Government of India & Government of The Netherlands

Technical Assistance
HYDROLOGY PROJECT

DHV CONSULTANTS &
DELFT HYDRAULICS with
HALCROW, TAHAL, CES,
ORG & JPS

VOLUME 1
HYDROLOGICAL INFORMATION SYSTEM

DESIGN MANUAL

Table of Contents

1 INTRODUCTION

1.1 GENERAL

Water plays a crucial role in the socio-economic development of India. Safe drinking water is required for the very large and growing population. Water has also become a major constraining factor for the growth of the agricultural and industrial sectors. In contrast, flooding frequently threatens populations and their properties. Competing demands between users and states require proper planning, design and management of water resources and water use systems. The availability of an efficient and comprehensive Hydrological Information System (HIS), comprising a reliable data base on all aspects of the hydrological cycle, is a prerequisite for such planning, design and management, to get better decisions made as well as to achieve efficiency.

The prime objective of the Hydrology Project is to develop a sustainable Hydrological Information System for 9 states in Peninsular India, set up by the state Surface Water and Groundwater Departments and by the central agencies (CWC and CGWB) with the following characteristics:

- Demand driven, i.e. output is tuned to the user needs
- Use of standardised equipment and adequate procedures for data collection and processing
- Computerised, comprehensive and easily accessible database
- Proper infrastructure to ensure sustainability.

This Hydrological Information System provides information on the spatial and temporal characteristics of water quantity and quality variables/parameters describing the water resources/water use system in Peninsular India. The information needs to be tuned and regularly be re-tuned to the requirements of the decision/policy makers, designers and researchers to be able to take decisions for long term planning, to design or to study the water resources system at large or its components.

This manual describes the procedures to be used to arrive at a sound operation of the Hydrological Information System as far as hydro-meteorological and surface water quantity and quality data are concerned. A similar manual is available for geo-hydrological data.

The manual consists of ten volumes, covering:

1. Hydrological Information System: a general introduction to the HIS, its structure, HIS job descriptions, Hydrological Data User Group organisation and data user need assessment
2. Sampling Principles: units, principles of sampling in time and space and sampling error theory
3. Hydro-meteorology: network design, implementation, operation and maintenance
4. Hydrometry: network design, implementation, operation and maintenance
5. Sediment transport measurements: network design, implementation and operation
6. Water Quality sampling: network design, implementation, operation and maintenance
7. Water Quality analysis: laboratory procedures
8. Data processing and analysis: specification of procedures for data processing centres
9. Data transfer, storage, and dissemination: specification of procedures for data storage centres.
10. SW-Protocols: Protocols for HIS activities and summary of data validation procedures.

Each volume comprises one or more of the following manuals, viz:

- Design Manual, (Volumes 1 to 6)
- Field Manual, (Volumes 1, 3 to 6)
- Reference Manual (Volumes 1 to 5)
- Operation Manual (Volumes 7 to 9)
- Protocols (Volume 10), and
- Data Entry Forms (Volume 10)

The Design Manuals provide the procedures for the design activities to be carried out for the implementation and further development of the HIS. The Field Manuals and Operation Manuals are *instruction books* describing in detail the activities to be carried out in the field (station operation, maintenance and calibration), at the laboratory (analysis), and at the data processing centres (data entry, validation, processing and analysis) and data storage centres (data transfer, storage and dissemination). A Field/Operation Manual is divided into a number of parts, each describing a certain activity, to be used at a particular field station, laboratory or processing/storage centre. The Reference Manual of a particular Volume includes additional or background information on topics dealt with or deliberately omitted in the Design, Field and Operation Manuals.

The distribution of the manuals to the field stations and the data processing centres is described in the 'READER's GUIDE to HIS Manual'.

1.2 NATIONAL WATER POLICY OF INDIA

Ultimately HIS is meant to contribute to the realisation of GOI's policies and strategies in the water sector. The National Water Policy (MOWR, 2002) (see Volume 1, Reference Manual) specifies the basic principles which should be followed in decision making and all activities in this sector, see Table 1.1. The National Water Policy complies with the general line of consensus that is emerging in the international fora on Integrated Water Resources Development. The Policy advocates an integrated planning and development of the conjunctive use of surface and groundwater, addressing the multiple uses of the water simultaneously. Priority should be given to domestic water supplies for urban and rural populations and drinking water supplies for livestock should be assured. The priority order for other users are as follows: irrigation, hydropower, navigation and industrial uses. However, the Policy identifies also the need to maintain minimum flows on river for flushing pollutants, maintaining wildlife and other environmental reasons. Moreover, the Policy mentions that the given prioritisation might be modified with reference to area-specific considerations.

More specifically related to the HIS, the National Water Policy stipulates in Articles 2.1 to 2.3:

> *"A well developed information system, for water related data in its entirety, at the national/state level, is a prime requisite for resources planning. A standardized national information system should be established with a network of data banks and data bases, integrating and strengthening the existing Central and State level agencies and improving the quality of data and the processing capabilities. Standards for coding, classification, processing of data and methods/procedures for its collection should be adopted. Advances in information technology must be introduced to create a modern information system promoting free exchange of data among the various agencies. Special efforts should be made to develop and continuously upgrade technological capability to collect, process and disseminate reliable data in the desired time frame. Apart from the data regarding water availability and actual water use, the system should also include comprehensive and reliable projections of future demands for water for diverse purposes."*

Actually, the National Water Policy is essentially a guideline. There is a need to develop more definite criteria for the management of this resource, such as the allocation of water amongst different users. Proper application of such criteria in any specific situation requires a sound understanding of the

available water resources and their existing uses. This has to be supported by reliable hydrological analysis for which, in turn, sufficient and accurate data is needed. HIS is set-up to provide this data. The National Water Policy recognises the need for more specific strategies by asking in Article 3.3 for the development of an overall water resources development plan for a hydrological basin as a whole, in order that the best possible combinations of options can be made.

National sector and state policies and strategies

Water management is not an objective in itself, should contribute to the realisation of sector policies and strategies. Most important sector policies are:

- Annual or Five Year Plan
- Agricultural and Irrigation Policies
- Drinking Water and Sanitation Policies
- Hydropower
- Environmental Protection, etc.

In all cases reliable data on hydrological quantity and quality variables and parameters are required for the analysis, design and implementation of strategies and policies, which are to be provided by the Hydrological Information System.

Summary of National Water Policy of India

1. Water is a prime natural resource, basic human need and a precious national asset. Planning and development of water resources need to be governed by national perspectives.
2. Water as a resource is one and indivisible. This needs a standardised national information system should be developed with free exchange of data.
3. Water availability should be maximised by planning for a hydrological basin as a whole, including appropriate institutions, taking into account conservation measures, recycling and inter-basin transfer.
4. Project planning should be done in an integrated and multi-disciplinary way, taking into account all users and social impacts and preserving the environment and ecological balance.
5. Project facilities of irrigation systems in command areas should be properly monitored, maintained and, if needed, modernised.
6. Proper organisational arrangement should ensure the sustainability and safety of water-related infrastructure.
7. Groundwater development should not exceed the maximum recharging possibilities and be done in conjunctive use with surface water.
8. Water allocation priorities are: drinking water, irrigation, hydro-power, navigation, industrial and other uses; these priorities might be modified if necessary in particular regions with reference to area specific considerations.
9. Adequate drinking water facilities should be provided.
10. Irrigation projects should be based on the command area development approach, aim for a maximisation of the production but with due regard to equity and social justice.
11. Water rates should be set at such level as to be affordable, but convey the scarcity value of the resource to the users and to foster the motivation for economic water use; they should be adequate to cover the annual maintenance and operation charges and a part of the fixed costs.
12. Efforts should be made to involve farmers and voluntary agencies in the management of the irrigation systems.
13. Surface and groundwater should be regularly monitored for quality and a phased programme should be undertaken for improving the water quality.
14. Economic development and spatial planning should be done with due regard to the constraints imposed by water availability.
15. Enhanced awareness should be promoted through education, regulation, incentives and disincentives.
16. For each flood prone basin a master plan should be developed for flood control and management, including soil conservation measures and preservation of forests; an extensive network for flood forecasting should be established for timely warning to settlements.
17. Erosion of land by sea and rivers should be minimised by suitable cost-effective measures
18. Drought prone areas should be given priority in planning water resources development through specific measures, i.e. water harvesting, groundwater use, inter-basin transfer and encouraging less water-demanding crops.
19. To support the effective and economical management of India's water resources appropriate inputs in the field of science and technology should be developed.
20. A perspective plan for standardised training should be an integral part of water resources development.

Conclusion: The planning and management of water resources and its optimal, economical and equitable use has become a matter of the utmost urgency. The success of the national water policy will depend entirely on the development and maintenance of a national consensus and commitment to its underlying principles and objectives.

Table 1.1: Summary of National Water Policy of India (MOWR, 2002)

2 HYDROLOGICAL INFORMATION SYSTEM

2.1 DEFINITION OF HIS

In each state and for the central agencies Hydrological Information Systems have been developed. A Hydrological Information System comprises the physical infrastructure and human resources to collect, process, store and disseminate data on hydrological, geo-hydrological and hydro-meteorological variables. The physical infrastructure includes observation networks, laboratories, data communication systems and data storage and processing centres equipped with databases and tools for data entry, validation, analysis, retrieval and dissemination. The human resource refers to well trained staff with a variety of skills to observe, validate, process, analyse and disseminate the data. Efficiency requires that all activities in the HIS are well tuned to each other, to provide the required data on time in proper form and at minimum cost.
In this chapter the scope of activities in the HIS, its structure and staffing is dealt with.

2.2 ROLE OF HIS

The primary role of the HIS is to provide reliable data sets for long-term planning and design and to frame rules for management of water resource and water use systems and for research activities in the related aspects. It is also desired that the system functions in such a manner that it provides the information to users in time and in proper form. The scope of HIS is not extended to provide data to users on a real-time basis for short-term forecasting or for operational use.

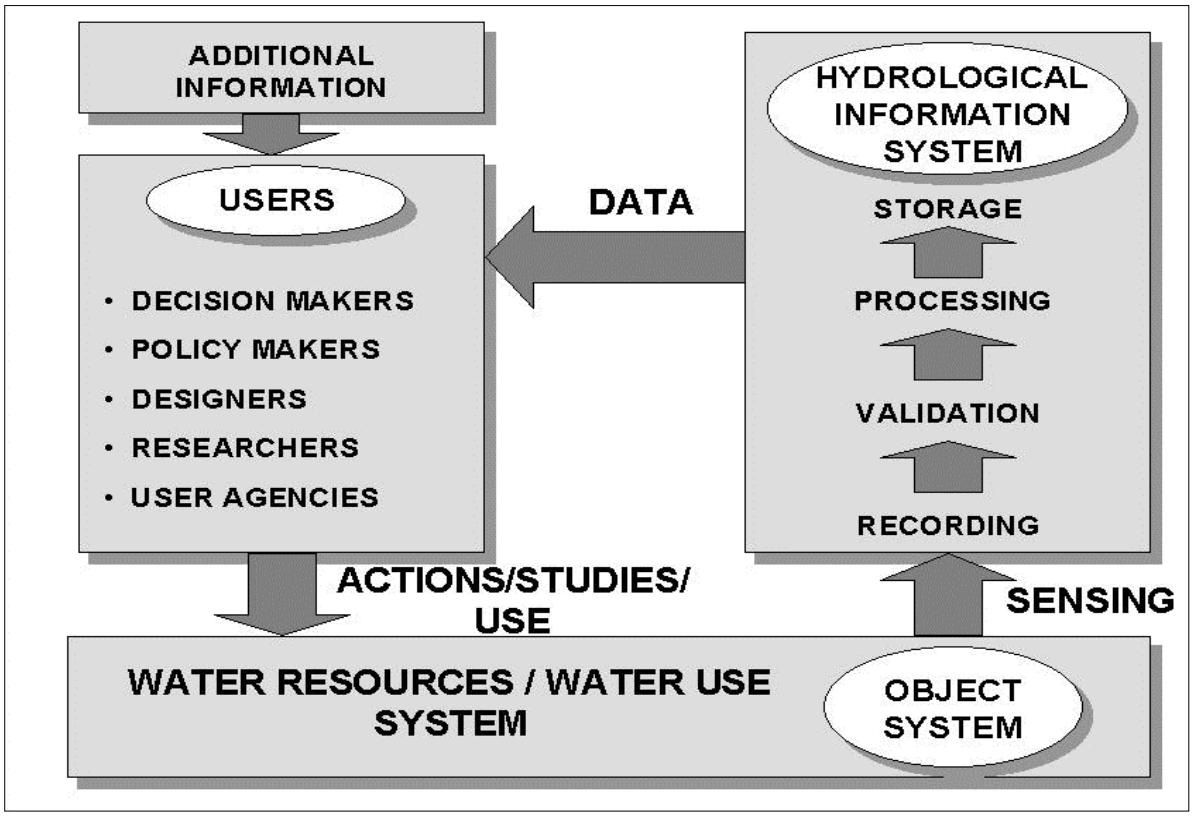

Figure 2.1: Role of Hydrological Information System

To be able to provide this information the first step is to obtain the information on the temporal and spatial characteristics of this object system by having a network of observational stations. The basic data collected for different hydro-meteorological phenomenon through this observational network is called the observed or field data. Such observed data have to be processed to ensure its reliability. Both field and processed data sets have to be properly stored, i.e. processed data for dissemination and field data to permit inspection and revalidation in response to queries from users.

2.3 SCOPE OF ACTIVITIES UNDER HIS

The activities under HIS can be broadly classified in the following categories:

- Assessing the needs of users
- Establishment of an observational network
- Management of historical data
- Data collection
- Data processing, analysis and reporting
- Data exchange and reporting
- Data storage and dissemination
- Institutional and human resource development

Assessing the needs of users

To make full consideration of user needs a Hydrological Data User Group (HDUG) for each state and for the central agencies has been constituted. Potential hydrological data users and the members of HIS implementing agencies are represented in these HDUGs. The main aim of such HDUGs is to review hydrological information needs and, on a regular basis of about 3-5 years, to identify shortfalls and to make suggestions and proposals for improvements. This will then require the implementing agency to reconsider its mandate and HIS objectives and incorporate improvements where possible. Improvements may also be needed to take care of equipment technology updates.

Establishment/review of observational networks

After the objectives of the system are laid down, the observational network has to be accordingly planned, designed and established/upgraded/adjusted. It is also important to ensure that the observational networks of different agencies are properly integrated so that duplication is avoided. The equipment as per the revised objectives and design are installed at the observational stations. The process may be repeated after periodic reviews of requirements.

Management of historical data

State and central agencies have maintained observational networks for many years and voluminous records are held, the majority on manuscript or chart records, which are not readily accessible for use and are of variable quality. A program of historical data entry has been established in each agency holding such data. Priority is given to ensuring that current data are entered validated and stored effectively. The next priority is for historic data of the immediate past ten years and so on.

Data collection

Institutional, human and budgetary supports are a prerequisite for smooth operation and maintenance of the observation stations and the associated collection of data. The established network has a number of observation stations and at each station a number of variables is observed at a specified frequency. The observations are taken manually or automatically depending upon the type of instrument available at the station. Suitable number of persons having skills appropriate to their job requirement (e.g., Supervisors, Technicians, Observers, Helpers etc.) are engaged and materials are

provided at the observation sites for carrying out day-to-day data collection work and also for regular maintenance.

Data processing, analysis and reporting

Data processing is a broad term covering all activities from receiving records of observed field data to making them available in a usable form. The field data are in a variety of formats such as hand-written records, charts and digital records. Data as observed and recorded may contain many gaps and inconsistencies. These observed data are passed through a series of operations, typically:

- Data entry
- Making necessary validation checks,
- Infilling missing values in a data series,
- Processing of field data to estimate required variables,
- Compilation of data in different forms and
- Analysis of data for commonly required statistics etc.

Most of the data processing activities are to be accomplished with the help of computers using dedicated hydrological data processing software. Of particular importance is assuring the quality and reliability of the data provided to users through the application of a variety of validation procedures and the flagging of suspect data. The user must be informed of the quality of the data supplied and whether the values are estimated or observed.

Reports are prepared to bring out the salient characteristics of the hydrological regime of the region for each year or season. Special reports are also made as and when required for attracting the attention of the users towards unusual events, major changes in the hydrological regime or to disseminate important revised long term statistics regularly.

Data exchange and communication

Data processing activities are carried out at more than one level within each agency and this makes it essential to have adequate data transport/communication links between them. The requirement for communication is to be based on a low frequency and high volume of communication. There is need for exchange of information between various agencies for the purpose of data validation as surface and groundwater networks are operated by different state and central agencies.

Data storage and dissemination

All available data sets are maintained in well-defined computerised databases using an industry-standard database management system. This is essential for the long-term sustainability of the data sets in proper form and their dissemination to the end users. Both, field and processed data sets are properly stored and archived to specified standards so that there is no loss of information. There is flexibility for data owners to decide user eligibility for data. Once eligibility is decided all agencies apply standard procedures for the dissemination of data to the users from the computerised databases.

The type of data stored in the database include:

- Geographical and space oriented data, i.e. static or semi-static data on catchment features and hydraulic infrastructure
- Location oriented data, including static or semi-static data of the observation stations and hydraulic structures
- Time oriented data, covering equidistant and non-equidistant time series for all types of meteorological, climatic, water quantity, quality and sediment data, and

- Relation oriented data on two or more variables/parameters used with respect to meteorological, climatic, water quantity, quality and sediment data

Institutional and Human Resources development

Since HIS is a vast system, the aspect of institutional and human resource development needs to be given proper emphasis. The institutions supporting the HIS must be developed in such a manner that the system is sustainable in the long run. The staff required to carry out different activities under HIS are to be made available and very importantly they must all be trained to carry out the desired tasks. Such training support is to be ensured on a sustainable basis since there will always be a need for training more staff, to replace staff moving out due to retirements and rotational transfers.

2.4 STRUCTURE OF HIS

To provide timely reliable space-, location-, time- and relation-oriented data of the water resources/water use system, the HIS comprises the following components (see Figure 2.2):

1. In each State

- Hydro-meteorological, Surface Water and Ground Water Observation Networks,
- Water Quality Laboratories,
- Sub-divisional/District Data Processing Centres, one in each Sub-division/District,
- Divisional/Regional Data Processing Centres, one in each Division/Region,
- State Data Processing Centres, one in the State Surface Water Department and one in the State Groundwater Department, and
- a State Data Storage Centre.

2. In the Central Water Commission

- Surface Water Observation Networks,
- Water Quality Laboratories,
- Sub-divisional Data Processing Centres, one in each Sub-division
- Divisional Data Processing Centres, one in each Division,
- for each Region a Data Processing and a Data Storage Centre, and
- at National level a National Data Centre.

3. In the Central Ground Water Board

- Groundwater Observation Networks,
- for each Unit a Data Processing Centre,
- for each Region a Data Processing and a Data Storage Centre, and
- a National Data Centre.

A data transport/communication system provides for data exchange within and between the states and central organisations.

Activities at various levels of the HIS

In short, in the HIS of a state the following activities take place at the various levels.

- At the **stations/wells** in the hydro-meteorological, surface water and groundwater observation networks field data and water quality samples are collected. The water samples are brought to

the Water Quality Laboratories. At regular intervals (monthly/quarterly) the field data are submitted to the Sub-divisional/District Data Processing Centres.

- In the **Water Quality Laboratories**, beside the analysis of water quality samples, the analysis results are entered in the computer and subjected to primary validation. At regular intervals, the laboratory passes the information on to the nearest Divisional or Regional Data Processing Centre.

- In the **Sub-divisional/District Data Processing Centres** all field data are entered in the computer and stored in a temporary database. Next, primary validation (entry control and reach checks) takes place on the data and feedback is given to the field stations. The computerised data are passed on to the Divisional/Regional Data Processing Centre immediately after finalisation of the primary processing. For purpose of validation and analysis of groundwater data the District Data Processing Centre also makes use of the data collected by CGWB, these are retrieved regularly from the Data Storage Centre.

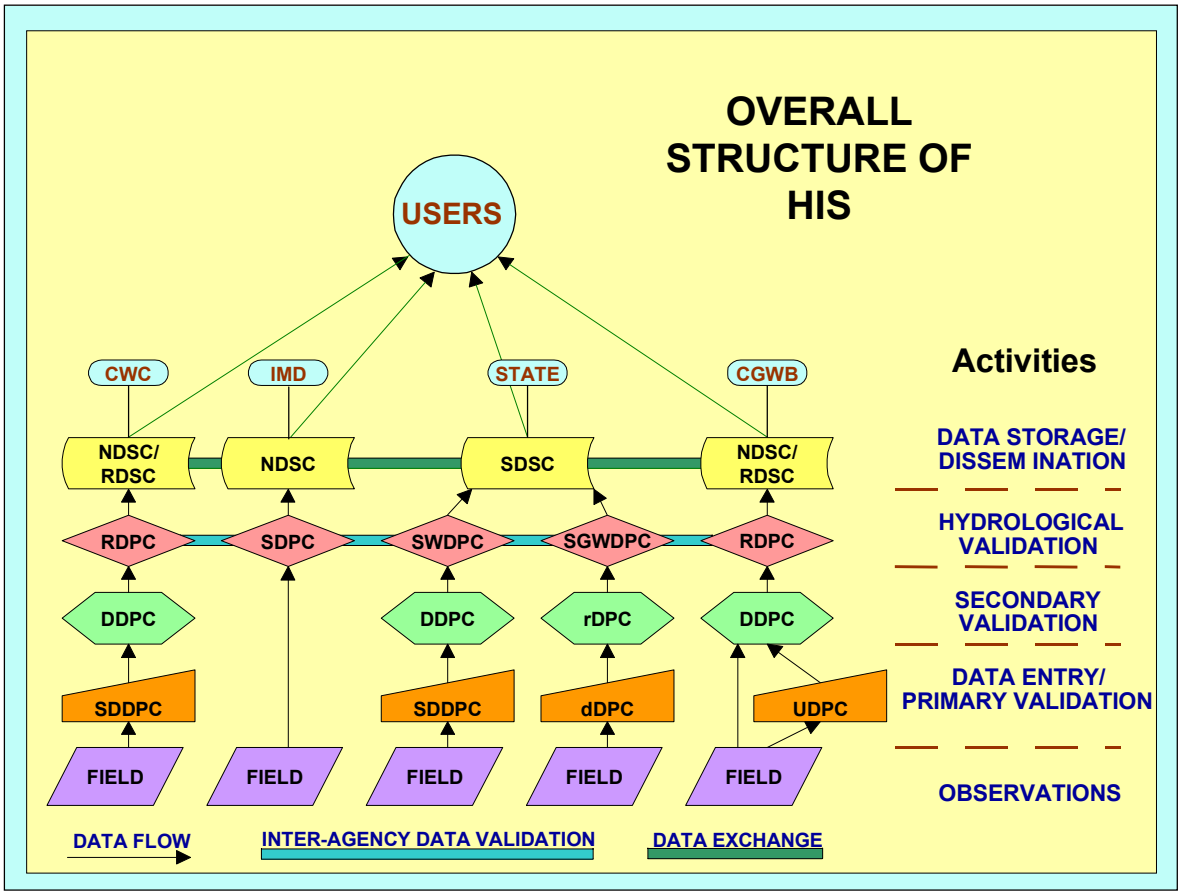

Figure 2.2: HIS structure at State/Regional level

In the **Divisional/Regional Data Processing Centres**, given their larger spatial coverage, more advanced secondary data validation is carried out. The data are stored in temporary databases. After validation, the surface water and groundwater data are transferred to their respective State Data Processing Centres.

- In the **State Data Processing Centres**, after reception of the data from its Divisions/Regions, a copy of the field data is transferred to the State Data Storage Centre. The main activity of the State Data Processing Centre is final data validation, completion, analysis and reporting. Here, the data are stored in temporary databases. At the end of the hydrological year, once the data

have been properly validated, the (authenticated) processed data is transferred to the State Data Storage Centre. To improve the effectiveness of the final validation, in the State Centres use is made of the relevant data collected by the Central Agencies.

- The **State Data Storage Centre** stores and administers the storage of all field and (authenticated) processed hydrological data collected in the State, and makes the data available to authorised Hydrological Data Users. As a State archive, it also maintains an HIS-Catalogue of all data stored in its own database and those stored in the databases of the other states and of the Central Agencies.

The flow of data at the various levels in the HIS organisation is shown in Figure 2.3.

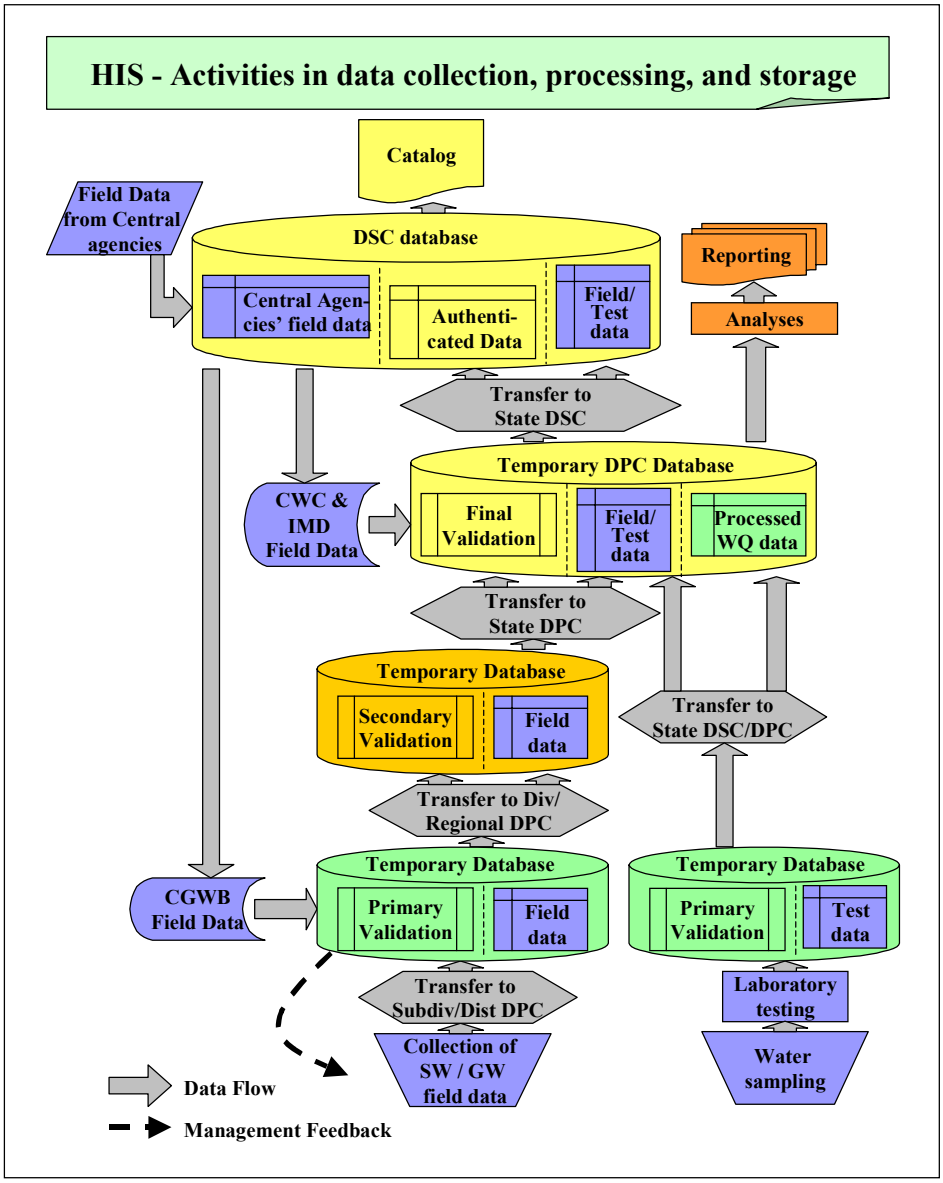

Figure 2.3: Data flow in HIS

Separation of data processing and data storage functions

In HIS the data processing and the data storage functions are separated; data processing is done in the Data Processing Centres, whereas the data archives are in the Data Storage Centres. Data processing and validation is a technical task for which hydrologists/geo-hydrologists are qualified, whereas final data storage, i.e. the library function, is the domain of database managers. This distinction is absolutely necessary for a number of reasons:

- Processing and storage are different disciplines, which require different expertise, tools, hardware support, activities and responsibilities,
- To guarantee discipline in building the database and its sustainability on the long term,
- To make sure that for design and decision making data are being used, which passed all steps of validation,
- To avoid mixing of fully processed data and the data under processing,
- To register and control receipt and supply of authenticated data to and from the database in a formalised manner,
- To ensure compatible database configuration and protocols by all agencies,
- To maintain a professional data security system under which each organisation maintains its independence for user authorisation and data circulation, and
- for an easier upgrading/replacement of either data storage or data processing tools in case of new developments

Centralised versus distributed storage

Though the approach described above calls for separation of data processing and data storage functions, separate Data Storage Centres for Surface Water and Groundwater Departments are not advocated. Combining the data storage activities in a State in one Data Storage Centre has advantages over separate centres, fully in line with the National Water Policy (MoWR, GoI, 2002). Advantages include:

1. A combined centre stimulates co-operation between all the Central and State Organisations which improves quality of the data,
2. It greatly benefits users by providing all information from a single place and thereby enhanced the water resources assessment,
3. It improves the sustainability of the system and enhances the chances of a uniform system/approach on the long term, and
4. It reduces cost of hardware, software and of staff.

In case of a combined Data Storage Centre the manager can be appointed from the Surface Water or Groundwater side at the discretion of the competent authority. Where Surface Water and Groundwater Organisations are placed under different ministries a formal decision has to be taken under which Ministry the Data Storage Centre has to be placed , with its inherent responsibilities for staffing and maintenance, or whether each organisation should have its own Data Storage Centre.

2.5 STAFFING OF HIS

S.No.	Category/HIS Function	Code
	General	
1.	**General**	
1.1	Data Centre manager/ Head of the Hydrological Info System	S12
2.	**Data Storage Centre**	
2.1	Database administrator	I2
2.2	Information techn. and database expert	I1
2.3	Secretary	-
	Surface Water	
3.	**State Data Processing Centre**	
3.1	State DPC manager	S11
3.2	Hydrologist	S10
3.3	Water quality expert	Q8
3.4	Information techn. and database expert	I1
3.5	DPC assistant	S4
3.6	Secretary	-
4.	**Divisional Data Processing Centre**	
4.1	Divisional DPC manager	S9
4.2	Assistant hydrologist	S5
4.3	Trainer (Ass. hydrologist)	S8
4.4	Hydrological equipment manager	S7
4.5	DPC assistant	S4
4.6	Secretary	-
5.	**Sub-divisional Data Processing Centre**	
5.1	Sub-divisional DPC manager	S6
5.2	Assistant hydrologist	S5
5.3	DPC assistant	S4
6.	**Field Station**	
6.1	Observer/Head of station	S3
6.2	Gauge reader	S2
6.3	Helper	S1
	Meteorology	
7.	**Full Climatic Station**	
7.1	Senior observer	M2
8.	**Rainfall station (rainfall)**	
8.1	Observer	M1
	Ground water	
9.	**State Data Processing Centre**	
9.1	State DPC manager	G12
9.2	Hydrogeologist	G11
9.3	Trainer	G10
9.4	Water quality expert	Q7
9.5	GIS expert	G9
9.6	Information techn. and database expert	I1
9.7	DPC assistant	G8
9.8	Secretary	-
10.	**Regional Data Processing Centre**	
10.1	Regional DPC manager	G7
10.2	Hydrogeologist	G6
10.3	Assistant hydrogeologist	G5
10.4	Geohydrological equipment manager	G4
11.	**District Data Processing Centre**	
11.1	District DPC manager	G3
11.2	GW Data Processor	G2
11.3	Field data collector	G1
	Water Quality	
12.	**Water quality laboratory**	
12.1	Laboratory supervisor	Q6
12.2	Head of the laboratory	Q5
12.3	Trainer (Chemist)	Q4
12.4	Chemist	Q3
12.5	Assistant chemist	Q2

Table 2.1: Staffing for HIS functions and coding as used in job descriptions

The following coding is used:
1. for Surface Water: S1..S12
2. for Meteorology: M1..M2
3. for Ground Water: G1..G12
4. for Water Quality: Q1..Q8
5. for Information Technology: I1..I2

In Table 2.1 an overview is given of the HIS functions, their requirement in the field stations/offices and in the data centres, and the coding as used in the job descriptions. The job descriptions associated with these functions are presented in the Chapter 1 of Volume 1, Field Manual, HIS.

Field staff

The staff requirements for the surface water gauging sites and meteorological sites are elaborated in Table 2.2. Note that the staff numbers and functions depend on the type of site. To be able to economise on staff numbers at surface water gauging sites one or both of the following measures can be taken to reduce on the number of flow measurements at a particular site:

1. by making a distinction between discharge stations with:
   - stable control sections, and
   - unstable control sections,

   and/or
2. by applying roving teams for discharge gauging.

For **unstable** control sections each year a discharge rating curve has to be established, whereas for the **stable** sites the establishment of such a curve once per three years will be sufficient.

Applying **roving teams** for flow measurements (not for gauge observations!) implies that one field team looks after more stations in a year. Assuming that at least 20 data points are required to establish a rating curve, and given the duration of the monsoon, it is anticipated that a roving team can cover at least two stations per year. Large annual savings are possible by implementing both measures.

With respect to rainfall and full climatic stations, a distinction is made between sites which do and those which do not coincide with surface water gauging stations. In the latter case separate observers are required, whereas at the surface water gauging site the gauge reader will carry out the meteorological observations.

S.No.	Name as per Job	HIS Designation	No. of Staff required for various types of sites						
			Fixed Staff			Roving Staff		Rainfall Station	Full Climatic Stations (FCS)
			Structure type site	Br./CW type site	Boat type site	Br./CW type site	Boat type site		
1	Helper	S1	0	0	0	1	2	0	0
2	Gauge reader	S2(+M1/M2)	1	1	1	1	1	0	0
3	Observer	S3	0	0	0	1	1	0	0
4	Observer (Met.)	M1	0	0	0	0	0	1	0
5	Sr. Obs. (Met.)	M2	0	0	0	0	0	0	1

Table 2.2: Field staff requirements

Data processing and storage centres and laboratories

In Table 2.3 and 2.4 the staff requirements for the Surface Water Data Centres and Water Quality Laboratories are elaborated.

S..No.	Name as per Job	HIS Designation	No. of Staff required for Office/WQ Laboratory									
			NDSC	NDPC	RDSC	RDPC	SDSC	SDPC	WQ II+	DO	WQ II	SDO
1	Manager Data Centre	S12	1	0	1	0	1	0	0	0	0	0
2	DB Administrator	I2	1	0	1	0	1	0	0	0	0	0
4	IT Expert	I1	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0	0
5	Secretary		0.5	0.5	0.5	0.5	0.5	0.5	0	0	0	0
6	Manager DPC	S11/S9/S6	0	1	0	1	0	1	0	1	0	1
7	Hydrologist	S10	0	4	0	4	0	4-6	0	0	0	0
8	WQ Expert	Q8	0	1	0	1	0	1	0	0	0	0
9	Assistant Hydrologist	S5	0	0	0	0	0	0	0	1	0	1
10	DPC Assistant	S4	0	2	0	2	0	2	0	1	0	1
11	Trainer (SW)	S8	0	0	0	0	0	0	0	1	0	0
12	Manager Hydro. Equip.(SW)	S7	0	0	0	0	0	0	0	1	0	0
13	Senior Chemist	Q6/Q5	0	0	0	0	0	0	1	0	1	0
14	Chemist	Q3	0	0	0	0	0	0	2	0	1	0
15	Assistant Chemist	Q2	0	0	0	0	0	0	3	0	2	0
16	Trainer (WQ)	Q4	0	0	0	0	0	0	0	0	1	0

Table 2.3: Staff requirements for various types of Surface Water offices and Water Quality laboratories

S.No.	Name as per Job	HIS Designation	No. of Staff required for Office/WQ Laboratory										
			NDSC	NDPC	RDSC	RDPC	SDSC	SDPC	WQ II+	UO	RO/ CO	SR/ DO	WQ II
1	Manager Data Centre	S12	1	0	1	0	1	0	0	0	0	0	0
2	DB Administrator	I2	1	0	1	0	1	0	0	0	0	0	0
3	IT Expert	I1	0.5	0.5	0.5	0.5	0.5	0.5	0	0	0	0	0
4	Secretary		0.5	0.5	0.5	0.5	0.5	0.5	0	0	0	0	0
5	Manager DPC	G12/G7/G3	0	1	0	1	0	1	0	1	1	1	0
7	Hydrogeologist	G11	0	4	0	4	0	4	0	0	1	0	0
8	WQ Expert	Q7	0	1	0	1	0	1	0	0	0	0	0
9	GIS Expert	G9	0	1	0	1	0	1	0	0	0	0	0
10	DPC Assistant	G8	0	2	0	2	0	2	0	0	0	0	0
11	Trainer (GW)	G10	0	0	0	1	0	1	0	0	0	0	0
12	Assistant hydrogeologist	G5	0	0	0	0	0	0	0	0	2	0	0
13	Equip. Manager (GW)	G4	0	0	0	0	0	0	0	0	1	0	0
14	GW Data Processor	G2	0	0	0	0	0	0	0	1	0	1	0
15	Field data collector	G1	0	0	0	0	0	0	0	3	0	3	0
16	Senior Chemist	Q6/Q5	0	0	0	0	0	0	1	0	0	0	1
17	Chemist	Q3	0	0	0	0	0	0	2	0	0	0	1
18	Assistant Chemist	Q2	0	0	0	0	0	0	3	0	0	0	2
19	Trainer (WQ)	Q4	0	0	0	0	0	0	0	0	0	0	1

Table 2.4: Staff requirements for various types of Ground Water offices and Water Quality laboratories

Legend:

Surface water (Table 2.3)
NDSC = National Data Storage Centre (CWC)
NDPC = National Data Processing Centre (CWC)
RDSC = Regional Data Storage Centre (CWC)
RDPC = Regional Data Processing Centre (CWC)
SDSC = State Data Storage Centre of State SW
SDPC = State Data Processing Centre of State SW
WQ II+ = WQ Level II+ Laboratory
WQ II = WQ Level II Laboratory
DO = Divisional offices of CWC and State SW agencies
SDO = Sub-divisional offices of CWC and State SW agencies

Groundwater (Table 2.4)
NDSC = National Data Storage Centre
NDPC = National Data Proc. Centre (CGWB)
RDSC = Regional Data Storage Centre (CGWB)
RDPC = Regional Data Proc. Centre (CGWB
SDSC = State Data Storage Centre of State GW
SDPC = State Data Proc. Centre of State GW
WQ II+ = WQ Level II+ Laboratory
WQ II = WQ Level II Laboratory
UO = Unit offices of CGWB
RO/CO = Regional/Circle offices of State GW
SR/DO = Sub-regional/District/Div. off.of state

In short, for the Surface Water Data Centres the listed staff will have the following tasks:

At Sub-divisional Data Processing Centre

- One data processing centre assistant for data entry and assistance job
- One assistant hydrologist for carrying out primary data validation will be available.
- The sub-divisional data processing centre manager will ensure the functioning of the Sub-divisional Data Processing Centre.

At the Divisional Data Processing Centre

- One data processing centre assistant for data entry and assistance job
- One assistant hydrologist for carrying out secondary data validation will be available.
- The divisional data processing centre manager will ensure the functioning of Divisional Data Processing Centre.

At the State/Regional Data Processing Centre

- Two data processing centre assistants for data entry and assistance job
- 4-6 hydrologists (as per quantum of work, roughly one hydrologist per division) for accomplishing final data validation, compilation and reporting activities will be available.
- Support of water quality, database and information technology expert will also be available at the centre.
- The State/Regional Data Processing Centre manager will ensure the overall functioning of the State/Regional Data Processing Centre.

At the State/Regional Data Storage Centre

- A data centre manager/head of the Data Storage Centre, who has the overall responsibility for the operation of the Data Storage Centre, the DSC liase with the data providers and the data users and administer/implement state/agency regulations and arrange data access privilege to users in accordance with the regulations in force.
- A database administrator, who has the overall responsibility for the operation of the database and administers the data input streams and data retrieval.
- Support of an information technology expert will be available,
- Support staff for reception and secretarial work.

2.6 TIME SCHEDULE FOR DATA TRANSFER AND PROCESSING

Maintenance of a strict time schedule for all the data transfer from the field and processing activities at the various data processing centres is of utmost importance for the following reasons:

- to give timely feedback to the field stations in case of error,
- to create continuity in the processing activities at various data centres,
- to accommodate regular exchange of data between the state and central agencies validating the data of the same river basin
- to ensure timely availability of authenticated data for use in planning, design and operation.

Hence, it is all the more important that activities at all the data processing centres are carried out in time. The time schedule for the completion of activities at various data processing centres is as given below.

At the Sub-divisional Data Processing Centres

- The data of any month from all the observational stations falling under its jurisdiction are required to be entered and primary validation to be completed by the 10th of the following month.
- The field and processed data sets along with the primary validation report for each preceding month must leave for divisional data centre by the 10th of every month. That is to say that the data set of June must be finalised and dispatched from the Sub-divisional Data Centres by 10th July.
- To maintain such a schedule, it is required that all the field data for the preceding month is received at the Sub-divisional Data Processing Centre by the 4th working day of every month. However, to ensure that data processing work is distributed evenly over the whole month, data will be forwarded from the field three times per month in ten-day periods. This will also ensure that the entry and primary validation activities will not be rushed through at the last moment.

At the Divisional Data Processing Centres

- The data of any month from all Sub-divisional Data Processing Centres under its jurisdiction must be available by the 15th on the following month. That is to say that the data sets of June must be available at the divisional data processing centres by the 15th of July. The same timing applies for the data of the Water Quality Laboratory.
- The secondary data validation and all other activities are scheduled to be completed by the end of this month. The field and processed data sets along with the primary and secondary validation reports for each preceding month must leave the divisional data processing by the end date of every month

At the State/Regional Data Processing Centre

- The data of any previous month from all the divisional data processing centres of the state/region must be available by the 5th of the next month. That is to say that the data sets of June (both field data and partly validated data) must reach the State/Regional Data Processing Centre by 5th August.
- Within 5 days the field data set must be transferred to the Data Storage Centre, i.e. the data of June should be available at the Data Storage Centre not later than 10th August.
- At the Data Processing Centre all the required actions must be completed on the incremental data sets by the last date of the month in which the data has been received, so the observed data of June is completed at the State/Regional Data Processing Centre by 31 August. These data will be held as a provisional processed data-set until the end of the water year, when they will be forwarded to the State/Regional Storage Centre as a confirmed (authenticated) data-set for general dissemination to users.

At the State/Regional Data Storage Centre

- Both field and fully processed and validated data will be held at the State/Regional Storage Centre
- Field data sets will be received within 6 weeks after the month in which the data have been collected.
- Fully processed and validated data will be received within three months after the end of the water year and made available for general dissemination. Only under exceptional circumstances will validated data from the State/Regional Data Storage Centre be retrieved for correction at the State/Regional Data Processing Centre. An example would be where gauging in an exceptional flood shows that a previous extrapolation of a rating curve has been incorrect, thus requiring reprocessing of some extreme flood discharges.

Inter-agency/inter-level meetings

There must also be at least two meetings every year in which different agencies, which operate in the region, discuss the consistency of the data sets between the agencies and finalise them. For the data pertaining to June-December and January-May such meetings must be concluded by the end of February and August each year, respectively. Before such finalisation the processed data sets must be considered as of provisional nature only.

A higher frequency of exchange of views on data interpretation between the various parties within the organisation and between the organisations working in the same region is essential and should be stimulated.

3 DATA USERS AND DATA REQUIREMENTS

3.1 GENERAL

In the set up of the Hydrological Information System the first question to be addressed is the type of information to be provided. This determines the layout of the observation network (parameters, network density, observation frequency, equipment, etc.) and the data available in the databases. The type of information to be provided requires an analysis of the potential hydrological data users. The Central and State Government agencies, which support the Hydrological Information System, are the major users of the generated information. There are scores of other governmental, non-governmental and private agencies also, which make good use of this information. It is obvious that the hydrological data needs, of the users, also change over time. Therefore, it is very important to identify the potential data users and regularly analyse their data needs. Normally, it is expected that the hydrological information service agencies satisfy most of the genuine data needs of the potential users in particular and society at large. For ensuring an optimal use of the public resources spent for maintaining such a Hydrological Information Service, it is therefore very essential to have a proper balance between the data needs of various users and mandate of various services supporting the hydrological information system.

To ensure that the HIS output remains at all times ‘demand driven’ each state/agency has to constituted a Hydrological Data User Group (HDUG). These HDUGs must represent all potential users within the State or intended to be covered by an agency.

To arrive at an HIS which complies with the objectives a thorough analysis of data user needs is required along the following steps:

- Identification of mandates of Hydrological Service agencies
- Assessment of hydrological data users and their data needs, and
- Preparation of a Hydrological Information Needs document.

These elements will be dealt with in the subsequent sub-sections. Finally a Working Plan for the Hydrological Data User Group is set up.

3.2 MANDATE OF HYDROLOGICAL SERVICE AGENCIES

The prime objective of any information system is to fulfil the needs of its users within the framework of its mandate. Different agencies operating various hydrological and meteorological networks have specified mandates for their hydrological information services. The first important issue is to review these goals for each of such services operative in the region. The definitive statements on the scope of each of the services would form the criteria for deciding which of the data needs of the users can be satisfied by the HIS. Normally, the scope of an agency with respect to HIS is spelt out in very

broad terms and it is possible to incorporate most of the demands of the data users. However, in cases where the existing mandate of an agency is not covering certain requirements of the users and the hydrological data users group also consider such requirements to be met by the HIS then the same should be formally brought to the notice of the concerned agency. The agency must then consider the matter for possible extension of its mandate with respect to HIS.

3.3 ASSESSMENT OF DATA REQUIREMENTS

The next step is to ascertain what is really required by the users. Often, this aspect is overlooked and it is taken that the information being provided is the same, which is required by the potential users. It is obvious that user needs change from time to time and the HIS would fulfil its commitment only if there is a continual review or assessment of the changing needs of the users. The assessment starts with an analysis of the objectives, functions of Water Resources Management (as related to planning and design). It is possible to make a direct link between the objectives of water resource management and use functions of the water system and the type of data that is needed from the Hydrological Information System.

Objectives, functions and activities of Water Resource Management

Based on the National Water Policy and overlying strategic national/state plans a concise objective of the water resources development in the country and in the states can be formulated. Such a specific statement on the objectives if formulated is likely to contain the elements as mentioned in the box.

Objectives WRM:
- to protect human life and economic functions against flooding
- to maintain ecologically sound water-systems
- to support use functions

Use functions:
- drinking and municipal water supply
- irrigation
- fisheries
- hydropower production
- shipping
- industrial water supply
- discharge of effluents (incl. cooling water)
- recreation

These objectives of water resource management and use functions of the water system are linked to the type of data that is needed from the Hydrological Information System, which is outlined (as an example) in Table 3.1.

However, from an analysis point of view Table 3.1 has only an illustrative value. It will be needed to define the activities that are related to these objectives/use functions and the institutions involved. Following gives a possible classification of such activities:

- WR Policy and Strategy Development
- River-basin planning and allocation
- Water Resources Assessment
- Conservation
- Water Demand Analysis
- Demand Management (efficient use)
- Pricing of water

- Legislation and Enforcement
- Water Resources Development and Distribution
- Monitoring
- Research

This classification should be adjusted to National/State situation by looking at the priorities (following from the policies mentioned above) and the institutional setting. Furthermore it will be required to define sub-activities.

Objective / function	**Data requirements from HIS (examples)**
Protection: - flooding - drainage	• design studies (e.g. embankments along rivers and canals, culverts and bridges to bypass floods under roads-railways) require data on temporal and spatial distribution of extreme rainfall, on discharge extremes and river stages; • flood early warning systems require the same kind of information
Ecological sound water systems: - ecology - forestry - erosion	• assessment and habitat studies require data on the natural river stage and flow dynamics, flow velocities, variation of groundwater levels, water quality and of anthropogenic effects; • forestry/erosion require data on rainfall, evaporation, variation of river stage/groundwater levels and on quality.
Drinking water supply Municipal water supply	• resource assessment and design studies require data on water quantity and quality, e.g. temporal distribution of river flows, groundwater levels.
Agriculture - irrigation - rain-fed agriculture	• assessment and design studies (reservoirs, intakes, irrigation schemes, etc.) require data on water quantity and quality data, including extreme rainfall and river flows (spillways), historical river regime (reservoirs) and sediment transport. • for the operation planning of the system data on water demands, rainfall, river stages and flows (quantity and quality) are needed. Real-time data and forecasts are however not provided by the HIS
Fisheries	• assessment and suitability studies require data on water depth, flow velocities and water quality.
Hydropower production	• the design and operation of micro, mini and macro-hydropower systems, often in combination with water use for irrigation and flood mitigating measures require data on water quantity and quality data, including extreme rainfall and river flows (spillways), historical river regime (reservoirs) and sediment transport. • for the operation of the system data on water demands, rainfall, river stages and flows (quantity and quality) in real-time and as forecasts are needed. Such data are however not provided by the HIS
Shipping	• Design and maintenance require information on water depth, flow velocities, sedimentation (note: inland shipping is of minor importance in India).
Industrial water supply	• Availability studies (for process and cooling water) require information comparable to drinking water supply.
Discharge of effluents	• Licensing and monitoring require data on flows, various water quality parameters.
Recreation	• Assessment studies and protection require on water quality conditions, water levels and flow velocities.

Table 3.1: Data requirements from HIS

3.4 HYDROLOGICAL DATA USER GROUP

Defining the institutions involved in carrying out the activities as described in Section 3.3 is the next step in the analysis. These institutions include first of all governmental organisations directly involved in these activities (e.g. water resources departments, CWC). Furthermore, also governmental organisations that have no direct responsibility for WRM but are related to the objectives and use functions of WRM (e.g. Roads and Railways department in relation to drainage, Thermal Power Corporations in relation to using cooling water) are to be included. Moreover, the user groups should also include NGO's and private organisations, such as Water User Associations, industries, etc. Finally, organisations that have supporting roles in this respect should be included, e.g. engineering consultants and contractors. Table 3.2 is a first list of potential data users to be considered for membership of the Hydrological Data User Groups (HDUG).

1. Governmental organisations:	**2. Non-governmental organisations:**
– State Surface Water Department – Central Water Commission – State Ground Water Department – Central Ground Water Board – Indian Meteorological Department – Irrigation Departments – State Pollution Control Board – Water Supply and Sewerage Board – Geology and Mines Department – Urban Water Supply and Drainage Board – Public Health Department – Hydropower Corporations – Thermal Power Corporations – Industries and Commerce Department – Agricultural Department – Fisheries Department – Forestry Department – Ministry of Environment and Forest – Ministry of Transport (for navigation) – Development Authorities – Roads Department – Railways Department – Drought Monitoring Cell – Tourist Board – Universities	– Chambers of Commerce – Water Users Associations – Farmers Development Agencies – Environmental Protection Organisations – Tourist Organisations
	3. Private sector – Industries: e.g. Paper Mills, Fiber Industries, Cotton Mills, – Engineering Consultants – Contractors, etc.

Table 3.2: List of potential members of a Hydrological Data User Group

Combining the activities presented in Table 3.1 with the organisations listed in Table 3.2 will result in Table 3.3. The table, once filled in, indicates which organisation is involved in which activity and in which capacity (e.g. responsible, supporting, co-ordination, co-operation, using). In the table a clear distinction has to be made between federal agencies and state agencies. Based on such tables the data users and broadly the data needs of all involved, can be determined/compiled.

Table 3.3: Involvement of organisations in water resources management activities

Activity	State Surface Water Department	Central Water Commission	State Ground Water Department	Central Ground Water Board	Indian Meteorological Department	Irrigation Departments	State Pollution Control Board	Water Supply and Sewerage Board	Geology and Mines Department	Urban Water Supply and Drainage Board	Public Health Department	Hydropower Corporations	Thermal Power Corporations	Industries and Commerce Department	Agricultural Department	Fisheries Department	Forestry Department	Ministry of Environment and Forest	Ministry of Transport (for navigation)	Development Authorities	Roads Department	Railways Department	Drought Monitoring Cell	Tourist Board	Universities	Chambers of Commerce	Water Users Associations	Farmers Development Agencies	Environmental Protection Organizations	Tourist Organizations	Industries	Engineering Consultants	Contractors.
WR Policy and Strategy Development																																	
River basin planning and allocation																																	
Water Resources Assessment																																	
survey and monitoring																																	
research and development																																	
Conservation																																	
treatment/re-use of (waste-) water																																	
watershed management																																	
Water Demand Analysis																																	
Demand Management (efficient use)																																	
Pricing of water																																	
water abstraction																																	
water delivery																																	
Legislation and Enforcement																																	
water abstraction licensing																																	
water pollution permits																																	
building/land-use permits																																	
Water Resources Devel. & Distribution																																	
domestic and municipal water																																	
industrial water																																	
Irrigation																																	
drainage / flood control																																	
sewareage / conveyance																																	
water treatment																																	

Through a process of group meetings, individual interviews and review meetings, identification of the users' need is to be ascertained. The HDUG meeting itself is not a proper platform to identify in detail the individual data needs. A more efficient procedure is a critical assessment through small interview teams, who explore in bilateral talks the mandates and data needs of the potential data users. In the interview teams both state surface and groundwater organisations are represented. To guide and streamline the discussions a questionnaire has been prepared, to be filled in during visit to the data user, addressing items like:

- description of data user (name, sector, mandate, provided services, staffing and financing).
- water system use (present and future) with respect to quantity and quality, and responsibility.
- data use and requirements (parameters, type, frequency of availability, in what form, accuracy, consequences if not available, appreciation of present status of data supply.

The full questionnaire with the suggested approach to be followed by the interview team is presented in the Part III of Volume 1, Field Manual, HIS, 'Data needs assessment'.

A document on Hydrological Information Needs (HIN) should be brought out at the end of this exercise after adequate consideration of the mandate of the hydrological services operative within a State or agency and also the identified needs of the users. Reference is made to the Part IV of Volume I, Field Manual, HIS showing a standard Table of Contents for the HIN. This exercise of having a formal assessment is a continual process wherein the review is made periodically at a specified interval of time (say every five years) and whenever there is an apparent or urgent need.

The 'Terms of Reference' (ToR) document in respect of constitution and functioning of the HDUGs lays down a broad framework of operational guidelines, so that a consistent and uniform approach for the management of HDUGs is adopted, across the states and central agencies where HIS is operational. Reference is made to the Part II, Volume 1, Field Manual, HIS for a complete presentation of the ToR for HDUG.

The ToR lists the overall purpose of setting up state and central level Hydrology Data Users Groups (HDUGs) as:

- To provide a common platform for interaction between hydrology data users and data providers.
- To create awareness amongst users about HIS data and educate them on the potentials and limitations of HIS.
- To understand, analyse and update information on the changing needs of data users from a macro level perspective.
- To review and recommend additions/deletions in the data collection networks and related HIS, if appropriate.
- HDUGs can also focus on technology changes that may warrant changes in monitoring and data management.

The role of an HDUG is twofold:

- advisory role and
- demand - supply linkage role

The recommended size of an HDUG in each state or central agency is approximately 25 to 30 members, representing governmental agencies (15 to 20 members) and voluntary organisations and private establishment (8 to 10 members). The specific criteria for selection of members from the three categories are detailed out in the annex to the ToR.

The ToR further specifies regulations governing the HDUG including position, membership and operational clauses and list out the scope activities in the advisory capacity and in the demand-supply linking role.

3.5 WORKING PLAN OF HDUGs

For each State there is one HDUG representing the Surface water and Groundwater related departments and users. Similarly, at the National level, one HDUG representing CWC, CGWB and users from potential sectors has been formed. The Convenor of the HDUGs at the States is the overall incharge of the State Data Storage Centre of the rank of Chief Engineer. If the Groundwater and Surface Water Data Storage Centres are separate in the State then the Incharges of these become the convenors of HDUG by rotation. Similarly, at the National level also, the overall incharges of the National Data Centres at CWC and CGWB, of the rank of Chief Engineer, act as Convenors of HDUG by rotation. The term for rotation should be the same as frequency of review. The overall responsibility of bringing out the HIN document and convey its recommendations to all the concerned agencies lies with the Convenor of the Group.