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# GROUNDWATER ASSESSMENT AND IDENTIFICATION OF RECHARGE SITES IN SOUTHERN HARYANA

**Doctoral Dissertation Abstract (2015)**

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In the absence of any perennial river and lesser availability of water in canals, groundwater has acquired a very significant position in terms of water supply in most parts of the world. The prevailing arid and semi-arid climatic conditions have further increased the dependence of people on groundwater to meet their water requirements. The resultant uncontrolled mining of this priceless resource has resulted the lowering of groundwater table. Therefore, the management of this priceless resource on sustainable basis is the need of the hour. Southern part of Haryana is in a disadvantageous position with regard to groundwater availability and groundwater table is declining at an alarming rate. The analysis of past ten year's groundwater level shows that it is receding at the rate of 76 cm per year. This rate of decline is much higher than the average rate of groundwater table decline of Haryana state i.e. 38 cm per year. Therefore, the present study encompasses the analysis of the status of groundwater utilization in Southern Haryana. It also identifies the suitable sites for the artificial recharge of groundwater to bridge the gap between the availability and draft of groundwater.

**Objectives**

The main objectives of the present study are:

- To assess the available groundwater resource of the study area.
- To assess the draft and to evaluate the stage of groundwater development.
- To identify the suitable artificial recharge sites and
- To check the feasibility of artificial recharge at proposed sites through field investigation.

**Database and Methodology**

To meet the objectives of the study, methodology developed by Groundwater Resource Estimation Committee-1997 (GWREC-97), Ministry of Water Resources, Government of India, has been used. The groundwater resource of Southern Haryana is estimated for kharif and rabi seasons separately and block is taken as an assessment unit. Groundwater resource is assessed for the quinquennial period of 2006 to 2010. The study is based on both primary and secondary data sources. Primary data were acquired through field survey for the verification of proposed artificial recharge sites. All other objectives are based on secondary data. The net annual groundwater availability is considered as the sum of recharge from rainfall (Rrf), return flow from irrigated fields (Rirf), seepage from canals (Rc), ponds, tanks, lakes (Rt) and recharge from rainwater harvesting structures (Rhs). The gross annual draft is considered as the sum of groundwater abstracted for domestic and irrigation uses. The assessment units (blocks) have been categorized as 'safe', 'semi critical', 'critical' and 'over exploited' based on the stage of groundwater development and long term (2000-10) fluctuation trends in the groundwater level for pre and post-monsoon seasons. A multi-parametric dataset was used for delineation of potential recharge zones and identification of suitable sites for artificial recharge of groundwater using Satty's analytical hierarchy process. One out of every five identified sites has been verified through field survey to check the feasibility for the construction of artificial recharge structures at these sites.

**Organization of the Material**

The study is composed of five chapters. First chapter deals with the statement of problem, review of literature, contextualization of study, objectives, profile of the study area, database and methodology.

Chapter two deal with the assessment of the available groundwater resource of Southern Haryana. It reveals that the estimated net annual availability of groundwater in Southern Haryana is 1,61,889 ha-m during the period 2006-10. Out of this, 1,18,078 ha-m is available during kharif season and 43,811 ha-m is available during rabi season. Recharge from rainfall and return flow from irrigated fields are the major components of groundwater recharge. They collectively contribute about 78 per cent of the total annual availability of groundwater. Remaining 22 per cent is received via canal seepage, recharge from surface water bodies like tanks, ponds, lakes and rainwater harvesting structures. The spatial analysis on availability of groundwater reveals that the highest net annual as well as seasonal availability is in Palwal block (14,365 ha-m) while it is lowest in Taoru block (2,892 ha-m). The study found that blocks with a good network of canals, especially unlined canals and comparatively more irrigated area (under water intensive crops; paddy in kharif season and wheat in rabi season) have more volume of groundwater available. Contrary to this, blocks with smaller irrigated areas and with no canal network or with the dominance of lined canals have lesser availability of groundwater.

Chapter three deal with the estimation of groundwater, quantification of gap between the availability and draft and evaluation of stage of groundwater development. It reveals that the gross annual groundwater draft of the study area is estimated as 1,81,534 ha-m for 2006-10. Out of this total, 49,066 ha-m is the draft of kharif season and 1,32,468 ha-m is of rabi season. Agriculture sector is the leading consumer of groundwater. The share of irrigation draft accounts for 80 per cent during kharif season and 89 per cent during rabi season. The spatial pattern of groundwater draft reveals that the highest volume of groundwater is drafted in Palwal block (20,086 ha-m) and lowest in Nagina block (2056 ha-m). The volume of groundwater draft is observed to be higher in blocks with larger irrigated area and bigger population size and vice-versa. The study shows an overdraft of groundwater with an annual deficit of 19,639 ha-m. It is also observed that out of the 25 blocks, 16 blocks are facing a deficit in the annual availability of groundwater. The annual deficit is even more than 3,000 ha-m in six blocks i.e. Pataudi, Palwal, Farukh Nagar, Kanina, Sohna and Khol. On the other hand, only 9 blocks have surplus availability of groundwater. The analysis of groundwater utilization pattern of the study area shows that 12 blocks are 'over-exploited', 7 blocks are 'critical', 2 blocks are 'semi-critical' and 4 are 'safe'. The study area on the whole is 'over-exploited', because the stage of groundwater development is 112 per cent and the annual rate of groundwater table depletion is 76 cm per year.

Delineation of groundwater potential zones and identification of suitable artificial recharge sites have been discussed in fourth chapter. Seven thematic layers namely soil texture, geology, geomorphology, lineament density, drainage density, slope and land use land cover are integrated using Satty's analytical hierarchy process and the resultant map is classified into four zones namely 'Highly Favorable', 'Moderate to Highly Favorable', 'Moderately Favorable' and 'Least Favorable' according to their potential for artificial recharge. A total of 1,304 sites are finalized keeping in mind that more sites should fall in the areas where groundwater depth is more than 6 meter below ground level (mbgl) and they lie in favorable artificial recharge zones. It has also been taken care that more sites should lie in blocks which are either 'over-exploited' or 'critical' from groundwater development point of view. These sites represent the ideal location for the construction of artificial recharge structures as they are identified on scientific and logical basis. There are five blocks (Ballabgarh, Hathin, Hodal, Hassanpur and Punhana) in the study area where no recharge sites are identified. These blocks have very low slope gradient, hence rainwater gets sufficient time to percolate downward to recharge groundwater table.

Chapter fifth deals with the field survey conducted to study the feasibility of artificial recharge over the identified sites. For this purpose, 260 sites have been randomly selected with an idea that at least one out of every five identified sites should be visited. The field data reveal that about 80 per cent (206 out of 260) of the total sampled sites are found with well-developed drainage network, low to moderate slope, coarse soil texture, deep groundwater level (more than 6 mbgl) and land use is either barren or scrub land or drainage course or waste land. These are considered as suitable sites for artificial recharge. The data further reveal that over 9 per cent (25 out of 260) of the sampled sites, some kind of artificial recharge structures have been constructed by government. These sites are also considered as suitable sites for artificial recharge. Remaining 29 sites are classified as unsuitable for artificial recharge of groundwater. Over these sites, the mining activity has made that part of hill to stand vertical generating no surface runoff.

The study concludes that in view of rapidly changing demographic profile and land utilization pattern, artificial recharge of groundwater is urgently required in Southern Haryana to control the prevailing imbalance of Groundwater resource. Few artificial recharge structures like check dams, marginal bunds, gully plugs, percolation embankments, percolation tanks and stock ponds have been constructed by different government agencies under various watershed development programs. But the continuous depletion of groundwater table of the study area indicates that more artificial recharge structures are required to be constructed to cope up with the problem of groundwater depletion.

The study recommends that time to time monitoring and strict action is required against the mining mafia. The mining activity is disturbing the ecology of the study area and affecting the artificial augmentation of the groundwater table in addition to the natural recharge. The factual situation as revealed by the present study does indicate that if preventive measures are not taken up to rationalize the demand with groundwater availability, Southern Haryana shall be in a crucial situation with respect to groundwater availability in the coming years. Though, the construction of artificial recharge structure is a big engineering work yet the basic information about soil texture, lithological composition, drainage order, recharge potential, slope, type of land use and presence of lineament at the proposed sites provided by this study could help to decide the type and size of artificial recharge structure. Phased construction of artificial recharge structures on these sites might help to bridge the gap between recharge and draft of groundwater. It may also help to alleviate the further decline of groundwater table by providing water in addition to natural recharge to the aquifers.