RESISTIVITY METHOD FOR ESTIMATING GROUNDWATER RECHARGE

Watershed management and Command Area Development (CAD) programmes rely on the improvement of soil moisture regime and enhancement of infiltration in the watersheds. The study of water and solute movement through the soil attains special significance in the context of human interference in the soil-atmosphere ecosystem.

For effective monitoring of groundwater recharge under in-situ conditions, regular monitoring and periodic appraisal of data from watersheds is crucial. This requires a technique that has a quick response to the water variation in the sub-surface, that is able to monitor the data regularly and, at the same time, is least destructive to the site. These objectives can be met by an automated resistivity measurement setup capable of regular monitoring of subsurface water movement and its variation with depth and time.

TECHNOLOGY

A procedure for estimation of in-situ groundwater recharge using periodic resistivity sounding measurements has been developed. The technique, being based on potential measurements of fairly large volume of subsurface soils, provides results representative of a region rather than a point value. In the resistivity sounding method, a constant current is injected into the ground through two metal electrodes for a certain time and the potential difference between another set of two metal electrodes is measured.

Moisture profile in the unsaturated zone can be represented as a one-dimensional model in situations where the movement of infiltrated water is dominantly vertical. Such a continuous profile can be analyzed using a stratified earth model, with different layers corresponding to different continuous segments of the moisture profile.

Figure – 1 Setup of resistivity electrodes

The estimation of moisture variation in a soil profile from the apparent resistivity measurement is essentially an inverse problem. The whole exercise may be viewed as a two-step process; first the resistivity variation with depth is determined after interpreting the apparent resistivity data, and then moisture content is estimated from this resistivity variation using a moisture-resistivity calibration equation.

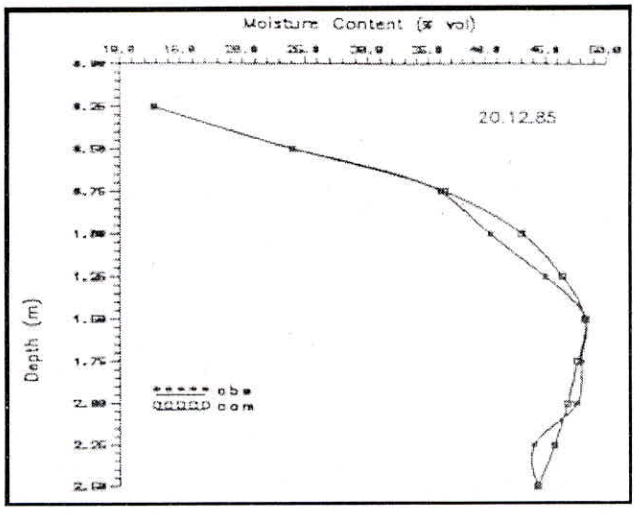

Figure – 2 Variation in moisture content with depth

Steps Involved

- Interpret apparent resistivity data in terms of layer parameters (layer resistivity and thickness).
- Convert layer resistivity to moisture content using calibration equation.
- Instant moisture profile is obtained.
- Repeat above steps to determine temporal variation in soil moisture content.
- Estimate groundwater recharge by determining moisture variation in the soil profile at different time instants.

With this technique, the movement of soil moisture with depth can be monitored using resistivity data alone. The developed technique was used to estimate the soil moisture profile at a site in Roorkee (Uttaranchal) using resistivity sounding data. The estimated values were compared with the observed values, and the error was found less than 10 % in all the cases.

ENVIRONMENTAL IMPACT

Since the resistivity technique does not require any digging of holes for measurements, it provides a non-destructive alternative to the conventional techniques. The technology has no adverse environmental impact.

ECONOMICS

Use of the technique for groundwater recharge estimation would require a resistivity meter, which requires a one-time investment of about Rs. 2 - 3 lakh. This instrument setup can then be used to cover a vast area for periodic measurements (e.g. at fortnightly or monthly intervals). A recurring expenditure of approx. Rs. 200 per day per site would be required to cover the expenses related to field observations and data processing etc. However, the information gathered by this technique is of utmost importance for understanding

the behaviour of unsaturated zone and recharge to groundwater. Thus, it will have tangible and intangible benefits.

BENEFICIARIES

Main beneficiaries of the developed technique would be CAD Departments and other organizations interested in groundwater recharge.

INTELLECTUAL PROPERTY RIGHTS

The National Institute of Hydrology, Roorkee owns the Intellectual Property Rights, being the developer of the methodology.