term and long term plans for water resources development and management, vast manpower resources will be needed with specialised knowledge and training in different aspects of water resources. The solution of interstate river disputes, implementation of National Water Policy, establishment of river basin authorities, modernisation of existing water laws to cover groundwater, design of data collection network for various elements and for all river basins, subbasins and ground water systems, scientific observation, collection and analysis of data, assessment of future water needs as well as available potential, preparation of short term and long range plans for water resources development, execution of projects, management and operation of systems, evaluation and monitoring of water resources and flood control projects, will require specialised manpower in adequate number. Some of the problems to be tackled by this manpower, both professional and subprofessional, are given below.

Problems to be tackled

1. Scientific observation, collection and analysis of data
   - meteorological
   - hydrological
   - landuse and vegetal cover
   - Agricultural use
   - Hydropower
   - Water use
   - Water demand
2. Assessment of water potentials, its distribution in time and space.
3. Modern methods of evaluation and analysis.
4. Assessment of present and future water needed.
5. Inter-basin water transfer.
6. Preparation of long range river basin plans for water resources development.
7. Optional development and water use management.
8. Flood plain management, zoning and flood forecasting.
9. Management of coastal and deltaic regions.
10. Hydrological problems of humid tropics
11. Silting of rivers and reservoirs
12. Pollution of surface and ground water and considerations to water quality.
13. River basin organisation to collect, coordinate, publish and analyse data and prepare river and basin plans.
14. Comprehensive studies for surface water and ground water inter-action.
15. Water balance of river basins and ground water systems.
16. Drainage of irrigation systems and control of waterlogging.
17. Coordination and planning with states.
18. Implementation of actions for elements of National Water Policy.
19. Interstate water problems.
20. Modernization of existing water laws.
21. Design of network systems of hydromet, streamflow, sediment, water quality and ground water for all river basins and subbasins and groundwater systems.
22. Planning for hydropower development.
23. Planning for Inland water transport and economics of development.
24. Water scarcity, drought and its management.
25. Development of Himalayan rivers snow and glacier hydrology problems.
26. Water conservation.

For the various needs indicated above, and on the basis of nature and workload involved, the following requirement of trained water resources engineers, hydrologists and sub- professionals (technicians) has been estimated as the requirement for the next 20 years. Some of these figures are based on R&D plans for water resources assessment and utilisation prepared

CWPC (now CWC) long time back. These figures are given in table 5.

For the various plans of water resources development and management, the approximate estimate of requirement of trained manpower is, thus, 6200 hydrology professions, 7200 water resources engineers and 21000 hydrology technicians (subprofessionals) and 22000 engineering subprofessionals, which will be needed in the next 20 years. Assuming that some of the requirement could be met out of the existing manpower of Engineers and hydrologists and subprofessionals, still a large manpower will be needed for National Water Resources Council, River basin authorities, Data systems, and augmentation of manpower of existing organisations and creation of regional research and planning centres. It is estimated that 9000 additional professionals and 20000 subprofessional will be required in the next 20 years. It will be necessary to augment the existing training facilities for professionals 600 every year. Trained subprofessional are not available in good number. There is a necessity to create 5 centres of training of technicians in the country to train 1000 technicians every year through 3 months training programmes. Training course for trainers will have to be created to train, 30 trainers every year.

Table 5 Manpower Required

S. No.	Organisation	Professional	Sub-Professional
1.	National Water Resources	500	6000
2.	River Valley Authorities	2500	4500
3.	Meteorological Organisation	500	2500
4.	Hydrometry and Flood Forecasting Organisation	800	4000
5.	CGWB	800	4000
6.	NIH	200	500
7.	Regional Research and Planning Centres	1000	4000
8.	Data System and Data Banks	300	500
9.	State Investigations, Hydrology, Data System and Water Resources Planning Organisations	6000	15000
10.	Educational and Research Institutions	800	2000
	TOTAL	**13400**	**43000**
	Hydrology (Engineers and Scientists)	6200	21000
	Water Resources Engineers	7200	22000

6.0 EMPLOYMENT OPPORTUNITIES

As per the requirement on a long term basis, the development has to be planned with river basin as a unit with river basin organistions established. A statuary organisation to overview the functioning of various organisations and agencies will have to be developed with adequate manpower and this organisation called as National Water Resources Council. Regional Research and planning centres will be required to be established manned by central government, data banks and data centres in centre and states, state investigation and hydrology planning set created or upgraded if existing. Data observation and collection system will be upgraded Research organisations including NIH will be strengthened. These will provide enough employment opportunities to new trained manpower in various sectors. Where fresh graduates or technicians will be recruited facilities will have to be available for training.

7.0 ACTION REQUIRED

There is need that all the irrigation departments in states be changed to water resources departments where not done so far. The cadre of hydrologist created and recruitment rules be modified to include hydrology as a discipline after a basic degree programme in hydrology started in selected institutions. All the state departments may have hydrology Chief Engineer incharge of Hydrology unit in the State. In smaller states this could be headed by a superintending Engineer. The functions of this unit be to upgrade the network, develop the observation and data collection and storage system, hydrological analysis, water yield, water quality, sediment design flood, water demand, planning and water management. Where possible there should be a unified set up for surface and groundwater. Similar set up for dam safety and operation of reservoirs with a flood warming system be established. In hilly regions, special set up for snow network and glacier studies to be established. There is a need to bring all organisations dealing with water be integrated and brought under the same department or a water commission established.

For specialised duties reasonable duty allowances be given for doing hydrology investigation and planning and dams safety and flood warming system. Special allowance to be provided to research organisation and consultancy fee should admissible do them.

There is also a need to develop cadre of system planners and construction specialists and those well-versed in construction planning. A special cadre of water managers be created to plan and manage water for different use.

8.0 CONCLUSIONS

The water resources planning and development requires multi disciplinary manpower, specialised in their fields. The water resources being a state subject, the development process is slow and it is further hamphered due to non existence of river valley authorities. This needs to be taken up on priority basis. The network of observations of various hydrological data is poor in all the states as also data storage system. There is an urgent need to create more manpower to handle various water resources problems. Special attention is needed for adequate number of trained and competent technicians who are the backbone of development with appropriate and good quality data.

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