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Artificial Ground Water Recharge

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The dependence on ground water as a reliable source for meeting the requirements for irrigation, drinking and industrial uses in India has been rising rapidly during the last few decades. Ground water development has occupied an important place in Indian economy because of its role in stabilizing agriculture and as a means for drought management. The ever-increasing demand of water has resulted in over-exploitation of groundwater resource, causing continuous decline in water table in various parts of the country. Therefore there is an urgent need of artificial groundwater recharge planning. On the basis of the present trend of groundwater exploitation it can be said that in future more and more area will fall under dark category creating conditions of groundwater mining.

In the present article, the physico-chemical properties of groundwater of shallow aquifer and their suitability for drinking, irrigation and industrial uses may take into consideration. The physico-chemical properties of ground water will be determined using standard methods of water quality analysis. Comprehensive and proper groundwater recharge plan for the identified landforms with their prevailing geomorphic features may be suggested to maintain the groundwater at a safe and desired level. Various water recharging structures namely: series of check dams, percolation tanks, farm ponds and nallah bunds are most possible techniques for recharging groundwater aquifer by utilizing excess water available during monsoon season in the form of runoff obtained from the land surface.

In many parts of the country, ground water development has already reached a critical stage, resulting in acute scarcity of the resource. Over- development of the ground water resources results in declining ground water levels, shortage in water supply, intrusion of saline water in coastal areas and increased pumping lifts necessitating deepening of ground water abstraction structures. These have serious implications on the environment and the socio-economic conditions of the populace. Worsening ground water quality has also adversely affected the availability of fresh ground water in several areas. The prevailing scenario of ground water development and management in India calls for urgent steps for

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augmentation of ground water resources to ensure their long term sustainability. The diverse nature of the terrain and complexities of hydro geological settings prevailing in the country makes this a challenging task.

Land and water are the two finite natural resources, and these are degrading rapidly due to unscrupulous and indiscriminate utilization. Immense pressure on these resources can be gauged from the fact that India shares 2.45% geographical area of the world but it supports 16% population and 18% livestock of the world (Katyal, 1998). It has been estimated that renewable water resources of the country account for about 4 per cent of global water availability. Leading experts on water resources are warning that the world is fast heading towards "a water shock" which even dwarf the oil crisis. They also fear that shortage of water and disputes relating to sharing of water resources among various countries may lead to the next world war. Today about 80 countries comprising 40% of world's population suffers from serious water shortages (UN, 1997).

The averages annual precipitation in India is estimated to be 4000 km^3 of which the monsoon precipitation during June to September is around 3000 $km^{3.}$ More than 50% of monsoon rainfall occurs in about 15 days and less than 100 hours. In eastern region annual rainfall ranges from 1008 mm to 3126 mm. The average runoff in rivers is estimated to be 1953 km^3 per year. In India, the per capita water availability came down from 5300 km^3 in 1995 to 2200 m^3 in the early nineties against the world's average of 7400 m^3 and Asian average of 3240 m^3. Per capita annual availability in the Brahmaputra is as high as 18400 m^3, whereas it is as low as 380 m^3 per capita water availability in some of the east-flowing rivers in Tamil Nadu. Per capita water availability is projected to be 1704 m^3, 1465 m^3 and 1235 m^3 by the year 2010, 2025 and 2050, respectively. As per UN standards, the countries with annual per capita water availability of less than 1700 m^3 are considered as water stressed and those with less than 1000 m^3 as water scarce, which already exists in some parts of the country (Cosgrave 2000).

With increasing use of groundwater for agricultural, municipal and industrial needs, the annual extraction of groundwater is greater than net average recharge from natural resources. There is a steady area increase in area irrigated from groundwater since independence. This has gone up from 6.5 M-ha in 1951 to 35.38 M-ha in 1993 and is rising at the rate of 1.5 M-ha annually. At the present rate, it is expected that by 2025 presently

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estimated water resources would be fully utilized. Even at the present rate of population growth and urban development, the gap in requirement and availability of water in mega-cities is going to be quite large. It is also expected that generation of waste water will also increase considerably. Re-use of this waste water for groundwater recharge will become essential in urban areas where surplus water is not available for recharge. This is also needed for environment conservation. The overexploitation of groundwater resources beyond the annual replenishment leads to continuous declining of water levels, reduction of well yield, drying up of shallow wells, deterioration of groundwater quality, seawater intrusion in coastal aquifers etc. These indirectly make agriculture uneconomic mainly for small scale farmers.

About 86.47 M-ha-m surplus monsoons runoff is available for recharge in 20 river basins of the country. However, on the basis of the availability of monsoon runoff and storage potential of vadose zone, the feasible groundwater storage has been estimated as 21.42 M-ha-m of which 16.05 M-ha-m will be utilizable.

Therefore, the exploitation, conservation and judicious use of water forms one of the important elements in country's development and planning. After few years water will be scarce resource and, therefore, needs to harness in most scientific and efficient manner or by recharging the ground water aquifer in which application of GIS and RS will play an important role.

India is basically an agrarian country with a gross cropped of 177 M ha. Out of the total geographical area 328.7 M ha, rainfed agriculture is undertaken in more than 60% of the country. After harvesting all the surface and groundwater for irrigation, the irrigated area will only be around 52% of cropped area in the country. India receives a rainfall of 4000 billion cubic meters annually, out of which 41% is lost as evaporation and transpiration, 40% lost as runoff, 10% seeps in recharging groundwater. Out of the 40% stream flow water, 8% is used for irrigation, 2% for domestic use, industries use 4% and electric generation is 12%. Hence 50% of the cropped area in the country will always depend on rain, which is very erratic, unpredictable and distributed over a short period of 3-4 months. With such variations in rainfall pattern, droughts and floods are recurring features of Indian agriculture.

The population of India is increasing at an annual rate of 1.7 crores and by the year 2050 may cross 150 crores. India will be requiring about 1,2010,000 lakh cubic meters of

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water in the year 2050 A.D to cater the needs of population for food, drinking water, domestic and industrial requirements due to which there is a great need to conserve the natural resources.

India is one of the few countries in the world with abundant land and water resources. Annual water resource in various river basins in the country is estimated to be about 187 M-ha-m. In addition, there is a dynamic rechargeable groundwater resource. Its potential has been estimated as 43.2 M-ha-m. This means that the total water availability in the country is about 230 M-ha-m and the per capita availability is about 2300 m^3/ year. Out of 187 M-ha-m, about 69 M-ha-m of the surface water and 43.2 M-ha-m of ground water are available for use. The present utility is about 60 M-ha-m for various purposes (The Hindu, 2002).

The long-term average annual precipitation for the country is 1160 mm (about 380 M-ha-m), which is the highest anywhere in the world for a country of comparable size (Lal, 2001). The annual rainfall in India, however, fluctuates widely. The highest annual rainfall in India of about 11,690 mm is recorded at Mousinram near Cherapunji in Meghalaya in the north-east. At the other extreme are places like Jaisalmer, in the west, which receive barely 150 mm of rain annually. Though the average rainfall is adequate, nearly three-quarters of the rain pours down in less than 120 days, from June to September. As much as 21 per cent of the area of the country receives less than 750 mm of rain annually while 15 per cent receives rainfall in excess of 1500 mm (Kumar et al., 2005).

Evidence in India suggests that crop yield/m^3 on ground water-irrigated farms tends to be 1.2 to 3 times higher than on surface-water-irrigated farms (Dhawan, 1986). Increasing pressure on groundwater during last decades, to meet out various demands leads excess draft of groundwater and it results as depletion in groundwater.

Land evaluation involves the execution and interpretation of basic surveys and studies of landforms, climate, soils, vegetation and other aspects of land, in terms of the requirements of alternative forms of land use. Land evaluation is the process of land performance when used for specific purposes. Another aspect of land evaluation is that of taking a specific area of land as the basis and making comparisons of this land with the land use. To get optimum returns from available land and water resources, it is necessary that the land should be evaluated for its capability and irrigability. Land use planning (LUP) depends on the systematic evaluation of the land and water resources. Out of total land area of 329 M ha, 173.64 M ha (52.8%) is affected by different kind of degradation. Water and wind erosion affect the maximum area (141.25 M ha), accounting for about 81.3 per cent of total degraded land. Assuming that 39% of soils are lost permanently into the sea or reservoirs annually, the country looses 0.8 metric tonnes of nitrogen, 1.8 metric tonnes of phosphorous and 26.3 metric tonnes of potassium every year (The Hindu, 2007).

Land use and land cover knowledge is important for planning and management activities concerned with the surface of the earth. It requires detailed, timely, accurate and reliable data on the extent, location and quality of land and water resources, and climate characteristics. The data on land use potential and the conservation needs can help in planning for uses that will maintain the quality of land. The application of GIS for land use surveys and mapping is gaining importance, largely because of its ability to provide rapid and reliable data within a given time framework. Geographic Information System provides an appropriate base for efficient management of land and water resources. This offers technologically suitable method for land resource assessment, delineating different land use patterns, flood management, irrigation water management, and assessment and monitoring of environmental impact of water resource projects. It is also useful in delineating hydro-morphological units in the area to decide suitable sites for water harvesting structures favourable for the problematic sites.

Groundwater has been considered as an important source of water supply due to its relatively low susceptibility to pollution in comparison to surface water, and its large storage capacity (USEPA, 1985). However, there are significant sources of diffuse and Point pollution of groundwater from land use activities, particularly agricultural practices. The intrusion of these pollutants to groundwater alters the water quality and reduces its value to the consumer (Melloul and Collin, 1994). Prevention of contamination is, therefore, critical for effective groundwater management. Spatial variability and data constraints preclude monitoring all groundwater and make remediation activities expensive and often impractical. Vulnerability assessment has been recognized for its ability to delineate areas that are more likely than others to become contaminated as a result of anthropogenic activities at / or near the earth’s surface. Once identified, these areas can be targeted by careful land-use planning, intensive monitoring, and by contamination prevention of the underlying GW.

The quality of groundwater is generally under a considerable potential of contamination especially in agriculture-dominated areas with intense activities that involve the use of fertilizers and pesticides. The issue of protection of groundwater against pollution is of crucial significance. Groundwater vulnerability is a Cornerstone in evaluating the risk of groundwater contamination and developing management options to preserve the quality of groundwater.

Environmental concerns related to GW generally focus on the impact of pollution and quality degradation in relation to human uses, particularly domestic supply. Due to high population growth and industrialization, greater amounts of domestic and industrial effluents are discharged that lead to the pollution of GW in shallow aquifers. Water pollution is a serious problem in India as almost 70% of its surface water resources and a great number of its GW reserves are already contaminated by biological, organic, and inorganic pollutants (Rao and Mamatha, 2004). The environmental concern related to the GW quality generally focuses on the impact of pollution and quality degradation on human health. Nearly two third of all ailments in India, such as jaundice, cholera, diarrhea and dysentery, typhoid, etc. are caused by the consumption of polluted water and these water-borne diseases claim nearly 1.5 million lives annually in the country, which means three persons die every 10 minutes due to contaminated water (Ghazali, 1992). Even today more than 90% of our rural population is primarily dependent on GW (Chandrashekhar et al., 1999). The quality of GW is as important as that of quantity because GW is the only source of drinking water in most of urban areas of India. The drinking water quality in Indian cities has been deteriorating in recent years mainly due to the high growth of population, unplanned growth of cities, mixed land use patterns, no proper sewage system, and poor disposal of the wastewater both from household as well as industrial activities.

There is an urgent need for artificial recharge of groundwater by augmenting the natural infiltration of precipitation into subsurface formation by some suitable method of recharge. Over-exploitation of groundwater has occurred leading to continuous decline of water table in different parts of the country. If immediate steps are not taken to arrest the decline of water table, it will not be possible even to sustain the present level of production. One of the ways to arrest and sustain the decline of water table is undertaking various methods of artificial recharge of groundwater. A severe decline in groundwater levels is observed in many parts of country, where the green revolution has been most successful. This situation calls for a constant monitoring of groundwater behaviour, in all the areas that are getting fast depleted, and requires adoption of sensible ways to control withdrawals so as to keep them within the limits of recharge capacities.

The indiscriminate exploitation of groundwater is leading to water table decline. There are various regions in our country where groundwater levels are depleting very fast and need attention of planners for developing some control measures. The water table decline has been occurring at a fast rate in these areas because of various regions, though it is due to increased intensity of cropping and misbalance in recharge and withdrawal but a peculiar phenomena has been observed that it is increasingly being observed in the areas where a high ET demanding crop like rice has been introduced in a big way. In order to maintain equilibrium between availability and withdrawal of groundwater, suitable and economical recharge techniques need to be adopted. The techniques should be easy, cost effective and sustainable in the long term. The scientific database on soil and water resources is prerequisite, in the areas where these resources are limited. The areas where the water table is continuously declining, it becomes necessary to study the soil and land characteristics in a sustained manner to arrest the declining water table at the desired level.