# GROUND WATER DEVELOPMENT AND MANAGEMENT - A NATIONAL PERSPECTIVE

Dr.R.K.PRASAD
CHAIRMAN,
Central Ground Water Board,
Ministry of Water Resources

## I. INTRODUCTION

Ground water has assumed a critical importance to meet the growing needs of our nation in its ever increasing domestic, industrial and agricultural growth needs. India is a vast country having diversified hydrogeological settings; Variations in the nature and composition of the rock types, the geological structures, geomorphological features and hydrometeorological conditions have correspondingly given rise to widely varying ground water situations in different parts of the country. Detailed surveys, exploration and resource evaluation studies, and proper planning of its development, management and conservation are essential for a safe and optimum utilisation of this vital resource of the country.

India is basically an agricultural country and irrigation accounts for merely 85 % of the ground water use. During the past few decades rapid progress has been made in the development of ground water resources, especially for irrigation. In addition to meeting the increasing demands of domestic and industrial needs its contribution to irrigated agriculture has increased from 6.5 million hectare in 1951 to 35.6 million hectare in 1990.

Over exploitation of ground water in certain parts has resulted in progressive lowering of water levels in localised areas and ingress of sea water along the coast in some areas. It is essential that in such areas ground water resources have to be supplimented through the means of artificial recharge techniques. On the other hand in many major canal command areas, the water table is progressively rising leading to the creation of water logging and salinity problems. Therefore, there is need for planned intergrated development of surface and ground water resources and their scientific management.

## II. GROUND WATER POTENTIAL AND DEVELOPMENT

In view of the diversified hydrogeological settings and hydrometeorological conditions, assessment of ground water resources of the country is a challenging task. Keeping this in view, Central Ground Water Board has undertaken a number of projects on ground water resource evaluation, adopting multi-disciplinary approach. These studies are primarily directed towards evolving methodologies for investigation and development of scientific norms for assessment of the ground water resource potential under various hydrogeological and agro-climatic set ups in the country.

Initially, assessment of ground water was carried out on sectoral or on regional basis for the purpose of some projects or to avail institutional finance, based on the data collected by the Central and State agencies. In 1972, guide lines for an approximate evaluation of ground water potential were circulated by the Government of India to all the State Governments and the related financial institutions. Subsequently, ground water resources of the country have been estimated based on the norms recommended in 1979 by the High Level Committee known as "Ground Water Over-Exploitation Committee". These estimates have been revised again as per the recommendations of the 'Ground Water Estimation Committee" (March 1984). The estimated total replenishable ground water resource of the country worked out to be 45.22 million ha.m., out of which 6.94 m.ha.m. have been kept for drinking, industrial and other commited uses, and the utilisable ground water resources for irrigation is 38.28 m.ha.m. The present draft is 10.65 m.ha.m. leaving a balance of 27.63 m.ha.m. of ground water resources available for exploitation. The present level of ground water development in the country is 27.82% (Table-1).

There has been spectacular expansion in the exploitation of ground water during the last few decades. The contribution of ground water to irrigated agriculture in India is now as high as 40%. The area irrigated from ground water which was 6.5 million hectares in 1950 has gone upto 35.6 million hectares by the end of Seventh Plan (1985-90) and another about 3 million hectares of irrigation potential has been created during the Annual Plan 1990-91 and 1991-92. With the availability of institutional finance, farmers have taken a big leap forward to have their own wells and pump sets. The farmers confidence in ground water has made its development essentially a peoples programme. These factors compiled with an expanding programme of Rural Electrification and increasing mobilization of institutional investment for minor irrigation works, led to a spectacular expansion in ground water development for irrigation in the recent years and is likely to increase further in future.

Ground water also plays a very important role to meet the water supply needs of our rural villages and urban towns and cities. A "Technology Mission for Drinking Water in Villages and Related Water Management" has been set up by the Government of India in August, 1986 to deal with specific problems like salinity, brackishness, iron, fluoride and bacteriological contamination and ground water management. The Technology Mission is adopting an integrated approach so that conservation and augmentation of water sources would be inter-related with rural water supply schemes, with a view to ensuring continued availability of safe water for drinking purposes.

### Exploration and Exploitation of Deep Aquifers

The Ganga alluvial plain forms a distinct physiographic unit of India lying between the Himalayan mountain ranges in the North and the Peninsular shield in the South. The ground water reservoir beneath the plain is probably the largest and potentially most productive in the entire world. The current development of ground water is limited to long term average recharge to the shallow aquifers (dynamic resources). The continued rise in water requirements has necessitated exploration for potential deeper confined aquifers underlying the alluvial plain. Central Ground Water Board has so far carried out ground water exploration upto a depth of 1000 metres and developed suitable technology for development of aquifers upto this depth. In the Ganga Basin, there are several potential deep fresh water aquifers below 1000 metres as indicated by the data from oilwell drilling by Oil and Natural Gas Commission. It is very essential to develop technical capability to explore and assess the potential of these deep aquifers from 1000 to 3000 metres and also to develop suitable designs of production wells to économically tap the fresh ground water available in these deep aquifers.

## III. GROUND WATER MANAGEMENT

When seen for the country as a whole there is considerable ground water still required to be developed. However, when viewed from microlevel angle, there are pockets where intensive development has led to rather critical situations and manifestations of problems like declining ground water levels, shortage in supply, saline water encroachment etc.

On the other hand, with the advent of intensive irrigation through surface irrigation projects, in certain canal command areas, because of excessive seepage from surface irrigation and due to poor sub-surface 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.

Development of ground water resources is required to be backed up by proper management options.

### (i) Increasing Recharge by means of Artificial Recharge Methods

In the high demand areas where ground water development has already reached a critical stage, the problems generally being faced are two fold i.e. on the one hand the demand out-strips the supply situation and on the other hand declining ground water levels increases pumping lifts and necessitates deepening of ground water structures and more energy consumption. In such areas, urgent steps are called for augmentation of ground water resources to arrest the declining trend of the ground water levels.

Artificial Recharge involves augmenting the natural movement of surface water into underground formations by some method of construction, by spreading of water through recharge basins, ponds pits, check dams/levees in the stream channels etc. by arresting the sub-surface ground water flow through construction of sub-surface dykes or by injecting water through wells in case of deep confined aquifers.

### (ii) Utilisation of surplus surface water for recharging the ground water resource.

The annual precipitation in our country is estimated as about 400 m.ha.m. (including snow fall) of which about 300 m.ha.m. is contributed by the monsoon rainfall in a period of 3 to 4 months. After allowing for evaporation and other losses, the country's estimated surface water potential is now assessed at about 187.6 m.ha.m. However, due to topographical and other constraints the utilisable resources have been assessed as about 68.8 m.ha.m. i.e. about 37%. Similarly the utilisable (Annual replenishable) ground water resources has been estimated as about 45.2 m.ha.m.. Thus the total utilisable quantum is 114 m.ha.m. i.e. 51% of the available water resources.

On a broad assessment of the potential of storage sites in the country as a whole, it is estimated that we will be in a position to store only about 35 to 40 percent of our utilisable surface water resources. In some basins, such a potential is as low as 15 to 20 percent. Therefore, it naturally follows that it will not be possible to utilise a high percentage of the available flows which continue to be wasted.

Part of this surplus water can be effectively utilised for artificially recharging the ground water in the over-exploited and other suitable areas and in areas where water levels are very deep such as Bhabar and Kandi belts, arid regions of Rajasthan etc. and where recharge and storage characteristics of the sub-surface media are favourable.

Sub-surface ground water reservoirs have capacity for multiple uses in addition to their conventional role as source of water supply. Ground water can be manipulated and managed and hence the space it occupies underground is subject to alternate uses. Artificial recharge of ground water reservoirs as on alternative to surface storage of water is an illustrative example of growing practice. It is necessary to identify areas where there is such scope and utilise part of the surplus surface water available during monsoon months, which can be fruitfully utilised during the lean, (summer) months.

### (iii) Ground Water for Drought Mitigation

The most significant attributes of ground water reservoirs are - it is a renewable resource, large fresh ground water available in storage, widespread occurrence etc, and ground water can be developed in simple stages by drilling new wells as the need for additional water arises. This flexible approach allows increases in the supply capacity to be closely tailored to meet demand growth. Water evaporation is eliminated in ground water storage and ground water requires only minimal treatment because it is naturally filtered and purified by the earth. It requires no extensive filtration to remove suspended matter and costly treatment to make the water bacteriologically safe. As ground water is found almost every where, it reduces the size of piped distribution system.

Scientific planning of ground water development should take into consideration the dynamic component for long term purposes. What is more relevant to the drought situation is the tremendous scope, ground water reservoirs offer to permit crisis management during the droughts through the static reserves.

### (iv) Management of Ground Water in areas with Salinity Problem

Ground water development and management of aquifers in saline areas involves maintaining usable quality of fresh water in aquifers and adopting measures to improve the quality of ground water in brackish or saline water bearing aquifers. The problems faced are different in coastal areas, irrigation command areas, inland saline tracts in arid regions and areas faced with pollution.

Development of water resources in Coastal areas is faced with twin problems of salinity influx during high tides through estuaries and maintaining hydro-dynamic equilibrium between fresh and salt water in aquifers to prevent or control saline water intrusion. Some of the measures to control sea-water intrusion include;

1. Reducing pumpage from existing wells and re-arrangement of pumping pattern,

2. Creation of fresh water ridge by Artificial Recharge, and

3. Construction of surface (Bandharas) or sub-surface barriers.

Well location, design, quantum of withdrawal and relation between salt and fresh water bodies are the important aspects that need to be considered while developing fresh water supplies in areas where quality problem exists. Ground water exploitation from thin lenses of fresh water as are found in oceanic Islands, coastal dunes etc. requires that the drawdown is minimised to avoid upconing of saline water. Infiltration galleries, ditches and radial wells are ideal for such situations.

(v) **Water Logging and Salinity**

With the advent of intensive irrigation through surface irrigation projects, in certain canal command areas because of excessive seepage from surface irrigation and due to poor sub-surface 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. The depth to water table when it starts effecting the yield of the crop adversely may vary over a wide range from zero for rice to above 1.5 m for other crops. In general the areas with water table within 2 m below ground level can be considered prone to water logging and those with water table within 2 and 3 m below ground level may be viewed as critical areas wherein any additional input of water without protective measures can turn them into water logged areas.

The National Commission of Agriculture (1976) has made an estimate of water logged areas based on the work carried out by various agencies. About 60 lakh hectares of area in the country was considered as water logged. Of this, 34 lakh hectares is because of surface flooding, mostly in the States of West Bengal, Orissa, Andhra Pradesh, Uttar Pradesh, Gujarat, Tamil Nadu and Kerala. In the remaining 26 lakh ha., the water logging is due to rise in ground water levels.

Based on the Central Ground Water Board water level data/maps (1982) the total area with ground water levels within 2 m during August is 363.602 lakh ha., and during the month of April the extent of such areas is of the order of 34.299 lakh ha. It is quite essential to monitor the rising trend of water levels, especially in the canal commands and plan remedial measures as soon as possible, in the areas identified as critical.

(vi) **Conjunctive Use of Surface and Ground Water**

Conjunctive use of surface and ground water combines the advantages of ground water storage with surface water system and serves as both a remedial and corrective measure for efficient water management and use.

The conjunctive use of surface and ground water provides a range of possibilities i.e. availability of adequate water supplies when supplemented by ground water at any point of time, advance irrigation in a season prior to availability of surface water and to give late waterings when surface water is not available.

Integrated and conjunctive use of surface and ground water has not so far been given the extent of attention and consideration it deserves. There is a dire need for developing it on more scientific lines in order to derive its full benefits. As the tools of modern technology have become more sophisticated by the development of high speed digital computers and related mathematical techniques, it is now possible to study the problems in a broader perspective and evolve solutions for the optimum benefits taking into consideration the simplest and complex aspects of the problems along with economic, social and environmental aspects.

## IV. SUMMARY AND CONCLUSIONS

In view of the diversified hydrogeological settings and hydrometeorological conditions, assessment of ground water resources of the country is a challenging task. The estimated total replenishable ground water resource of the country worked out to be 45.22 m.ha.m., out of which the utilisable ground water resource for irrigation is 38.38 m.ha.m. The present draft is 10.65 m.ha.m., leaving a balance of 27.63 m.ha.m. of ground water resource available for exploitation. In the Ganga Basin, there are several potential deep fresh water aquifers below 1000 m and it is very essential to explore and assess the potential of these deep aquifers.

When seen for the country as a whole there is considerable ground water still required to be developed. However, there are pockets where intensive development has led to rather critical situations and manifestation of problems like declining ground water levels, shortage in supply, saline water encroachment etc. On the other hand, with the advent of intensive irrigation projects, in certain canal command areas, because of excessive seepage from irrigation and due to poor sub-surface drainage, the water table is progressively rising and has already created water logging and salinity in several parts of the country.

Development of ground water resources is required to be backed up by proper management options. In areas with declining water levels, urgent steps are called for augmentation of ground water resources to arrest the declining trend of the ground water levels. Part of the surplus surface water during monsoon months can be effectively utilised for artificially recharging the ground water in over-exploited areas. Ground water reservoirs offer to permit crisis management during droughts through the scientific management of its static reserves. Ground water development and management of aquifer in saline areas involves maintaining usable quality of fresh water in aquifers and adopting measures to improve the quality of ground water in brackish or saline water bearing aquifers. It is essential to monitor the rising trend of water levels, especially in the canal command and plan remedial measures. There is urgent need for integrated and conjunctive use of surface and ground water in order to optimise the use of this vital resource of the country.

TABLE [illegible].1

GROUND WATER RESOURCE ESTIMATES

AS PER NORMS OF GROUND WATER ESTIMATION COMMITTEE

Provisional & Tentative

| S.NO | State/Uts | Total replenishable Ground Water Resource (m.ha.m/Yr) | Provision for drinking, industrial & other uses (m.ha.m/Yr) | Utilisable Ground Water-Resources for Irrigation (m.ha.m/Yr) | Net Draft (m.ha.m/Yr) | Balance Ground Water potential available for exploitation (m.ha.m/Yr) | Level of Ground Water Development (%) |
|---|---|---|---|---|---|---|---|
| 1 | Andhra Pradesh | 4.3366 | 0.6505 | 3.6861 | 0.7410 | 2.9451 | 20.10 |
| 2 | Arunachal Pradesh | 0.1439 | 0.0216 | 0.1223 | 0.0000 | 0.1223 | 0.00 |
| 3 | Assam | 2.3528 | 0.3529 | 1.9999 | 0.0456 | 1.9543 | 2.28 |
| 4 | Bihar | 3.3773 | 0.5067 | 2.8706 | 0.6761 | 2.1945 | 23.55 |
| 5 | Gujarat | | | | | | |
| | Un-confined | 2.0377 | 0.3057 | 1.7320 | 0.5336 | 1.1984 | 30.81 |
| | Confined | 0.2175 | 0.0327 | 0.1848 | 0.1075 | 0.0773 | 58.17 |
| 6 | Goa | 0.0605 | 0.0151 | 0.0454 | 0.0035 | 0.0419 | 7.71 |
| 7 | Haryana | 0.8524 | 0.1276 | 0.7248 | 0.5085 | 0.2163 | 70.16 |
| 8 | Himachal Pradesh | 0.0357 | 0.0072 | 0.0285 | 0.0062 | 0.0223 | 21.75 |
| 9 | Jammu & Kashmir | 0.4425 | 0.0689 | 0.3737 | 0.0046 | 0.3691 | 1.23 |
| 10 | Karnataka | 1.6187 | 0.2428 | 1.3759 | 0.4669 | 0.9090 | 33.93 |
| 11 | Kerala | 0.8117 | 0.1246 | 0.6871 | 0.0656 | 0.6215 | 9.55 |
| 12 | Madhya Pradesh | 5.9718 | 0.8958 | 5.0760 | 0.6326 | 4.4434 | 12.46 |
| 13 | Maharashtra | 3.8836 | 0.6738 | 3.2098 | 0.7076 | 2.5022 | 22.04 |
| 14 | Manipur | 0.0118 | 0.0018 | 0.0100 | 0.0000 | 0.0100 | 0.00 |
| 15 | Meghalaya | 0.0425 | 0.0064 | 0.0361 | 0.000024 | 0.036076 | 0.07 |
| 16 | Mizoram | | | | Not Assessed | | |
| 17 | Nagaland | 0.0052 | 0.0008 | 0.0044 | 0.0000 | 0.0044 | 0.00 |
| 18 | Orissa | 2.3280 | 0.3492 | 1.9788 | 0.0950 | 1.8838 | 4.80 |
| 19 | Punjab | 1.7971 | 0.2695 | 1.5276 | 1.5181 | 0.0095 | 99.38 |
| 20 | Rajasthan | 1.6224 | 0.2938 | 1.3286 | 0.4927 | 0.8359 | 37.08 |
| 21 | Sikkim | | | | Not Assessed | | |
| 22 | Tamil Nadu | 3.0162 | 0.4526 | 2.5636 | 1.1987 | 1.3649 | 46.76 |
| 23 | Tripura | 0.0629 | 0.0094 | 0.0535 | 0.0049 | 0.0486 | 9.16 |
| 24 | Uttar Pradesh | 8.0450 | 1.2068 | 6.8382 | 2.4944 | 4.3438 | 36.48 |
| 25 | West Bengal | 2.0708 | 0.3106 | 1.7602 | 0.2911 | 1.4691 | 16.54 |
| | Total States | 45.1447 | 6.9268 | 38.2179 | 10.594224 | 27.623676 | 27.72 |
| | UNION TERRITORIES | | | | | | |
| 1 | Andaman & Nicobar | | | | | | |
| 2 | Chandigarh | 0.0035 | | 0.0035 | 0.0059 | -0.0024 | 168.57 |
| 3 | Dadra & Nagar Haveli | 0.0075 | 0.0023 | 0.0052 | 0.0005 | 0.0047 | 9.62 |
| 4 | Delhi | 0.0504 | 0.0076 | 0.0428 | 0.0287 | 0.0141 | 67.06 |
| 5 | Daman & Diu | | | | Not Assessed | | |
| 6 | Lakshadweep | | | | Not Assessed | | |
| 7 | Pondicherry | 0.0175 | 0.0026 | 0.0149 | 0.0204 | -0.0055 | 136.91 |
| | Total Uts | 0.0789 | 0.0125 | 0.0664 | 0.0555 | 0.0109 | 83.68 |
| | TOTAL ALL INDIA | 45.2236 | 6.9393 | 38.2843 | 10.649724 | 27.634576 | 27.82 |