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National Network for Groundwater Monitoring

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Abstract : *In the growing complexity of modern society resulting in phenomenal growth of ground water use, it becomes important to monitor ground water regime in different hydrogeological situations. The national network of observation wells set up by Central Ground Water Board has been discussed. Status of ground water development and need for monitoring ground water levels and quality have been explained. Criteria followed in establishing the national network observation stations, frequency of observation, data collection, processing and analysis have been explained. Need for establishment of optimum network and development of suitable data base system and software to analyse these data has been emphasized.*

I. Introduction

The growing complexity of modern Society puts increasing stress on groundwater. In a situation characterised by phenomenal growth of groundwater use, it is of utmost importance that ground water regime in different hydro-geological 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 and to study the response of groundwater levels to increase or decrease in the amounts of inputs from various sources; the Central Ground Water Board, the National Apex Organisation, has set up a national net work of observation wells and is monitoring water level and water quality data from these observation wells. At present 1427 observation wells (By March, 1988) have been established and it is planned to set up another 3000 observation wells by the end of VII Plan period. It is necessary to critically review the adequacy or need for additional stations in the light of the complex hydrogeological situations in the country, in order to get a reliable picture on the groundwater situation in the country from time to time.

II. Status of Groundwater Development

Groundwater is a renewable natural resource and has the remarkable distinction of being highly dependable, safe and ubiquitous. There has been spectacular expansion in the exploitation of groundwater during the last few decades. From a mere 6.5 million hectares in 1950-51, it came to provide 27.8 million hectares of irrigation by the end of VI Plan (1984-85) making a contribution of about 45% of total irrigation. It is proposed to create 12.9m.ha. of irrigation potential during the VII Plan period (1985-90) of which 7.1m.ha. i.e. about 55% would come from groundwater. Groundwater is one of the important sources of domestic and industrial water supply of our rural villages and urban towns and cities. The total number of dug wells in the country have gone up from 3.86 million in 1950-51 to 9.17 million by March, 1987, and similarly the number of private shallow tubewells which were only 3000 in 1950-51 have gone upto 3.84 million by March, 1987. By the end of VII Plan period a phenominal figure of over 12 million irrigation pumpsets are expected to be in position for use.

The farmers dependence on and confidence in groundwater has made its development essentially a people's programme. The entire groundwater development of the country is primarily sustained by the financial investments made by the farmers themselves either individually or through cooperative efforts from finance obtained as loans from institutional sources. Public Sector outlay in the case of groundwater schemes is limited to only such items as groundwater surveys, public tubewells, services provided and grants extended to small farmers. These factors coupled with an expanding programme of rural electrification and increasing mobilisation of institutional investment for minor irrigation works, led to a spectacular expansion in groundwater development for irrigation in the recent years and is likely to increase further in future.

III. Need for Monitoring Groundwater Levels and Quality :

The estimated total replenishnable groundwater resource of the entire country works out to 45.66m.ha.m. out of which 7.05 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 38.61m.ha.m. The present net draft is 10.47m.ha.m. leaving a balance of 28.14m.ha.m. of groundwater resource are 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 manifestations of the problems like declining groundwater levels, shortage in supply, saline water encroachment etc.

Over exploitatiion 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 soil structure and salt balance of the soil causing damage to the soils, reduction in crop yields etc. In Mahsana 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 Tamilnadu 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 water logging 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 the groundwater regime through a net work of observation wells covering the entire country.

IV Establishment of National Hydrograph Network

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 arstwhile Ground Water Division of the Geological Survey of India established a net work of observation wells and commenced monitoring them in 1969 for water levels 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 lictounit. 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. At present i.e. by March, 1988 there are 9427 such stations. It is likely that by the end of VII Plan period i.e. by March, 1990, the strength of the National Network observation wells will reach about 12500. The Statewise distribution of these network stations as on March, 1987 in shown in Table-1 and their location in Plate-I.

The following criteria has been followed in establishing the National Network Observation Stations by the CGWB :

(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.

(ii) The well should tap the phreatic 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.

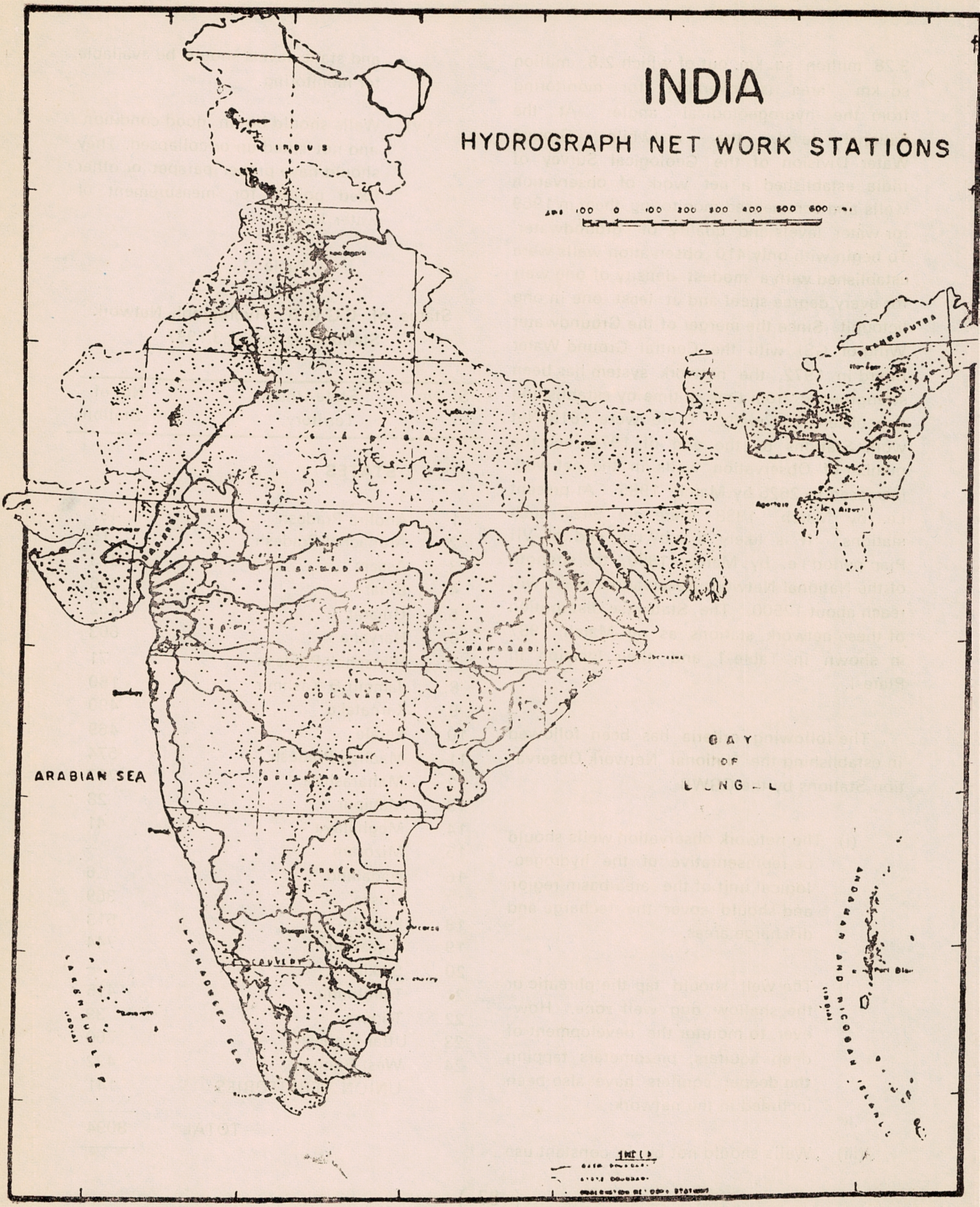
(iii) Wells should not be in constant use and static levels should be available for monitoring.

(iv) 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.

Table 1

Status of C.G.W.B. Hydrograph Network Stations as on 31.3.1987

Sl. No.	State/Union Territory	No. of Stations
	STATES	
1.	Andhra Pradesh	467
2.	Arunachal Pradesh	15
3.	Assam	313
4.	Bihar	296
5.	Gujarat	452
6.	Haryana	603
7.	Himachal Pradesh	71
8.	Jammu & Kashmir	150
9.	Karnataka	490
10.	Kerala	469
11.	Madhya Pradesh	574
12.	Maharashtra	707
13.	Manipur	28
14.	Meghalaya	41
15.	Mizoram	—
16.	Nagaland	6
17.	Orissa	369
18.	Punjab	513
19.	Rajasthan	744
20.	Sikkim	—
21.	Tamilnadu	415
22.	Tripura	39
23	Uttar Pradesh	760
24.	West Bengal	422
	UNION TERRITORIES	141
	TOTAL	8094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(v) Wells set up should be in hydraulic continuity with the aquifer system in use and not abandoned ones, so that they represent the water level and water quality of the aquifer in which they are situated.

(vi) Wells should have adequate water column to ensure that they do not dry up in summer or in years of low rainfall.

The National observation well network established by CGWB reflects the micro-level changes in the groundwater situation in different parts of the country. For micro-level monitoring of groundwater regime, the State Groundwater Organisations have set up their own observation well networks.

V Criteria for Network Density

Several factors to which potentiometric changes in observation wells are responsive will determine the net work density besides economic factors. As a first step, it is reasonable to establish network observation wells as dense as rain gauges in as much as the rainfall is the most dominant variable on which the water level fluctuations depend. As per the ISI recommendations (1969) the raingauge density should be 1 for 520 sq. km. in plain area and 1 for 130 sq. km. for hilly regions. The require ment of raingauges increases in the variability of rainfall.

However, as rainfall is not the only variable that determines the groundwater regime, the observation well network density cannot be directly related to the raingauge network density. The behaviour of water table/piezometric head water level fluctuations and water quality in an aquifer in an area/basin is very complex being dependent on various aspects like, (1) hydrogeological situation prevailing in the area, (2) groundwater withdrawals, (3) recharge conditions and impact of water applied for irrigation (4) Saline water intrusion, (5) groundwater pollution etc. At a specific location, it may be necessary to monitor phreatic as well as one or more confied aquifers also. Such special features of depth environment call for a higher network density.

Studies by the Central Ground Water Board in the Vedavati Sub-basin have shown that by an analysis of correlation metrix within sample space, an optimum density of 1 well for 266 sq. kms. was adequate. More such detailed studies and analysis for different hydrogeological situations in the country are to be carried out before a tangible criteria for optimal design of network could be adopted.

VI 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 statistical analysis. 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 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,

VII Data Collection, Processing and Analysis

So far data collection from the National network stations by CGWB is manual and stored in registers & files. From time to time the data is processd, analysed and interpreted in reference hydrometeorological conditions and other data such as ground water 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 Observation well net work stations 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 micro-processor based data system for recording and transmission of data. These would not only eliminate human errors but also speed up the process of 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 in all State and Central Organisations, Also it would be desirable to develop system linkages to facilitate users, access to the required hydrogeological and water level data for use in planning, design and operation.

Electronic computers of different sizes/configurations with their capability of rapid processing and objective analysis of data have made it possible to develop an efficient data storage and processing system. The data handling by Computers would also enable pre-processing and compilation and will improve the data reliability. The vast volume of data already collected and being collected from all these national network stations and planned to be stored on Computer systems would need appropriate softwares for retrieval in desired formats. Software would also be required to analyse these data for comprehensive studies pertaining to system simulation, identification and forecasting.

VIII Conclusions

Establishment of an adequate and optimum number of National network of observation stations is imperative to monitor groundwater level 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 observation well net work of 9427 stations by March, 1988 & planned to increase to 12500 by the end of VII Plan which reflects macro level changes in the groundwater regime in the country.

There is need for research to determine the optimum density of observation network stations for various hydrogeological situations and groundwater regimes prevalent in the country.

There is also need for development of suitable data base system and it would be necessary to use automated instruments for ground water level data collection and micro-processor based data system for recording and transmission of data. Software would also be required to be developed, to analyse these data for comprehensive studies pertaining to system simulation, identification and forecasting.

References

Baweja B.K. and Karanth K.R., "Criteria for establishing and Monitoring Ground Water Observation Well Net Work Stations in India".

Central Ground Water Board, Vedavathi River Groundwater Project (1978)—An approach to determine the minimum density of observation well net work, Part-I. A case study of Vedavathi Sub-basin, Karnateaka, Unpublished Report of CGWB.

Annual Report 1987-88, Ministry of Water Resources, Government of India, April, 1988.

Raju K.C.B., 'Groundwater - Assessment and Monitoring A Review. Proc. First National Water Convention. Vel. II, CBIP New Delhi Oct., 1987.