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# National Ground Water Observation System and Need for It'S Improvement

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# NATIONAL GROUNDWATER OBSERVATION SYSTEM AND NEED FOR IT'S IMPROVEMENT

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## ABSTRACT

The Central Ground Water Board, the National apex organisation has set up a national network of observation wells and is monitoring Water Level and Water quality from these observation wells to keep a watch on the changes in the ground water regime consequent to extensive development, excessive irrigation and seepage in the Cenal Command areas, pollution from various sources such as industries etc. The Board has established 15,972 National Hydrograph Net work stations by March 1993. The state Governments have also established their own groundwater observation well networks. There is need to improve this existing system of data collection and infrastructural facilities at the state and National level. The basic structural modifications needed to strengthen the existing National and state data collection networks are outlined.

The National Hydrograph observation well Network established by the Central Groundwater Board reflect the macrolevel changes in the ground water situation in the country where as the micro level monitoring of the groundwater regime is undertaken by the State Ground Water Department who have set up more then 30,000 Network observation stations. Various steps contemplated to integrate the National and state Groundwater observation well net works to evolve a uniform system of data collection, processing and analysis by the CGWB and States, have been mentioned.

There is a growing need for a flexible and dynamic data base management system to store the ever increasing amount of data and to make them available and accessible to a wide range of users. The details of the proposed National Groundwater Information system to be established in collaboration with the state Governments and other agencies to collecat store, update; process and disseminate the groundwataer data, to enable planning and effective management of groundwater resources of the country, have been presented.

## 1.0 INTRODUCTION

Groundwater is one ot the earths most widely distributed and most important resource. It is a renewable natural

resource and has the remarkable distinction of being highly dependable, safe and ubiqutious. There has been spectacular expansion in the exploitation of groundwater during the last few decades. The growing complexity of modern society puts increasing stress on groundwater. In a situation charcterised by phenomenal growth of groundwater use, it is of utmost importance that groundwater regime in different hydrogeological situations in the country is monitored regularly in respect of its quantity and quality.

To keep a watch on the groundwater situation in different parts of the country, the Central Ground Water Board, the National apex organisation has set up a national network of ovservation wells and is monitoring water level and water quality from these observation wells. The state Govts. have also established their own groundwater observation well networks. There is need to integrate the National and state Networks and to modernise the data collection, processing and analysis systems.

## 2.0 NEED FOR MONITORING GROUNDWATER LEVELS AND QUALITY

The estimated total replenishable groundwater resources of the entire country works out to 45.22m.ha.m. out of which 6.94 m.ha.m. are generally set apart for drinking, industrial and other committed uses and the utilisable groundwater resources for irrigation is taken to be of the order of 38.28 m.ha.m. The present net draft is 10.65 m.ha.m. leaving a balance of 27.63 m.ha.m. of groundwater resource, still available for exploitation for irrigation.

When seen for the country as a whole there is considerable groundwater still required to be developed. However, when viewed from the micro-level angle, there are pockets\areas where intensive development has led to rather critical situation and manifestation of the problems like declining groundwater levels, shortage in supply, saline water encroachment etc.

Over exploitation of groundwater results in progressive lowering of water levels and consequent decline in yield and productivity of wells, intrusion of seawater along the coast, drying of springs and shallow dugwells, increasing cost of lifting of water due to declining water levels, reduction in the free flows and even local subsidence at some places.

In the coastal region of Saurashtra, Gujarat from Madhopur to Una, indiscriminate groundwater exploitation resulted in saline water ingression and deterioration of groundwater quality. Excessive use of saline water, in turn affected the structure and salt balance of the soil causing damage to the soils, reduction in crop yields etc. In Mehasana area, Gujarat, excessive groundwater exploitation has resulted in progressive decline in water levels in the shallow aquifers in the Central and South Central parts of the areas. Similar problem exist in the Chandigarh area of Union Territory, the Kurukshetra area of

Haryana State and in some pockets in Tamil Nadu and Kerala.

With the advent of intensive irrigation through Surface irrigation projects, in certain canal Command Areas, because of excessive application of surface irrigation waters and due to poor subsurface drainage, the water table is progressively rising and has already created waterlogging and salinity in several parts of the country, making the soils unproductive and restricting the growth of plants resulting in decline in crop yields.

To keep a close watch on such groundwater situations in various parts of the country, to observe the effects of increasing stress on the groundwater system and to study the response of groundwater levels to such changes consequent to extensive development, it is very essential to have effective monitoring of groundwater regime through a network of observation wells covering the entire country.

## 3.0 ESTABLISHMENT OF NATIONAL HYDROGRAPH NETWORK

The objective of establishing groundwater monitoring network stations or observation well networks is to study the reaction of the groundwater regimen to natural and artificial conditions of recharge and discharge, in relation to geology and hydrologic characterstics. A proper monitoring network is primarily required to evaluate the dynamic reaction of the groundwater system under natural and stressed conditions.

The criteria that has been followed in establishing the National Net work observation wells by the Central Ground Water Board are.

(i) The Network observation wells should be representative of the hydrogeological unit of the area/basin/region and should cover the recharge and discharge areas.

(2) The well should tap the phreactic or the shallow dug well zone. However, to monitor the development of deep aquifers, piezometers tapping the deeper aquifers have also been included in the network.

(3) Wells should not be in constant use and static levels should be available for monitoring.

(4) Wells should be in good condition, and not silted up or collapsed. They should have proper parapet or other fixed points for measurement of water levels.

### 3.1 Status of National Hydrograph Net work:

The total area of the country is about 3.28 million sq.km. out of which 2.8 million sq.km. area is coverable for monitoring from the hydrogeological angle. At the national level, the

erstwhile Ground Water Division of the Geological Survey of India established a net work of observation wells and commenced monitoring them in 1969 for water leavels and quality of groundwater. To begin with only 410 observation wells were established with a modest density of one well for every degree sheet and at least one in one lithounit. Since the merger of the Groundwater Wing of GSI with the Central Ground Water Board in 1972, the network system has been strengthened, from time to time by establishing new observation wells. There were 1618 Net work Stations by the end of 1976 and the number of Observation wells in the net work increased to 2625 by March, 1985. By March 1990, the number of Hydrograph network stations increased to 12,477.

At presant ie by March 1993, the Board has established 15,972 National Hydrograph Net work stations. The statwise distribution of these network stations is shown in table 1.

### 3.2 Frequency of Observations

Periodicity of observations will depend on the purpose for which such data are required. Readings have to be taken at regular intervals, eliminating inconsistencies in the frequency of data, so that the data collected can be meaningfully subjected to Scientific analyses. Initially, monitoring of water levels of all the National network stations was carried out five times a year i.e. during January, April, June, August and November and water samples were taken twice a year in April and November to monitor the changes in water quality. However, an analysis of a decade's data (1969-79) indicated that dropping one of the measurement schedules will not result in any loss of information and instead of April and June measurements, the measurements in May, can meet the requirements of proper interpretation of data. Hence from 1984 onwards, the water level measurements are being taken four times a year during January, May, August and November and water samples are being collected once in a year during the month of May.

### 3.3 Data Collection, Processing and Analysis

So far data collection from the National network stations by CGWB is mostly manual and stored in registers & files. From time to time the data is processd, analysed and interpreted in reference to hydrometeorological conditions and other data such as groundwater extraction etc. and regionwise mimeographed reports are being issued. Presently CGWB has developed a computerised data storage and retrieval system and the entire data of the National Network of Observation Wells is being transferred on standard format.

However, there is a need for development of suitable data base system. It would be necessary to use automated instruments for groundwater level data collection and microprocessor based data system for recording and transmission of data. These would not only eliminate human errors but also speed up the process of

Table 1 : Statewise Status of National Hydrograph Network stations

| Sr. No. | State/Union Territory | No. of NHNS as on 31.3.1993 |
|---|---|---|
| (1) | (2) | (3) |
| 1. | Uttar Pradesh | 1704 |
| 2. | Andhra Pradesh | 1025 |
| 3. | Tamil Nadu | 819 |
| 4. | Pondichery | 16 |
| 5. | Bihar | 614 |
| 6. | West Bengal | 982 |
| 7. | Sikkim | 0 |
| 8. | Andaman, Nicobar Islands | 32 |
| 9. | Rajasthan | 1357 |
| 10. | Maharashtra | 1529 |
| 11. | Dadra & Nagar Haveli | 5 |
| 12. | Assam | *459 |
| 13. | Tripura | 49 |
| 14. | Arunachal Pradesh | 17 |
| 15. | Mizoram | 0 |
| 16. | Meghalaya | 41 |
| 17. | Manipur | 29 |
| 18. | Nagaland | 8 |
| 19. | Haryana | **707 |
| 20. | Punjab | 615 |
| 21. | Jammu & Kashmir | 156 |
| 22. | Himachal Pradesh | 79 |
| 23. | Delhi | 88 |
| 24. | Chandigarh | 21 |
| 25. | Madhya Pradesh | 1372 |
| 26. | Orissa | 1116 |
| 27. | Karnataka | 1330 |
| 28. | Goa | 58 |
| 29. | Gujarat | 1056 |
| 30. | Daman & Diu | 7 |
| 31. | Kerala | 651 |
| 32. | Lakshadweep | 30 |
| | TOTAL | 15972 |

* Includes 7 NHNS increased in the region during 1992-93 as break-up still to be recieved.

** Includes 37 NHNS increased in the region during 1992-93 as break-up still to be recieved.

data collection and transmission. Also the micro-processor based system would enable speedy processing of such data including consistancy checks and filling up of missing data etc. This would make good quality of data available in real time. Standard formats have to be developed for proper storage and transmission which would enable uniformity in data compilation by all State and Central Organisations. Also it would be desirable to develop system linkages to facilitate users, access to the required hydrogeological and ground water level data for use in planning, design and operation.

## 4.0 STRENGTHENING THE EXISTING DATA COLLECTION NET WORK

To achieve a desired degree of growth in the field of ground water investigations and development for meeting the various requirements, there is a need to improve the system of data collection, infrastructural facilities at the state, Regional and National levels. Establishment of an adequate and optimum number of National and State Net work of observation stations is imperative to monitor ground water level and Chemical quality changes brought out by increasing groundwater development in the country.

The basic structural modifications needed for strengthening the existing National and state data collection network, are briefly outlined below

a. The number of Data Collection Net Work stations have to be increased, where ever required, in order to make them representative of different hydrogeological situations existing in the country.

b. As, currently, the shallow aquifer zone is adequately represented by the existing monitoring stations, future emphasis should be to construct Piezometers to monitor the piezometric heads of the confined and deep aquifers in the country.

c. Water quality monitoring should also include monitoring of the pollution of groundwater. The network should be so planned that the areas likely to face the problems of pollution of groundwater such as industrial areas and urban complexes should be adequately covered.

d. In coastal areas with multi aquifer systems and likely problems of sea water intrusion, suitable Piezometer nests should be established for regular monitoring of Piezometric heads and water quality changes.

e. It is necessary to establish suitable grid of observation stations in all the Canal Command areas, in order to identify the areas water logged and prone to water logging. This will help in planning the remedial steps to control and prevent water logging in these areas.

f. As, the mechanism of recharge to groundwater through the unsaturated zone is little understood, so far and only a very few studies were made on this aspect in the country, it is necessary to initiate soil Moisture Monitoring Net Works in selected sub-basins.

g. So far the data collection from the Net Work stations in the country is mostly manual. It is necessary to install automatic Water Level Recorders and Data loggers on a number of net work stations for continuous monitoring of water level and quality changes.

h. Collection of representative Water samples from the net work stations also form an important data collection activity. It is necessary to procure a number of latest water sampling devices for collecting representative water samples from various depth zones and to strengthen the existing Central and State Chemical laboratories by equipping them with modern analytical instruments.

## 5.0 INTEGRATION OF CENTRAL AND STATE HYDROGRAPH NETWORK STATIONS

The National Hydrograph Observation Network Stations established by the Central Ground Water Board reflect the macro level changes in the ground water situation in different parts of the country. The data generated by these Network Stations monitored four times a year are used to prepare the ground water level changes maps for different States and for the country as a whole. These maps alongwith an explanatory note giving the extent of water level changes, reasons for such variations are presented after each measurements to the State Government for taking necessary action regarding ground water development. Further a Ground Water Year Book for each State is prepared, wherein the data collected from the Hydrograph Network Stations is analyzed and presented. These are also circulated to the State Governments and all User Agencies.

The micro level monitoring of ground water regime is undertaken by the respective State Ground Water Departments in different States who have set up more than 30,000 Network Stations. These stations are being monitored by the State Government at various frequencies and are generally twice a year to monitor pre and post monsoon water levels. Based on the objectives of a particular project and the requirement of data some of the wells are even measured monthly/bi-monthly. The objectives of the monitoring of State Government are with reference to specific problems like water logging in the command, to monitor the water level changes due to surface water irrigation, to assess the ground water situation in intensive and over-exploited areas etc.

During 8th plan, the Central Ground Water Board would be taking up the work of integration of Hydrograph network Stations of Central Ground Water Board and State Government with a view to

have common approach for monitoring Hydrograph Network Stations. The integration of the Hydrograph Network Station of State Ground Water Department and the Central Ground Water Board would be with a view to finally establish optimum network density and its realistic configuration. The first step would be to establish the basic structure, geometry and hydrologic characteristic of the flow field in a ground water regime. This would be done with the help of data already generated by Central Ground Water Board and the State Ground Water Department during various studies. The second step would be then to establish the dynamic reaction of the ground water system under natural and stressed conditions. The data already generated from the Hydrograph Network Stations monitoring, from the State Ground Water Organisations and Centaral Ground Water Board would be analysed to assess this component. Based on the Hydrologic, climatic and hydrochemical factors, the data would be subjected to statistical analysis to arrive at optimum numbers of network, which should be required to monitor the regional ground water Levels. Standardisation of the network design would be made and the Hydrograph Network Stations confirming to these standards, either from Central Ground Water Boarad or from State Ground Organisation would then be taken up as National Hydrograph Network Stations. The formats utilized by Central Ground Water Board for monitoring the Hydrograph Network Station will be circulated to the State Governments for adoption for the monitoring work. An uniform system of data collection, processing, and analysis by the Central Ground Water Board and the States would be evolved.

## 6.0 PROPOSED NATIONAL & STATE GROUNDWATER DATA BANKS AND THEIR INTEGRATION

Water Resources Development and Management require a wide range of data that is usually scattered in files and reports in the various State and Central agencies. The volume of data in recent years has greatly increased. The poor accessibility to the data as a result of outdated method of data keeping prevent it from being used effectively in resource development, planning and management.

There is therefore a growing need for a flexible and dynamic data base management system to store the everincreasing amount of data and more important to make them available and accessible to a wide range of users. The advantage of databases is its flexibility in the sense that it can easily be accessed and reproduced according to a tailor-made format depending on its use and its dynamism in the sense that it can constantly be updated.

As of now, the existing database in CG B holds groundwater level data from over 15000 network stations in the country with an average of 15 years of record per station. Additionally CGWB has data on various aquifer parameters collected from about 9000 boreholes. Besides, it has large volume of data on hydrological, hydrometeorological & geophysical studies. The Stato Ground Water Organisations have also accumulated a variety of large

volume of data over the years.

National Water policy has stressed that a standardised national information system should be established with a network of data banks and databases, integrating and strengthening the existing Central and State level agencies and improving the quality of data and the processing capabilities. It has also emphasised that there shold be free exchange of data among the various user agencies and duplication in the data collection should be avoided. Apart from data regarding availability and use, the system should also make comprehensive and reliable projections of future demands of water for diverse use sectors.

The establishment of a National Ground Water DATA Network will be cooperative work of Central Ground Water Board and State Ground Water Organisations. The CGW, will coordinate and integrate this activity and decide on the type of data to be collected and stored, the formats for collection, storage and quick reteieval, so that an integrated National Data Network become operational.

It is proposed to establish a National Ground Water Information System (NGWIS) in collaboration with state Government and other agencies to collect, store, update, process and disseminate ground water data as a part of an overall National Ground Resources Data Bank.

The salient features of the proposed National Ground Water Information system (NGWIS) manner of implementation and interlinking of Central & State Data Banks of the same is briefly described below:

**a. Salient Features**

* Setting up of a Integrated National Ground Water Information System in Central Ground Water Board.

* Equipping and strengthening Central Ground Water Board and state ground Water Organisations (SGWOS) with necessary Hardware & Software capabilities.

* Designing of databases to accept large volumes of attribute and spatial data from variety of sources, and to efficiently store, retrieve, manipulate, integrate, analyse, display and disseminate according to the user-defined specifications.

* Amalgamation of diverse data-sets in geographic information system.

* Devemopment of multi-dimensional databases (timeindependent & time-dependent) and analysis packages.

b. **Manner of Implementation**

A unified & integrated Ground Water Information system to be operated on various computer nodes located throughout the NIC Network (NICNET) by using Modems on P & T lines. Three major types of nodes have been identified:

- National Node (CGWB, New Delhi)
- State nodes (SGWDS)
- Regional nodes (CGWB Regional Offices)

**National node**

National node of ground water information system will be located at Central Ground Water Board, New Delhi/Faridabad where it will be managed and operated for scientific information management. The node configuration will consist of computers that may be used independently or linked together to allow better use of available resources.

The National node will perform various functions including

- Network management.
- Software procurement, dissemination and distribution
- Indexing of ground water information system
- Processing and dissemination of ground water & related data requiring centralised storage.

**Regional nodes**

Each CGWB Regional office may operate and maintain a fully or partial configuration of GWIS system as needed. These nodes will also consist of single computer to begin with and will also use the GWIS for effecting storage, analysis and dissemination of ground water data collected by it.

**State Nodes**

The State nodes will form the bulk of ground water information system network and will be distributed nation-wide. They may consist of simple computer that will effect storage and dissemination of all detailed site specific ground water & related data collected by the State Ground Water Organisation (SGWO).

Each State node will operate and maintain a complete configuration of the Ground Water Information System (GWIS) and will be responsible for storing, indexing, managing and disseminating the ground water data collected within its

geographic area of operation.

Documentation for all software sub-systems & modules within GWIS will be released as official CGWB publications. Each software module will be documented by the following items.

- Programme specifications used for development
- Test-analysis report
- User manual
- Operations manual
- Programme maintenance manual

All software distributions will be made from the National node of GWIS. General distribution will be made to all nodes for any new release of the GWIS software.

Various application software will be provided in the GWIS architecture to support commonly used applications including:

- Tabling
- Spreadsheet
- Plotting
- Mapping
- General Computation
- Statistical analysis
- Numerical analysis

Software for GWIS will be developed in distributed manner. To assure adequate exchange of information pertinent to the GWIS among developers, a designed data dictionary will be mantained at the National node (CGWB, New Delhi/Faridabad) of GWIS for common access by all development personnel. The design data dictionary will assure consistency in system terminology, data base & data element definitions and a wide array of other items used in the design of development process.

## C. Interlinking of Central, State & Regional Nodes

Flow diagram indicating linkage of Central computing & storing facility of CGWB (HQ) to State Nodes and Regional office Nodes is shown in fig.1. Central Node shall have a super-mini computer system where as all Regional/State Nodes can have PC/AT 386 system which will transmit data using MODEMS through P & T lines to the Central super - Mini computer at Central Node at

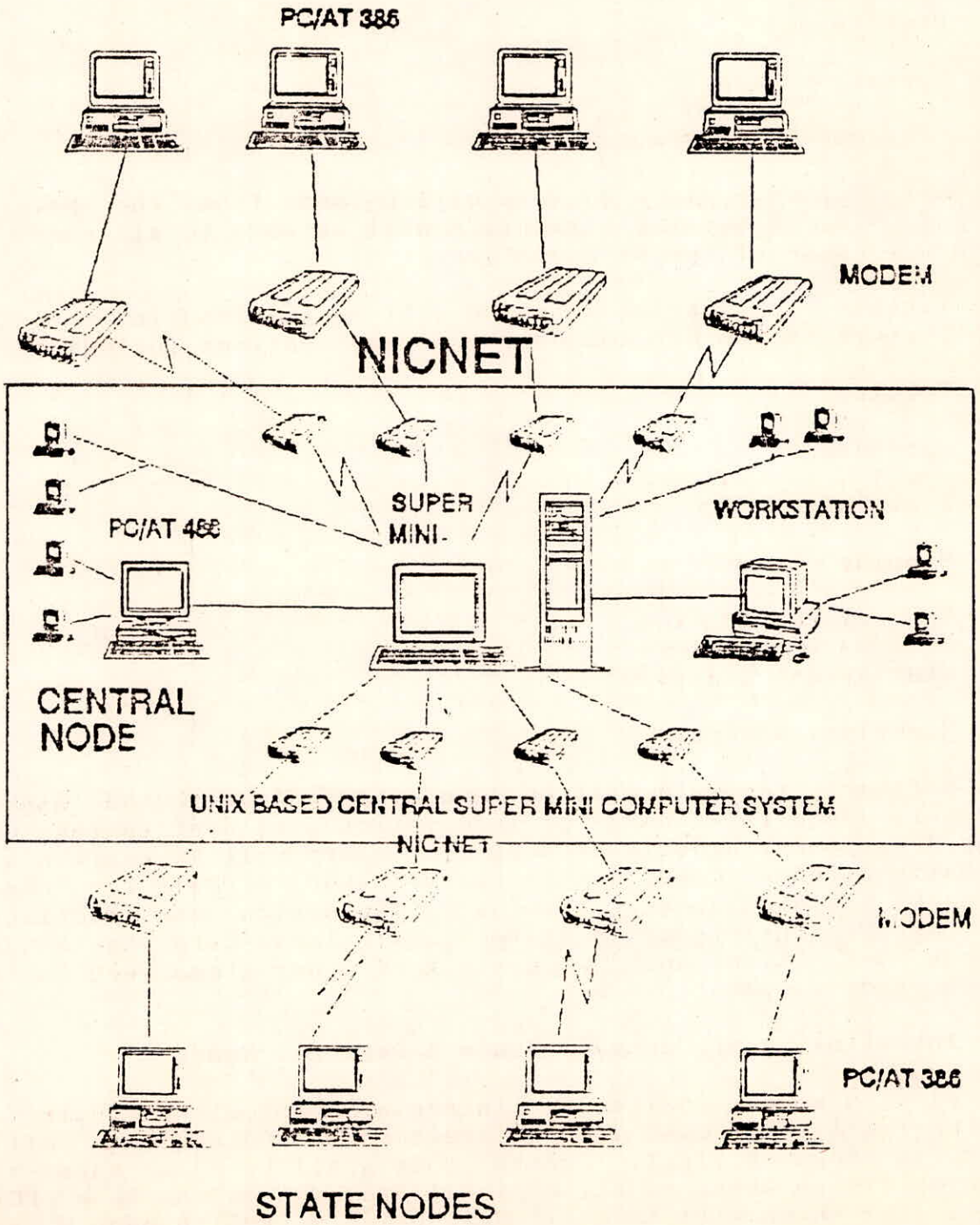


FIG.1–DIAGRAM SHOWING LINKAGE OF CENTRAL, STATE AND REGIONAL NODES

CGWB (HQ) New Delhi/Faridabad. These data shall be integrated at the main System and analysed. The workstation and Geographic Information system (GIS) can be used from the main system.

## 7.0 SUM UP AND CONCLUSIONS

Establishment of an adequate and optimum number of National Network of observation stations is imperative to monitor groundwater levels and chemical quality changes brought out by increasing groundwater development in the country.

Central Ground Water Board, the National Apex Organisation has set up a fairly representative national groundwater observation well net work of 15972 stations by the end of March 1993. The states also have their own groundwater observation well net works. These is need to strengthen and modernise the Central and State net works and to integrate them.

There is also need for establishing an integrated National and state Groundwater Data storage and Retrieval system (Groundwater Information System) to collect, store, update, process and disseminate groundwater data, to enable planning and management of groundwater resource with a view to achieve optimum and safe development of this vital resource of the country.