VERTICAL COMPONENT OF GROUNDWATER RECHARGE

Estimation of recharge to groundwater is essential for evaluation of groundwater resources. In most of the cases, major source of recharge to groundwater is precipitation. However, in the irrigated areas, the return seepage also contributes to groundwater recharge significantly. As the recharge to groundwater is one of the important parameters for water balance study of a project, it should be estimated very correctly, otherwise it can lead to a great deal of miscalculations in the planning of water resources projects.

Tritium Tagging Technique is used to estimate the recharge to groundwater more accurately than other conventional methods. This technique can also be used to map potential areas for groundwater recharge in a watershed/catchment that could be used for implementation of artificial recharge measures in the areas facing groundwater scarcity problem. On the basis of experimental data, mathematical relations can be developed between rainfall and recharge at regional scale that can be used to compute recharge with respect to rainfall in future.

TECHNOLOGY

Tritium Tagging Technique is used to estimate vertical component of recharge to groundwater in a selected area due to rainfall and irrigation. In this technique, if the recharge due to monsoon rains is to be determined, then tritium of very small quantity (2 ml) and specific activity (40 μCi) is injected in a number of holes at a depth of 70 – 100 cm at a selected site before the onset of monsoon rains (for estimating irrigation return flow, the injection can be made according to the season and crop at the selected field site) and the soil samples are collected from the pre-marked points after the monsoon is over. The volumetric moisture content of each soil sample is estimated in the laboratory and the soil samples are subjected to distillation in the laboratory. The tritium activity of each distilled sample is measured in the laboratory using normal liquid scintillation counter. Knowing the peak shift of tritium and average volumetric moisture content in

Figure – 1 A view of Tritium injection

the peak shift region, the amount of recharge to groundwater is estimated by multiplying peak shift with average volumetric moisture content in the peak shift region at each site. Further, mathematical approach can be followed to develop empirical relations on regional scale that can be used to compute recharge to groundwater due to rainfall in that region in future.

The National Institute of Hydrology, Roorkee has successfully implemented this technology in parts of Ganga-Yamuna doab, Naramada basin, Bundelkhand region of U.P. State, and alluvial areas of Maharashtra. As an example, brief details of study carried out in Bundelkhand region are given here.

The Bundelkhand region in India comprises 12 districts out of which 5 fall in Uttar Pradesh and 7 fall in Madhya Pradesh. The study area comprises four districts, namely Jalaun, Banda, Hamirpur and Jhansi, covering an area of about 24079 km^2. The area falls in subtropical region characterized by hot and prolonged summer followed by rainy season and cold winter. The distribution of rainfall is erratic in the Bundelkhand region and its amount is comparatively less, causing occasional drought conditions. Districts Jalaun and Banda and parts of districts Hamirpur (60%) and Jhansi (10%) are underlain by indo-gangetic marginal alluvium of quaternary age and comprise mainly of sands of various grades, clay and clay mixed with kankar while the major parts of district Jhansi and about 40% area of district Hamirpur fall under rocky formation. Therefore, the surface soil in Hamirpur is more compact in comparison to that of the other two districts.

Bundelkhand region faces acute water deficiency due to higher evaporation losses of rain and surface waters. Although the rainfall in this region is less in comparison to the surrounding region, yet it is much higher in comparison to the rainfall in semi-arid regions. The groundwater reserves are limited and groundwater level is deep at a number of places. Hence, it is treated as an undeclared semi-arid region in India.

Tritium was injected at 25 sites before the start of monsoon rains. Soil samples were collected from the injected sites in the month of November and recharge percentages were determined. Since the sampling was carried out in

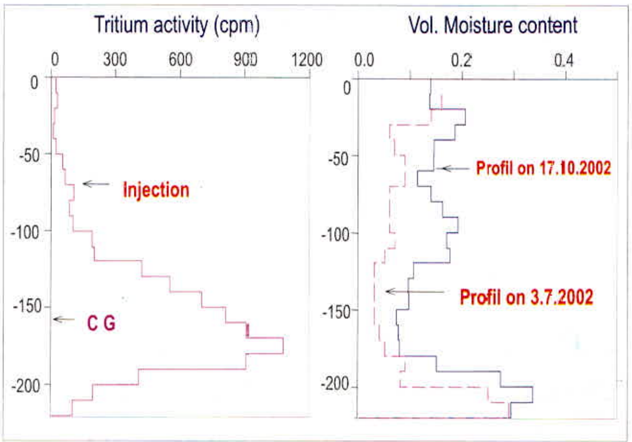

Figure – 2 Tritium and soil moisture profiles

November, the water input for irrigation was also taken into account while determining the recharge percentage.

Mathematical Approach

Groundwater recharge by rainfall is a very complex process influenced by numerous surface and sub-surface parameters including rainfall intensity, its frequency and several other local factors (e.g. vegetation cover, soil properties etc.). Therefore, it is advisable that once the recharge to groundwater due to rainfall and/or irrigation is determined using Tritium Tagging Technique, a suitable mathematical approach be developed to account for all the known and unknown factors affecting the rainfall-recharge process. If correct information of all the processes and parameters that affect the rainfall-recharge process are possible to obtain, a suitable mathematical model can be developed.

It has been observed that for similar site conditions, recharge values follow a unique logarithmic relationship with rainfall. Different relations are observed for different set of sites. The following two mathematical formulae fairly satisfy the variation of recharge:

Group A $\quad Rg = 29.316 \ln(P) - 111.259 \; (r = 0.83) \quad \ldots(1)$

Group B $\quad Rg = 12.861 \ln(P) - 48.757 \; (r = 0.85) \quad \ldots(2)$

where Rg is the recharge to groundwater in cm and P is the rainfall in cm.

It is observed that recharge values for the sites which fall in the marginal alluvium region follow equation (1) while those which fall in the hard rock region follow equation (2).

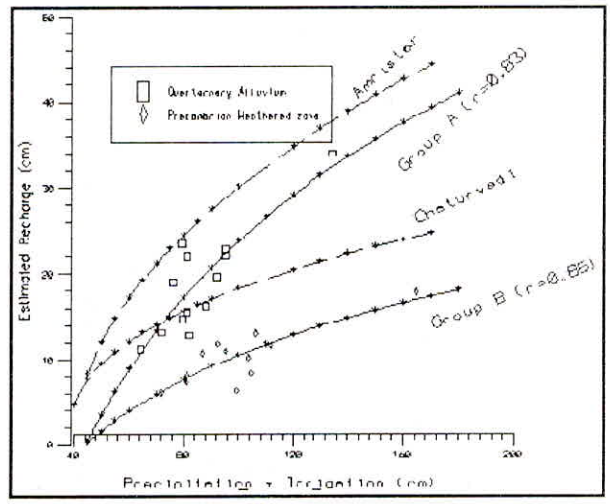

Figure – 3 Recharge variation with irrigation and precipitation input

ENVIRONMENTAL IMPACT

A hazardous radioisotope, i.e. tritium is used in this technique. However, there is no adverse impact of this radioisotope on environment as such as very low activity tritium is used.

ECONOMICS

The expenditure for collection of samples will be Rs.1000.00 per site per 10 sq. km excluding travelling charges. As the measurement of tritium activity can be done either at NIH, Roorkee or at other isotope laboratories available in the country at a nominal cost, therefore, the cost of instrumentation is not included here. This technology has long-term benefits, both direct as well as indirect.

BENEFICIARIES

Central and State Groundwater Organisations and other agencies that are responsible for evaluation and development of groundwater resources, and R & D organisations that are working in the area of water resources.

INTELLECTUAL PROPERTY RIGHTS

The National Institute of Hydrology, Roorkee owns the Intellectual Property Rights for the second part of this technology.