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Management of Groundwater for Drinking Water Supply in India

By

T. S. Raju
Superintending Hydrologist
Central Ground Water Board
Faridabad (Haryana)

Abstract : *The drinking & domestic water supply needs of the country excluding the livestock needs work out to be 4.06 million hectare metres per year by the year 2001. The ground water plays an important role in planning and meeting the requirement of domestic, drinking and industrial water supply. Although, ground water is a renewable resource, its distribution varies depending upon the hydrogeological set up and location & design of water wells becomes a very important aspect to ensure sustained water supply. Over exploitation of groundwater results in progressive lowering of water levels and consequent decline in the yield and productivity of wells, intrusion of seawater, increasing cost of lifting etc. Urgent steps are needed for augmentation of groundwater resources in such areas by adopting suitable artificial recharge techniques. Possibility of recharging the groundwater, using treated sewage effluent and adopting Soil Aquifer Treatment Systems, in our metropolitan cities needs to be carefully examined. Desalination of saline water to bring the quality of water to permissible limit, suitable for drinking also offers wide scope to meet the water supply needs in areas where groundwater is saline but is the only source of drinking water. Development of deep aquifers in hard rock areas as groundwater sanctuaries to meet the urgent needs of drinking water in critical times of droughts is suggested.*

1. Introduction

Out of the total population of India (68,51,84692 as per 1981 Census) 23.31 percent is Urban, living in towns and Cities and the rest is rural, living in villages. Planning and provision of adequate and safe water supply to all our villages, towns and cities to meet the increasing domestic, drinking and industrial water supply needs is very essential and a challenging task. It is planned to provide drinking water to all the villages in the country by the end of VII Plan (1985-90). A "Technology Mission for Drinking water in villages and related Water Management" was set up in 1986 to improve the performance and cost effectiveness of the on-going programmes in the field of rural drinking water supply so as to ensure the availability of an adequate quantity of drinking water of acceptable quality and sustained availability of such water on a long term basis.

Groundwater plays a very important role in meeting the water supply needs of our rural villages and urban towns & Cities. Although groundwater is a renewable resource, its distribution is not wholly even in space and time. Special problems manifest while developing and managing these resourses, especially in areas where there are salinity problems. Augmentation of groundwater resources, treatment of Sewage and use of treated surplus sewage effluent for recharging the aquifers in Urban complexes, desalination of saline groundwater and development of deep aquifers in hard rock areas as groundwater sanctuaries are some of the possibilities of groundwater management to meet the increasing needs of drinking water supplies in the country.

2. Status of Rural and Urban Water Supply

Out of the total number of 5.75 lakh villages in the country as many as 2.27 lakh villages were considered to be problem villages. (Base year 1985-86). These problem villages have been identified by the States based on following criteria, stipulated by Government of India.

1. Villages not having an assured source of drinking water within a reasonable distance (1.6 kms.) and within a depth of 15 m.
2. Villages which suffer from excess salinity, iron and fluoride or other toxic elements hazardous to health.
3. Villages where the sources of water are liable to the risk of cholera, typhoid or guinea worm infection.

India is signatory to the declaration of United Nations Organisation to observe the period 1981-90 as the International Drinking Water supply and Sanitation Decade and adequate drinking water shall be made available for all people by the year 1990.

Out of the 2,27,000 problem villages, the major problem in case 1,54,300 villages is source finding, in 43,600 villages is biological contamination and in case of the remaining 29,100 villages it is chemical contamination.

A "Technology Mission for Drinking Water in Villages and Related Water Management" has been set up by the Govt. of India in August, 1986, to deal with specific problems like salinity and brackishness, iron, fluoride and bacteriological contamination and groundwater management. Scientific methods have been developed to assess availability of water, the permissible rate of withdrawal and recharging requirement for the water sources. The technology mission would adopt an integrated and inter-disciplinary approach so that conservation and augmentation of water sources would be inter-related with rural water supply schemes with a view to ensure continued availability of safe water for drinking purposes. To achieve this objective pilot Projects will be taken up in different States. In the project areas with the coordinated efforts of various Departments/agencies and use of technologies, drinking water problems will be dealt with and low cost and replicable solutions will be evolved.

Ten such projects have been initiated during 1986-87 and twelve Projects are proposed during 1987-88 in different districts of the country. In the remaining two years of the Seventh Plan period 1988-89 and 1989-90, it is proposed to cover a further 28 districts. The insight and experience gathered from these pilot projects could be utilised in other parts of the country. The strategy would be to deal with the total problem of drinking water supply in the project areas by following an integrated and inter-disciplinary approach. The Rural Development Department in this Ministry of Agriculture will be the nodal Deptt. for this Technology Mission.

The Central Groundwater Board, Ministry of Water Resources which is the nodal agency for source finding, is associating with the Mission authorities, both at district and State level in providing (i) data on availability of groundwater resources and (ii) technologies for locating water resources. As a co-ordinator and convener of Technical Advisory Group-I (Water Resources) of the Mission, the C.G.W.B. took stock of progress of the activities of various participating organisations and chalked out

future plan of action with regard to appraisal of available data and the need for collecting additional data.

Under the Mission activities, the Central Groundwater Board is updating data and information for various project areas, pin-point ing sites for drilling through hydrogeological and geophysical survey and identifying areas for future groundwater exploration and development.

In the year 1985-86, safe drinking water supply has been provided to 28177 problem Villages and the remaining 198823 problem villages are planned to be covered by the year 1989-90.

The present position of water supply in our Urban areas i.e. towns, cities and urban complexes is very much inadequate. News of severe deficits in water supply especially in years of low rainfall, in cities like Madras, Hyderabad, Bangalore and many other towns and cities in the country has become very common. The rapidly increasing concentration of population and industrial complexes in our towns and city complexes are likely to pose a major problem in the coming future and provision for adequate water supply has to be made to meet their increasing demands (of domestic, drinking and industrial needs) of water. Multi-disciplinary approach involving all the concerned departments is essential to evolve pragmatic and reliable long term plans to meet the present and future water requirements of all our towns and cities.

3. Water Supply needs and Groundwater Resources

Groundwater plays a very important role in meeting the water supply needs of our rural villages, urban towns, and city complexes as it is widely distributed, dependable and can be put to use with ease & speed.

The Technology Mission on drinking water in villages has kept its objective to supply potable water at the rate of 40 litres per capita per day (lpcd) and in case of desert areas the norm being 70 lpcd (40 for human beings and 30 for cattle).

The drinking & domestic water supply needs of the country excluding the livestock needs as per the norms of 70 lpcd for rural population and 200 lpcd for urban population as prescribed by the Ministry of Urban Development (Works and Housing) Government of India in the manual 'Water Supply and Treatment' works out to be 24876 MOM/Yr in the year 1981 and increases to 40628 MCM/Yr or 4.06 Million hectare meters per year (Table 1) by the Year 2001.

Table I : Drinking & Domestic Water Supply Needs of the country

Year	Population (Million)			Water Supply Needs (MCM/Yr)		
	Urban	Rural	Total	Urban	Rural	Total
1981	158	527	685	11534	13438	24876
1986	192	569	761	14016	14510	28526
1991	230	607	837	16790	15479	32269
1996	274	639	913	20002	16295	36297
2001	326	660	986	23798	16830	40628

In case of Urban areas i.e. towns and cities, the industrial water supply needs which will be of considerable magnitude and in case of rural areas the water supply needs of livestock, have to be taken into consideration in working out the total water supply needs of the country.

India is a vast country having diversified hydrogeological setting. Variations in the nature and composition of the rock types, the geological structures, geomorphological set up and hydrometeorological conditions have correspondingly given rise to widely varying groundwater situation in different parts of the country. As such, assessment of the ground water resources of the country is a challenging task. Keeping this in view, the Central Ground Water Board has undertaken a number of projects on ground water resources assessment 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 agroclimatic 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 guidelines for an approximate evaluation of ground water potential were circulated by the Govt. of India to all the State Govts. and the related financial institutions. Subsequently, ground water resources of the country have been estimated based on the norms recommended by a high level committee known as "Groundwater Over-Exploitation Committee". These estimates are being revised again as per the recommendations of the Groundwater Estimation Committee (March, 1984). The estmated (Tentative) total replenishable ground water resource of the entire country works out to 45.66 Million hectare meters out of which 15% i.e. 7.03 Million hectare meters have been kept for drinking, domestic and industrial needs, committed use of base flow and to account for unrecoverable losses etc. Therefore ground water can play a critical role to meet the drinking and domestic water supply needs of country.

4. Management of Groundwater for Drinking Water Supply

Although groundwater is a renewable resource, its distribution varies depending upon the hydrogeological setup. Special problems manifest while developing and managing these resources especially in areas where there are problems of salinity.

4.1 Location of well sites & design of water wells

Groundwater is the main source available for water supply for most villages in the country. Accordingly, the rural water supply in the country is mainly met by constructing dugwells or borewells and installing suitable water lifting devices. Majority of the problem villages are confined to the hard rock terrain, where the aquifer is highly heterogeneous and proper siting and design of wells becomes a very important aspect to ensure sustained water supply. Based on detailed hydrogeological survey and supported by data from drilling & construction of water supply wells. While designing these wells it is necessary to take into consideration the long term data on water level fluctuation in the area, and to account for likely declines in the water levels during the drought years, to enable them to provide uninterrupted water supply even during drought years. Generally, the temporary depletion of water table taking place in a drought year is made up in years of high rainfall or in other words, temporary utilisation of static reserves and consequent depletion in water levels in drought years is made up in years of high rainfall. However, in areas where continuous declining trend in water level is noticed, caution has to be exercised and necessary corrective steps have to be taken up.

Groundwater studies in Purulia district on a microlevel observation (D.K. Fouzdar & S.C. Jaiswal 1983) revealed that even in a chronic drought area the severity of drought is confined within the limits of a few villages only and not to the entire area. Analysis of hydrogeological and long term water level data would pinpoint crisis areas so that limited financial and man-power resources could be optimally employed.

Hydrogeological Surveys indicated that Village disposal sites are the main sources of pollution, and as such hydrogeologist should select sites not only to obtain good yields but also to ensure potable water as far as possible. The wells located on the upslope of the villages and wells tapping deeper aquifers are commonly free from man-made pollution.

4.2 Management of groundwater in areas with Salinity problems

Groundwater development and management of aquifers in saline areas involves maintaining usable quality of freshwater in aquifers and adopting measures to improve the quality of groundwater 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 hydrodynamice equilibrium between fresh and salt water in aquifers to prevent or control salinewater intrusion. Some of the measures to control sea water intrusion include :

1. Reducing pumpage from existing wells and rearrangement of pumping pattern.
2. Creation of a freshwater ridge by artificial recharge.
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. Groundwater exploitation from thin lenses of freshwater as are found in oceanic Islands, coastal dunes etc. requires that the drawdown is minimised to avoid upconing of salinewater. Infiltration galleries, ditches and radial wells are ideal for such situations.

Sucking in of salinewater can be prevented by coupled wells or dual pumping. Coupled wells are two wells located side by side, one of which is screened in the freshwater zone and the other in the saline zone. When both are pumped simultaneously, a surface flow division is well maintained above the interface and then the interface will not be disturbed.

While salinity stratification in multi-aquifer system exists, saline zones should be properly identified and sealed of at the time of well completion to preclude contamination of freshwater zones. If a well turns saline due to upconing of interface it can be kept in operation if a second pump is installed to tap the bottom section of the wells. Thus while the upper pump draws from the upper freshwater zone, the lower one draws the upconed salinewater.

Where fresh water is not available in sufficient quantity at the place required and importation of water proves too costly or other wise not feasible, it becomes necessary to increase supplies by blending freshwater with inferior quality of water.

4.3 Augmentation of groundwater resources

Over exploitation of groundwater results in progressive lowering of water levels and consequent decline in the yield and productivity of wells, intrusion of sea-water, increasing cost of lifting of water due to declining water levels, reduction in the free flows and even local subsidence at some places.

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.

In these 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 groundwater levels increases pumping lifts and necessitates deepening of groundwater structures, seriously effecting socio-economic conditions. Urgent steps are called for augmentation of ground water resource potential in such areas, to arrest the declining trend of the groundwater levels and reverse it if possible, to reduce surface runoff and sub-surface outflow and eliminate the component of rejected recharge. It is in this context that the arid and semi-arid regions, the drought prone areas, and the areas where groundwater development has reached a high stage, require consideration for artificial recharge measures to augment the groundwater reservoir potential. Artificial recharge involves accelarating the natural movement of surface water into underground formations by some method of construction, by spreading of water or by artificially changing the conditions or injecting water through wells.

4.4 Sewage Treatment and recharge

Reclaiming water from sewage and industrial waste is an attractive possibility in metropolitation areas where there is high concentration of population and water consuming industries. The idea of using sewage reclaimed water to meet industrial needs was conceived in 1964 and the Tamil Nadu Govt. sanctioned a project for conducting research and evolving a method for implementing sewage reclamation on a large scale. TWAD Board has set up four sewage farms in Madras and Metrowater has set up sewage treatment plants each of 5 mgd in 3 farms. Bombay, a pioneer in this field is now allowing a local industrial firm to treat 5 mgd of the City Sewage for its use. More industries there are putting up similar sewage treatment plants. The reclaimed water, it is claimed can be put to various uses including drinking and domestic, depending on the extent of treatment. However, it is better suited for industrial purposes as cooling etc.

By infiltration recharge systems, improvement in quality of water is accomplished as it passes through soil and aquifer. The "renovated" water is collected from the aquifer with drains or wells in such a way that movement of the waste water till usable quality is attained occurs through non exploited portion of the aquifer. Such systems are called Soil Aquifer Treatment Systems (SAT). As a rule of thumb, one month underground detention and 100 m under ground travel distance are considered adequate for most quality improvement in a SAT system.

TWAD Board officials are now trying to recharge the groundwater by applying treated high rate filter effluent on the experimental soil column and through a procedure of alternating controlled inundation and drying of the column. This study has vast potential for a wider experimentation and later integration with ground water aquifers as a method to use the present surplus sewage effluent for recharging the aquifers.

4.5 Desalination of saline groundwater

Desalination of saline groundwater to bring the quality of water to the permissible limit, suitable for drinking, offers wide scope in developing safe and reliable water supply in areas where groundwater is saline but is the only source of drinking water.

At Puthagram, a small habitation of 300 Adi Dravidars, 28 Kms. from Madras on Ambathur Road, groundwater is the only source of drinking water, but the quality of water from the open well and a borewell is saline containing 4134 mg. of total dissolved solids perlitre (Permissible limit being 500 mg per litre). A desalination plant, which works based on reverse osmosis, was installed by the Bharat Heavy Electricals Ltd, Hyderabad at a cost of Rs. 9.18 lakhs. The technical know how was obtained from the Central Salt and Marine Chemicals Research Institute, Bhavnagar. This plant could now deliver 50,000 litres of good drinking water everyday containing only 400 mg. of TDS per litre. The other process of desalination provalent is Electrodialysis process. Several such desalination plants have already been set up in different places in the country. With the indegenous knowhow, desalination of saline groundwater offers good scope to meet the drinking water supply needs in areas where no other cheap alternative is available.

4.6 Groundwater Sanctuaries

Provision of reliable and safe drinking water to all rural and urban populations in the country in essential. In areas with very limited water supplies and which experience chronic droughts, it is necessary to develop ground water sanctuaries which can be used at the time of critical need. In the hard rock areas, covering the entire Deccan Plateau and other parts of the country, hydrogeological investigation and groundwater exploration has indicated that some of the deep zones are good aquifers but their aerial extent and potential are limited. Analysis of Pumping tests on wells tapping such zones showed that the specific capacity of these wells declines rapidly after a certain period of pumping, indicating limited storage conditions. As such, development of such deep aquifers zones in hard rock areas for irrigational need should be discouraged and these aquifer zones must be developed as groundwater sanctuaries to meet the urgent needs of drinking water supply of the local population in critical times.