

# **PROTOCOL FOR RE-ESTIMATION OF STATE-LEVEL ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES IN INDIA**

In order to facilitate continuous refinements in the Ground water resources estimation a uniform procedure for assessment methodology has been suggested. Details are available at our web site [www.cgwb.gov.in](http://www.cgwb.gov.in) .

## **1. Setting up of State Level Committee**

Ground Water Resources assessment should be carried out under the overall supervision of a **State Level Committee** headed by Secretary in Charge of Water Resources. Members of the committee would include Heads of various state Govt agencies like Water Resources Department, State Ground Water Departments, Water Supply & Sanitation Department, Dept. of Agriculture, Public Health & Engineering Department, Rural Water Supply Department, Minor Irrigation Department, Department of Industries and NABARD. Regional Director, CGWB would be the Member Secretary of the Committee. The State level Committee may co-opt other members if necessary. This committee will be a Standing Committee responsible for ground water resources assessment, field validation and strengthening of database required for assessment in the respective States.

## **2 Setting up of Groundwater Resources Assessment Cell in States**

Groundwater resources estimation is a continuous process and therefore there is an urgent need to setup **Groundwater Resources Assessment Cell** in each State Ground Water Department with dedicated manpower for continuous updation of database like water level, canal details, well census etc., periodical groundwater resources assessment, field validations of the estimates and refinements of norms for various parameters like specific yield, rainfall recharge / infiltration factor, canal seepage factor, recharge factor from irrigation, unit ground water draft. Additional parameter for assessment if needed may also be taken into consideration by State Ground Water Department.

## **3. Identification of data gaps**

As a first step towards ground water resources assessment, CGWB and concerned State agencies would reconcile the three basic database/ parameters viz. Water level, Specific Yield and Unit Draft and compile the information in a common format. The objective is to identify the data-gaps prior to estimation and strengthening of database in-between consecutive assessments.

## **4. Preliminary evaluation of assessment units**

A preliminary assessment about the ground water situation of each assessment unit would be made jointly by CGWB and State agency based on hydro geological conditions as per the hydro geological survey reports and reports of various field investigations carried out by the Centre/State agencies and ground water level data/ trends existing with CGWB/ State Govt.

agencies. This would be a preliminary evaluation of the status of ground water regime in the Assessment Unit.

#### **5. Need based Inputs from remote sensing data**

Need based use of Remote sensing techniques in some of the fields of resources estimation may be considered. Remote sensing data can be utilized to provide/refine the inputs (such as runoff and recharge areas, sources of localized recharge, spatial recharge patterns, crop consumptive use patterns, areal extent of water bodies, recharge structures etc.) for recharge assessment depending upon the requirement and applicability.

6. This would be followed by finalization of the values of different parameters to be used for resources assessment and undertake field studies to collect relevant information.

#### **7. Estimation guidelines and norms**

Based on the available database and parameter estimations/ norms, State Ground Water Department and CGWB would jointly carry out resources assessment following groundwater resources assessment guidelines/ norms and subsequent guidelines regarding Categorization and allocation of ground water resources for utilization. The details of the groundwater resources assessment methodology is given in two documents which are available at the website – [www.cgwb.gov.in](http://www.cgwb.gov.in)

The document entitled **“Ground Water Resources Estimation Methodology & Detail Guidelines for implementing the Ground Water Estimation Methodology”**

The basic steps recommended for groundwater resources assessment methodology is as follows –

- Demarcation of assessment units/ sub-units: units - block (predominantly alluvial states), watershed (pre-dominantly hard rock states)/ sub-units within assessment units – command, non-command, poor quality area.
- Computations of season-wise (monsoon & non-monsoon) gross ground water draft.
- Computations of season-wise (monsoon & non-monsoon) recharge from other sources – recharge from canal seepage, surface water and ground water irrigation, recharge from tanks & ponds, recharge from water conservation structures. Recharge from other sources is estimated using norms recommended in the above mentioned documents available at the website - [www.cgwb.gov.in](http://www.cgwb.gov.in).
- Computation of season-wise (monsoon & non-monsoon) rainfall recharge -
  - Monsoon rainfall recharge : using two methods namely Water level fluctuation method and Rainfall Infiltration Method

➤ Non-monsoon rainfall recharge : using Rainfall Infiltration Method.

- Annual Replenishable Ground Water Resources : sum-total of Monsoon and non-Monsoon ground water recharge
- Allocation for Natural Ground Water Discharge during Non-Monsoon season : 5% to 10% of Annual Replenishable Ground Water Resources
- Net Annual Ground Water Availability : Annual Replenishable Ground Water Resources – Allocation for Natural Ground Water Discharge.
- Stage of Ground Water Development = 
$$\frac{\text{Gross Annual Ground Water Draft}}{\text{Net Annual Ground Water Availability}}$$
- Categorization of Assessment units based on - Stage of Ground Water Development and long term Water Level Trend as enumerated below

Sl. NO.	Stage of Ground Water Development (%)	Significant Long term Decline		Categorization
		Pre-monsoon	Post-monsoon	
1	≤ 70%	No	No	SAFE
		Yes/No	No/Yes	To be re-assessed
		Yes	Yes	To be re-assessed
2	> 70% and ≤ 90%	No	No	SAFE
		Yes/No	No/Yes	SEMI- CRITICAL
		Yes	Yes	To be re-assessed
3	> 90% and ≤ 100%	No	No	To be re-assessed
		Yes/No	No/Yes	SEMI-CRITICAL
		Yes	Yes	CRITICAL
4	> 100%	No	No	To be Re-assessed
		Yes/No	No/Yes	OVER- EXPLOITED
		Yes	Yes	OVER- EXPLOITED

Note:

1. 'To be re-assessed' means that data is to be checked for the purpose of categorization.
2. The long term ground water level data should preferably be for the period of 10 years.
3. The significant rate of water level decline may be taken between 10 and 20 cm per year depending upon the local hydrogeological conditions.

## 8. Future allocation of ground water resources

Future allocation of ground water resources for utilization to be computed as given below:

➤ Case I, when  $GWav \geq Dgi + Alld$

In such cases Allocation for future domestic requirement =  $Alld$

➤ Case II, when  $GWav < Dgi + Alld$

In such cases Allocation for future domestic requirement =  $(GWav - Dgi)$  or  $Dgd$ , whichever is more.

Where,

$GWav$  = Net Annual Ground Water Availability

$Dgi$  = Existing Ground Water draft for Irrigation

$Dgd$  = Existing Ground Water draft for Domestic use

$Dg$  = Existing Ground water draft for all uses

$Alld$  = Computed value of allocation for domestic use

(Based on projected population, fractional load and per capita requirement)

9. The results of ground water resources assessment shall be reconciled with the findings of the preliminary assessment (point 3, above) before ***finalizing the Categorization the assessment units.***

## 10. Field validation

Upon completion of ground water estimation exercises, field validations need to be carried out based on sample survey. Each state should carry out field validation in at least 10% of the assessment units, in different hydrogeological setup, or one in each district whichever is more. These could be Over-exploited or other category assessment units as decided by the State level Committee. In case of States where Over-exploited assessment units are more than 20% of the total numbers, field validation to be done for 15% of the total number of assessment units.

Field level validations need to be taken up in the following manner -

- i. 10% of the villages in the assessment unit should be taken for field validation. The sample villages may be selected based on prevailing hydrogeological conditions and should be representative of the assessment unit.
- ii. The sample survey would be conducted based on personal enquiry and field investigations with special emphasis on -
  - Inventory of all the wells in the village, measurement of water levels and information on their historical trend.
  - Total number of ground water abstraction structures for various uses in the village and their operational status over the years.

The results of field validation studies shall be reviewed by the State level Standing Committee and appropriate corrective measures suggested if required.

## 11. Generation of State-level report and National level compilation

State-level reports to be prepared and approved under the supervision of the **State level Committee. National level compilation** to be carried out under the supervision of an **Central level Expert Group** headed by Chairman, CGWB and drawing members from various Central and State Agencies. Member (SAM), CGWB to be the Member Secretary of the *Central level Expert Group*.

## 12. Application of alternative methods

Corrective measures shall include micro-level study as suggested in Chapter 5.14 in the Report of Ground Water Resources Assessment Methodology, 1997 and / or estimation of ground water recharge and parameter estimations using alternate methods in the identified assessment units.

The alternate methods are enumerated below.

### A. **Soil moisture technique**

*Soil moisture (Thorntwaite's Book Keeping method) technique* can usually be applied in semi-arid and humid parts of the country. For humid areas, monthly balancing is sufficient. But for semi-arid regions, weekly balancing will be more preferable. Available spreadsheets for the method can be readily used.

The salient features of the method are as follows –

- Soil moisture budgeting, taking into account Evapotranspirational abstraction from precipitation, provides a measure of moisture available for runoff and infiltration.
- In this method, measurements of field capacity and wilting point are to be made to determine the available moisture down to the root zone.
- Monthly Potential Evapotranspiration (EPT) and rainfall are tabulated and compared.
- If rainfall P in a month is less than PET, then Actual Evapotranspiration (AET) is equal to P, the period being one of water deficit.
- If the rainfall is more than PET, then  $AET = PET$ , the balance of rainfall raising the moisture level of the soil to field capacity.
- After meeting the soil-moisture deficit, the excess of rainfall over PET becomes the moisture surplus, also called water surplus.
- The saturated soil makes available moisture for evapotranspiration if the rainfall is below the PET.
- The soil moisture is continuously depleted till it reaches wilting point if there is no further rainfall. If any soil moisture is left at the end of the calendar year (or water year), it is carried over to the next year.
- The moisture surplus results in surface runoff and recharge to the ground water body. The runoff can be determined by gauging at the basin outlet or estimated from rainfall-runoff curves. The difference between the moisture surplus and runoff gives the ground water recharge.

## **B. Applied tracer technique**

*Applied tracer technique* can usually be used for arid and semi-arid agro-climatic regions of the country. Applied tracers such as tritium are normally used for recharge estimation. The salient features of the tritium technique is given in the following lines –

- In tritium injection technique, the moisture at certain depth in the soil profile is tagged with Tritiated water.
- The tracer moves downward along with the infiltrating moisture due to subsequent precipitation or irrigation.
- A soil core is collected from the injection site after certain interval of time and the moisture content and tracer concentration are measured from various depth intervals.
- The displaced position of the tracer is indicated by the peak in its concentration.
- Moisture content of the soil column, between injection depth and displaced depth of the soil core, is the measure of recharge to groundwater over the time interval between injection of Tritium and collection of soil profile.

## **C. Chloride Mass Balance**

*Chloride Mass Balance* can usually be applied in arid and semi-arid regions.

Chloride Mass Balance Method (CMB) is governed by the principle that the amount of Chloride (Cl) into the system is balanced by amount of Cl out of the system for negligible surface runoff.

- In this procedure, mean rainfall is estimated.
- Chloride concentration in rainfall is analyzed and weighted mean chloride concentrations in rainfall over a minimum of three years for the area are calculated.
- Unsaturated zone soils samples were obtained at regular intervals through auguring or other dry drilling techniques.
- Moisture content is measured gravimetrically (by weighing before and after drying).
- Chloride concentration in dry deposition and water samples in water saturated zones were analyzed.
- Rainfall recharge is given as the product of mean rainfall and ratio of Chloride concentration in rainfall plus dry deposition and Chloride concentration in soil moisture or ground water.

The description and literary references on the alternate methods of ground water recharge assessments are given in 'Report of the Group for suggesting New and Alternate Methods for Ground Water Resources Assessment' which is available in the web site – [www.cgwb.gov.in](http://www.cgwb.gov.in).

The choice of the appropriate technique/ methodology for application in the identified assessment units as described above (point 11 & 12) would be decided by the **State level Committee** based on the applicability of the technique/ methodology and availability of data.

13. The *parameter estimation* should be taken up in *project mode* by CGWB and State agencies in collaboration with academic / research institutes.

14. The findings of the various projects/ R&D studies related to ground water resources estimation as suggested above be reviewed by the standing committee namely ***R&D Advisory Committee on Ground Water Estimation*** for further refinements in the parameter norms and assessment methodology.

15. Final re-estimation of country-wide Dynamic Ground Water Assessment, preparation and approval of National level report shall be done by **Central Level Expert Group**.