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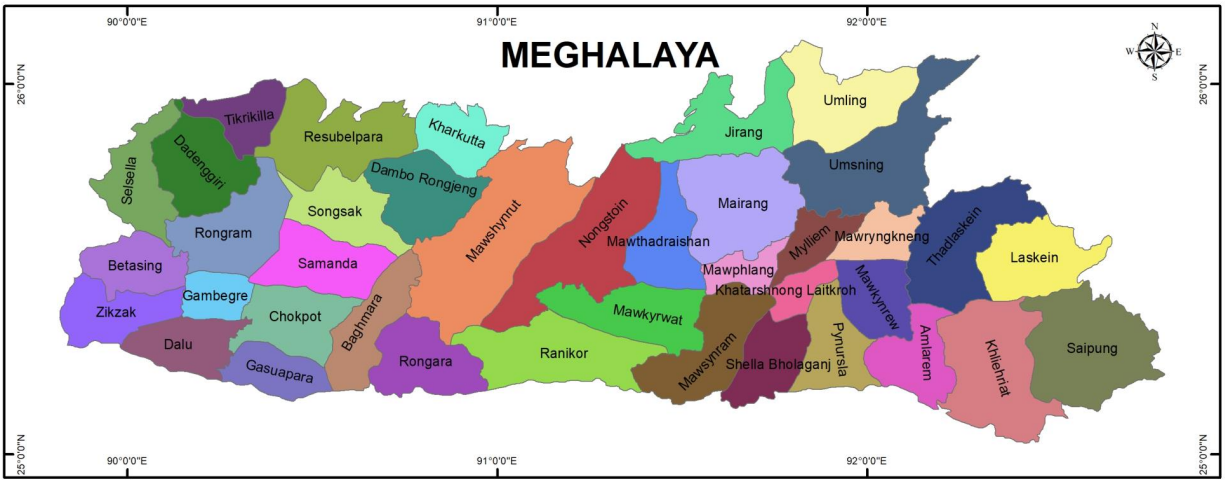
CENTRAL GROUND WATER BOARD



DYNAMIC GROUND WATER RESOURCES, MEGHALAYA (As on March, 2023)

CENTRAL GROUND WATER BOARD

NORTH EASTERN REGION, GUWAHATI

DECEMBER 2023

REPORT ON
DYNAMIC GROUND WATER RESOURCES OF MEGHALAYA
(As on March, 2023)

Jointly carried out by

Water Resources Department, Government of Meghalaya
&
Central Ground Water Board, State Unit Office, Shillong

CENTRAL GROUND WATER BOARD
NORTH EASTERN REGION, GUWAHATI
GUWAHATI
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PREFACE

Meghalaya is a land with verdant hills and fast flowing streams. Development of ground water in the State is practically negligible. Utilising groundwater requires pumping up of water from tube wells, while, it is easy to utilize the surface water from streams and springs by tapping water source at higher altitudes and supply water using gravity flow for drinking/domestic purpose or for irrigation at lower altitudes, sometimes even without proper distribution channels. Moreover, rainfall is abundant. In spite of this, there is acute shortage of water during the summer as the major part of rainfall is lost as surface run-off. Development of ground water resource will help in overall sustainable development of the State and its people and bring about industrial and agricultural revolution in this tribal State

For a scientific planning of development of dynamic ground water resource potential, estimation of ground water resource has been done based on the latest methodology as recommended by Ground Water Resource Estimation Committee-2015(GEC-2015) and duly approved by Govt. of India.

The report on dynamic Ground water resource potential has been assessed based on the field data generated by Central Ground Water Board and statistical information collected from other State Departments. The annual ground water recharge, net ground water availability and existing gross extraction on irrigation and domestic uses, etc, have been estimated for the state. The report also highlights on the net annual ground water availability for future use.

The total annual ground water recharge in the state of Meghalaya is 1.83 BCM. The Annual Extractable Ground Water Resources of the state is 1.51 BCM after deducting the natural discharge. Present Ground Water Extraction is 0.07 BCM out of which 0.02445 BCM extraction is on account of irrigation, 0.000252 BCM is on account of Industrial extraction and the annual domestic extraction is 0.04431 BCM. The annual allocation for Domestic use has been made as 0.05 BCM based upon the population data projected upto year 2025. The over-all stage of ground water extraction of the state is a meager 4.58%.

This report, with its comprehensive technical data, offers valuable insights into the current groundwater scenario in Meghalaya State. It will serve as a crucial resource for policymakers, technical experts, professionals, and user agencies, enabling them to manage groundwater development in a planned and sustainable manner.

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CONTRIBUTORS

Estimation of dynamic ground water resources of Meghalaya is based on the data provided by various state and central government departments like Water Resources Department, North Eastern Space Application Centre (NESAC), Community & Rural Development Department, Agriculture Department, Directorate of Economics and Statistics, Directorate of Fisheries, Soil and Water Conservation Department, Public Health Engineering Department, Govt. of Meghalaya etc. During this assessment, all the block wise data were collected through District Level Committee on Ground Water Resource (DLCGWR).

The computation of the resource estimation was done through INGRES software and compilation, uploading of data and preparation of the report was done by Shri Shasinlo Kent, Scientist-C and Ms. Rinku Rani Das, Scientist-B of CGWB, SUO, Shillong under the supervision of Ms. D. Rabha, Scientist-D & Officer-In-Charge, CGWB, SUO, Shillong.

1. INTRODUCTION

The state of Meghalaya has eleven districts namely- East Khasi Hills, West Khasi Hills, South West Khasi Hills, East Jaintia Hills, West Jaintia Hills, Ri-Bhoi, East Garo Hills, North Garo Hills, South Garo Hills, West Garo Hills and South West Garo Hills. The dynamic ground water resources of Meghalaya 2022-23 have been assessed block-wise for the first time and prior to this it was assessed district wise. Watershed as an assessment unit could not be taken up due to paucity of watershed wise data in Meghalaya. Hence, for the current resource assessment the total number of assessment unit (block) is 39.

As per 2011 Census, the total population of the State is 29,66,889 as against 23,18,822 in 2001 Census and 17,74,778 in 1991. The total geographical area of Meghalaya is 22,429 sq. km and population Density is 132 persons per sq. km which is lower than national average of 382 per sq km. The total population growth in this decade was 27.95 percent while in previous decade it was 29.94 percent. The population of Meghalaya forms 0.25 percent of India in 2011, while in 2001, the figure was 0.23 percent.

Meghalaya is basically an Agricultural State with about 80% of its total population depending entirely on Agriculture for their livelihood. The total cropped area in the State has increased by about 42 per cent during the last twenty-five years. Food grain production sector covers an area of over 60 per cent of the total crop area. With the introduction of different crops of high yielding varieties in the mid-seventies, remarkable increase in food grain production has been made.

In Meghalaya, monsoon is for a period of about 5 months, from June to October, with torrential rains caused by the South West Monsoon. Rainfall varies from place to place and altitude to altitude. The amount of rainfall over Cherrapunjee and Mawsynram is quite high. During the last two decades, it has ranged from 11,995 mm to 14,189 mm in Cherrapunjee and over Mawsynram it was 10,689 mm to 13,802 mm. Nature in its generous abundance, has bestowed Meghalaya a unique array of vegetation ranging from tropical and sub-tropical to temperate or near temperate.

The previous assessment of groundwater resources of Meghalaya was carried out during 2021-22. The dynamic ground water resource of the state has been re-estimated jointly by Central Ground Water Board and Water Resources Department, Govt. of Meghalaya based on GEC 2015 methodology for the assessment year 2022-23. Census figures for population as per 2011 census report were used and the various data for the year 2022-23 provided by Water Resources Department, North Eastern Space Application Centre (NESAC), Community & Rural Development Department, Agriculture Department, Directorate of Economics and Statistics, Directorate of Fisheries, Soil and Water Conservation Department, Public Health Engineering Department, Govt. of Meghalaya etc have been used to revise and update the assessment of dynamic groundwater resources of Meghalaya.

2 HYDROMETEOROLOGICAL CONDITION OF MEGHALAYA

High altitude areas of the region have temperate climate and the low altitude areas have tropical to sub-tropical climate. Generally the central hills area experiences an ambient annual temperature of 20° C; elsewhere the temperature is greater than that. The summer temperature is as high as 25° C and mean winter temperature ranges from 2° to 9° with periodic deviation to below the freezing point, marked by the appearance of ground frost in the early morning. Meghalaya experiences a remarkably high rainfall profile during the South -West monsoon, which usually starts from the middle of May and declines towards mid-October. There are four seasons in Meghalaya namely summer, monsoon or rainy, autumn and winter. The summer season extends from end of March to Mid-May, which is characterized by relatively high temperature, occasional thunderstorm, and high wind velocities. The rainy season commences with the onset of southwest monsoon in April and lasts up to October that encourages a lot of wet cultivation in the state. This is followed by short autumn from mid-October to November. The winter season extends from December to the end of March. This is the coldest season of the year with sharp decline in the temperature. During winter some high altitude areas of the state experiences very cold nights with mercury dipping to –1°C to –2°C. Winter is basically dry with reducing diurnal range of temperature. Rainfall is abundant and it is the single most dominant element of the climate of Meghalaya. Rainfall during the Monsoon season varies from 100 cm in the west central part to over 1000 cm in the south and southeast. Average rainy days during the season vary from 60 in the west-central part to over 100 days in the southeastern part. Heavy precipitation occurs in areas like Cherrapunjee (Sohra) and Mawsynram. Mawsynram and Cherrapunji in the East Khasi Hills district are geographically considered as the rainiest places in the World. — Cherrapunji, which has an average annual precipitation of about 11,430 mm (450 inches) and Mawsynram, a village directly west of Cherrapunji, where rainfall of around 17,800 mm (700 inches) per year has been recorded. The area receives rainfall on an average for 161 days in a year.

The climate of Meghalaya is mainly controlled by:

a) The maritime air masses coming from south and southwest.

b) Alternating pressure cells of North West India and Bay of Bengal

c) Physiography

3. HYDROGEOLGICAL SETUP OF MEGHALAYA

The hydrogeological formations occurring in the state is complex and heterogeneous in nature and the major part is covered by hard and massive rocks.

The consolidated formation comprises the Archaean Gneissic Complex, acid and basic intrusive, quartzite and phyllite of Shillong Group of rocks. These formations lack primary porosity and the movement and occurrence of ground water is controlled by secondary porosity like joints, faults etc. These formations have rather low ground water potentiality.

Semi-consolidated formations of the state include limestone, sandstone, siltstone and shale, interbedded with the coal seams. The Khasi, Jaintia and Dupitila Group of rock comprise the semi-consolidated formation. The aquifers are thick and discontinuous in nature and are more prospective for groundwater development than crystalline Archaean rocks.

The unconsolidated sediments comprising sand, gravel, silt clay etc are found to occur as thin veneer along rivulets and as valley-fills. Significant thickness of this unconsolidated formation is found to occur only along extreme north-western fringe of the state in South West Garo Hills and West Garo Hills district.

3.1 Aquifer System:

The aquifer system in the state can be divided as a two aquifer systems, viz., first aquifer (shallow) and second aquifer (deeper). Shallow or first aquifer consists of weathered residuum where ground water occurs under water table condition and is mainly developed through construction of dug wells. The second aquifer is the deeper aquifer which tapped the fractured zone and is mainly developed through borewells. Based on the study of litholog and analysis of depth of construction of dug wells and bore wells, it is found that the first aquifer occur within depth of 20 to 40m. Ground water in the second aquifer occurs under semi-confined to confined condition in the fractures upto the maximum explored depth of 280m.

Ground water exploration has been carried out in different parts of the state to delineate the potential aquifers and their geometry and to determine the hydrogeological parameters of the aquifer systems.

In general, the yield from the gneissic complex is more than that of granitic plutons. Quartzite formations, in turn, sustain higher yields than both granitic and gneissic formations. Within this hard rock terrain, most fractures occur primarily within a depth of 150 meters. The cavernous limestone of the Jaintia Hills holds greater potential for groundwater occurrence compared to the Cherrapunjee area.

In the western fringes of the Garo hills, Alluvium and Upper Tertiary sediments have formed some of the most productive aquifers of the State. Ground water occurs under unconfined to confined conditions within depth of 300m. In this area , yield of tubewells occur in the range of 4.8 -164.8 m^3/hour, tapping prominent aquifer zones of 30 -60 m thickness within constructed depth of 200m for a maximum drawdown of 13.3 m. Dupitala and Chengapara sandstones make good aquifers. The discharge in these formations was found ranging from 25-150 m^3/hr for wells drilled down to a depth of 250 m and 25 m^3/hr in shallow wells of 50 m depth. Auto flowing wells are reported from Ampati, Bairagipara, Zikzak etc. with artesian head ranging from 0.80 to 9m.

Summarized results of exploration carried out by CGWB in Meghalaya is presented in Table1 and the hydrogeology of Meghalaya in Table 2.

Table 1: Summarized results of groundwater exploration in Meghalaya.

Area	Rock type	Depth Drilled (m)	Discharge (m^3/hr)	Drawdown (m)	Specific Capacity (lpm /m)	T (m^2/d)	Storativity (S)
Khasi, Jaintia and Garo Hills	Hard rock	37 – 248	0.54 – 18	2.40 – 44	6 – 70	3 – 288	-
Greater Shillong	Hard Rock	80 – 232	5 – 40	2 – 40	-	1 – 87	-
Garo Hills	Soft rock	22 – 300	8 – 222	1.50 – 13.30	75 – 1726	4 – 1595	3.7×10^{-4} to 9.9×10^{-1}

Table 2: Hydrogeology of Meghalaya

Age	Group	Formation	Lithology	Hydrogeological Conditions	Yield (m^3/hr)
Pleistocene to Holocene	Newer (Recent) and Older Alluvium		Unconsolidated Sediments Sand, silt and clay	Thick, continuous aquifer in the western, northern and southern fringes of the State. Ground water occurs under unconfined to semi-confined conditions; Depth to water level rests at 3 to 5 m.bgl (metres below ground level)	30 - 100
Mio- Pliocene		Dupitla	Mottled clay, sandstone, shale and conglomerate	Thick, discontinuous aquifer encountered down to 250 m.bgl in the West Garo Hills area. Groundwater occurs under semi-confined to confined conditions; Depth to water level rests at 4 to 9 m.bgl	25 - 150
Oligo-Miocene	Garo group	Chengapara	Coarse sandstone, siltstone, clay and marl		
		Baghmara	Coarse sandstone, conglomerate, silty clay and fossiliferous limestone		
		Simsang	Fine sandstone and alternation of siltstone- mudstone		
Eocene-Oligocene	Barail group	-------	Coarse sandstone, shale, minor coal lenses carbonaceous shale,		
Palaeocene-Eocene	Jaintia group	Kopili	Shale, sandstone, marls and coal	Discontinuous aquifer in the cavernous limestones and sandstones area. Groundwater occurs under unconfined to semi-confined conditions; Depth to water level rests at 2 to 4 m.bgl	5 - 15
		Shella	Alternation of sandstone, limestone		
		Langer	Calcareous shale, sandstone, limestone		
Upper Cretaceous	Khasi Group	Mahadek	Arkosic sandstone (Glauconitic)		
			Conglomerate		
		Jadukata	Conglomerate/sandstone		
Paleo-Meso Proterozoic	Shillong Group		Quarzite, phyllite, quartz-sericite schist, conglomerate	Aquifer formed by weathered and fractured zones extending down to 150 m. bgl. Groundwater occurs under unconfined to semi-confined conditions; Depth to water level rests at 7 to 17 m.bgl	2 - 10
Archaean - Proterozoic	Meghalaya Archaean Gneissic Complex		Granite gneiss, Biotite gneiss, mica schist, silliminite- quartz schist, pyroxene granulite, gabbro & diorite, acidic and basic intrusives		

3.2 Ground water regime:

In Meghalaya, ground water occurs under unconfined to semi-confined conditions. However, in southern part of West Garo Hills district of Meghalaya, ground water occurs under confined conditions giving rise to auto flow wells.

In unconsolidated formation , the pre and post monsoon water levels generally varies from 2 to 10 mbgl and 2 to 5 mbgl respectively. The water levels in consolidated/semi-consolidated formation rest in the range of 2 - 45 mbgl both pre and post monsoon periods.

Water level trends for the period of last 10 years shows that there is no significant decline anywhere in the State. Maximum stations show a rise or fall in water level in the range of 0 to 10 cm/yr.

3.3 Spring:

Spring is defined as a localized natural discharge of ground water appearing at the ground surface as a current of flowing water through well-defined outlets. Though ground water prospect is low in hilly areas, ground water emanates as springs. Meghalaya endowed with abundant rainfall, numerous springs appears in the state during rainy season. However, most of the spring dries up or its discharge dwindles during the lean period.

Studies on Springs in Meghalaya have been carried out as a part of study under National Aquifer Mapping Programme. The location of the springs are mainly restricted to foothills and intermontane valleys. In hilly areas, traditionally, villagers are highly depended on the spring water for their drinking and domestic purposes. Most of the springs dry up during the lean period. Some perennial springs flow throughout the year but their yield decrease significantly during the dry season (March – April). On the basis of the study it has been found that several potential perennial springs exist in the state. Most of the springs showed drastic increase in discharge during post-monsoon season suggesting the direct influence of rainfall recharge.

Springs found in Meghalaya are mainly depression (topographic) and fractured types. It has also been observed that the discharge of springs increased during monsoon season and gradually decreases with the cessation in rainfall. Spring discharge as observed in the state has been presented in **Table.3.**

Table.3: Springs in Meghalaya

District	**No. of Springs studied**	**Spring discharge (litre per minute)**	
		Pre-monsoon	**Post monsoon**
East Garo Hills	13	1.5 - 30	18.46 -34
East Jaintia Hills	9	0.36-6.6	1.02-27
East Khasi Hills	54	0.6-120	3-180
North Garo Hills	1	144	276
Ri-Bhoi	17	0.57-81	0.6-102
South Garo Hills	7	1.02-6	5.4-25.8
South West Garo Hills	2	0.6-54	0.6-20.4
West Garo Hills	7	0-7.0	10 - 30
West Jaintia Hills	25	0-36.6	.06 – 40.2
West Khasi Hills	25	0.6 - 60	0.2 ->96

3.4 Ground Water Quality

Ground water in the State ranges from acidic to alkaline with pH values ranging from 4.42 to 10.51. The electrical conductivity values for ground water in phreatic aquifer in Meghalaya range from 14.1 to 662 µs/cm at 25ºC indicating the quality of ground water to be of low salinity and the water is potable. Total hardness (Ca+Mg) expressed as $CaCO_3$ in ppm is small indicating that the water is soft in quality. The other chemical constituents of ground water namely HCO_3, Cl, Ca, Mg, Fe etc. all are within permissible limit according to Bureau of Indian Standard (IS: 10500-91**).** The chemical analysis of ground water samples from phreatic aquifer reveals that the ground water of Meghalaya is generally suitable for drinking purposes. Almost all the chemical constituents are within the permissible limits of drinking water standards except for Iron and Flouride which is high in some pockets. Higher concentration of iron above permissible limit in phreatic aquifer and semi confined aquifer were found in some pockets of 7 districts. High fluoride concentration beyond permissible limit were found in some deeper aquifer in 2 districts viz. East Jaintia Hills district at Mynthlu and at four locations (Chasingre, Rongram, Jengjal and Dadenggre) in West Garo Hills district. The ranges of the water quality data from dug well, borewell and springs is shown in table below;

Table 4: Water quality data from dug well, borewell and springs

Sl. No.	Chemical constituents (Concentrations in mg/l except pH & EC)	Dug well	Borewell	Spring
		Range		
1	pH	4.79 to 8.58	4.42 to 10.51	4.60 to 8.8
2	EC* µS/cm at 25°C	14.1 to 662	20 to 545.2	13.03 to 405
3	Turbidity(NTU)	BDL to 29	BDL to 4.9	BDL to 1.2
4	TDS	BDL to 385	BDL to 283.2	BDL to 236
5	CO_3	BDL to 172.3	BDL to 240.6	BDL to 89.79
6	HCO_3	BDL to 220	BDL to 176	BDL to 195.16
7	TH as $CaCO_3$*	10.01 to 95.1	10 to 135.13	10 to 195.16
8	Cl*	7.09 to 63.12	7.09 to 165.13	14.18 to 67.35
9	SO_4	BDL to 87.1	BDL to 67.35	BDL to 46.49
10	NO_3	BDl to 29.3	BDL to 79.81	BDL to 9.88
11	F^-	BDL to 0.54	BDL to 3.47	BDL to 1.7
12	Ca*	1.7 to 70	0.22 to 41.6	1.7 to 93.6
13	Mg*	0 to 26.69	1.2 to 32	0.5 to 16.5
14	TH*	15 to 180	1.2 to 136	15 to 276.5
15	Na*	0.6 to 74	BDL to 100	0.13 to 37.1
16	K*	0.12 to 45.1	BDL to 86.26	0.04 to 27.88
17	Fe	BDL to 4.43	BDL to 39.65	BDl to 2.4

4. GROUND WATER RESOURCES ESTIMATION METHODOLOGY-GEC'2015

The present methodology used for resource assessment is known as Ground Water Resource Estimation Methodology – 2015 (GEC'2015). The revised methodology GEC 2015 recommends aquifer wise ground water resource assessment. Ground water resources have two components – Replenishable ground water resources or Dynamic ground water resources and In-storage resources or Static resources. GEC 2015 recommends estimation of Replenishable and in-storage ground water resources for both unconfined and confined aquifers. In GEC'2015, two approaches are recommended – water level fluctuation method and norms of rainfall infiltration method. The water level fluctuation method is based on the concept of storage change due to difference between various input and output components. Input refers to recharge from rainfall and other sources and subsurface inflow into the unit of assessment. Output refers to ground water draft, ground water evaporation, transpiration, base flow to streams and subsurface outflow from the unit. Since the data on subsurface inflow/ outflow are not readily available, it is advantageous to adopt the unit for ground water assessment as basin/ sub basin/ watershed, as the inflow / outflow across these boundaries may be taken as negligible.

Thus the ground water resources assessment unit is in general watershed particularly in hard rock areas. In case of alluvial areas, administrative block can also be the assessment unit. In each assessment unit, hilly areas having slope more than 20% are deleted from the total area to get the area suitable for recharge. Further, areas where the quality of ground water is beyond the usable limits should be identified and handled separately. The remaining area after deleting the hilly area and separating the area with poor ground water quality is to be delineated into command and non-command areas. Ground water assessment in command and non-command areas are done separately for monsoon and non-monsoon seasons.

4.1 Ground water Recharge

Monsoon season

Recharge from rainfall is estimated by using the following relationship -

Rrf = RFIF * A* (R – a)/1000

Where,

Rrf= Rainfall recharge in ham

A = Area in Hectares

RFIF = Rainfall Infiltration Factor

R = Rainfall in mm

a = Minimum threshold value above which rainfall induces ground water recharge in mm

The threshold limit of minimum and maximum rainfall event which can induce recharge to the aquifer is to be considered while estimating ground water recharge using rainfall infiltration factor method. The minimum threshold limit is in accordance with the

relation shown in above equation and the maximum threshold limit is based on the premise that after a certain limit, the rate of storm rain is too high to contribute to infiltration and they will only contribute to surface runoff. It is suggested that 10% of Normal annual rainfall may be taken as minimum rainfall threshold and 3000 mm as maximum rainfall limit.

The resources assessment during monsoon season is estimated as the sum total of the change in storage and gross draft. The change in storage is computed by multiplying water level fluctuation between pre and post monsoon periods with the area of assessment and specific yield. Monsoon recharge can be expressed as –

$$R_{RF} = h \times Sy \times A - R_{OS} \pm VF \pm LF + GE + T + E + B$$

Where,

h = rise in water level in the monsoon season, A = area for computation of recharge,

Sy = specific yield, D_G = gross ground water draft, R_{OS}= Other sources of ground water recharge during monsoon season include R_c, R_{sw}, R_t, R_{gw}, R_{wc} which are recharge from seepage from canals, surface water irrigation, tanks and ponds, ground water irrigation, water conservation structures respectively; LF = Recharge through Lateral flow/ Through flow across assessment unit boundary in the monsoon season for the i^{th} particular year, VF – Vertical inter aquifer flow in the monsoon season for the i^{th} particular year, T- Transpiration in the monsoon season for the i^{th} particular year, E- Evaporation in the monsoon season for the i^{th} particular year, GE = Ground water extraction in monsoon season for the i^{th} particular year, B = Base flow the monsoon season for the i^{th} particular year

The monsoon ground water recharge has two components – rainfall recharge and recharge from other sources. Mathematically it can be represented as –

$$R(Normal) = R_{RF}\,(normal) + R_{OS}$$

Where,

R_{rf} is the normal monsoon rainfall recharge. R_{OS} is the other sources of ground water recharge during monsoon season include R_c, R_{sw}, R_t, R_{gw}, R_{wc} which are recharge from seepage from canals, surface water irrigation, tanks and ponds, ground water irrigation, water conservation structures respectively

The rainfall recharge during monsoon season computed by Water Level Fluctuation (WLF) method is compared with recharge figures from Rainfall Infiltration Factor (RIF) method. In case the difference between the two sets of data are more than 20%, then RIF figure is considered, otherwise monsoon recharge from WLF is adopted. While adopting the rainfall recharge figures, weightage is to be given to WLF method over adhoc norms method of RIF. Hence, wherever the difference between RIF & WLF is more than 20%, data have to be scrutinized and corrected accordingly.

Non-Monsoon season

During non-Monsoon season, rainfall recharge is computed by using Rainfall Infiltration Factor (RIF) method. Recharge from other sources is then added to get total non-

Monsoon recharge. In case of areas receiving less than 10% of the annual rainfall during non-monsoon season, the rainfall recharge is ignored.

Total annual ground water recharge

The total annual ground water recharge of the area is the sum-total of monsoon and non-monsoon recharge. An allowance is kept for natural discharge in the non-monsoon season by deducting 5% of total annual ground water recharge, if WLF method is employed to compute rainfall recharge during monsoon season and 10% of total annual ground water recharge if RIF method is employed. The balance ground water available accounts for existing ground water withdrawal for various uses and potential for future development. This quantity is termed as Annual Extractable Ground Water Resources.

Annual Extractable Ground Water Resources (AEGR) = Annual Ground Water Recharge – Natural discharge during non-monsoon season

Norms for estimation of recharge

GEC'2015 methodology has recommended norms for various parameters being used in ground water recharge estimation. These norms vary depending upon water bearing formations and agroclimatic conditions. While norms for specific yield and recharge from rainfall values are to be adopted within the guidelines of GEC'2015, in case of other parameters like seepage from canals, return flow from irrigation, recharge from tanks & ponds, water conservation structures, results of specific case studies may replace the adhoc norms.

4.2 Ground Water Extraction

The gross yearly ground water extraction is to be calculated for Irrigation, Domestic and Industrial uses. The gross ground water extraction would include the ground water extraction from all existing ground water structures during monsoon as well as during non-monsoon period. While the number of ground water structures should preferably be based on latest well census, the average unit draft from different types of structures should be based on specific studies or ad-hoc norms given in GEC2015 report.

4.3 Stage of ground water Extraction & Categorization of units

The stage of Ground water Development is defined by,

$$\text{Stage of Ground water Extraction (\%)} = \frac{\text{Existing Gross Ground water extraction for all uses}}{\text{AEGR}} \times 100$$

Validation of Stage of Ground Water Extraction

The assessment based on the stage of ground water extraction has inherent uncertainties. It is desirable to validate the 'Stage of Ground Water Extraction' with long term trend of ground water levels.

If the ground water resource assessment and the trend of long term water levels

contradict each other, this anomalous situation requires a review of the ground water resource computation, as well as the reliability of water level data. The mismatch conditions are enumerated below.

SOGWE	Ground Water Level Trend	Remarks
≤70%	Significant decline in trend in both pre-monsoon and post-monsoon	Not acceptable and needs reassessment
>100%	No significant decline in both pre-monsoon and post-monsoon long term trend	Not acceptable and needs reassessment

Categorisation of Assessment Units

As emphasised in the National Water Policy, 2012, a convergence of Quantity and Quality of ground water resources is required while assessing the ground water status in an assessment unit. Therefore, it is recommended to separate estimation of resources where water quality is beyond permissible limits for the parameter salinity.

Categorisation of Assessment Units Based on Quantity: The categorisation based on status of ground water quantity is defined by Stage of Ground Water Extractions given below:

Stage of Ground Water Extraction	Category
≤70%	Safe
>70%and ≤90%	Semi-Critical
>90%and ≤100%	Critical
> 100%	Over Exploited

Categorisation of Assessment Units Based on Quality

The committee recommends that each assessment unit, in addition to the quantity based categorisation (safe, semi-critical, critical and over-exploited) should bear a quality hazard identifier. Such quality hazards are to be based on available ground water monitoring data of State Ground Water Departments and/or Central Ground Water Board. If any of the three quality hazards in terms of Arsenic, Fluoride and Salinity are encountered in the assessment sub unit in mappable units, the assessment sub unit may be tagged with the particular quality hazard.

4.4 Allocation of ground water resource for utilization

The net annual ground water availability is to be apportioned between domestic, industrial and irrigation uses. Among these, as per the National Water Policy, 2002, requirement for domestic water supply is to be accorded priority. The requirement for domestic and industrial water supply is to be kept based on population as projected to the

year 2025. The water available for irrigation use is obtained by deducting the allocation for domestic and industrial use, from the net annual ground water availability.

4.5 Poor quality ground water

Computation of ground water recharge in poor quality ground water is to be done on the same line as described above. However, in saline areas, there may be practical difficulty due to non availability of data, as there will usually be no observation wells in such areas. Recharge assessment in such cases may be done based on rainfall infiltration factor method.

4.6 Apportioning of ground water assessment from watershed to development unit

Where the assessment unit is a watershed, the ground water assessment is converted in terms of an administrative unit such as block/ taluka/ mandal. This is done by converting the volumetric resource into depth unit and then multiplying this depth with the corresponding area of the block.

4.7 Additional Potential Recharge

In shallow water table areas, particularly in discharge areas, rejected recharge would be considerable and water level fluctuation are subdued resulting in under-estimation of recharge component. In the area where the ground water level is less than 5m below ground level or in waterlogged areas, ground water resources have to be estimated upto 5m bgl only based on the following equation -

Potential ground water recharge = (5-D) x A x Sp. Yield

Where,

D = Depth to water table below ground surface in pre-monsoon season in shallow aquifers;

A = Area of shallow water table zone.

The potential recharge from flood plain is estimated based on the same norms as for ponds, tanks and lakes.

Potential Resource Due to Spring Discharge: Spring discharge constitutes an additional source of ground water in hilly areas which emerges at the places where ground water level cuts the surface topography. The spring discharge is equal to the ground water recharge minus the outflow through evaporation and evapotranspiration and vertical and lateral sub-surface flow.

5 PROCEDURE FOLLOWED IN THE PRESENT ASSESSMENT INCLUDING ASSUMPTIONS

5.1 Data source for each of the data element and how the data was used in the computation (constraint in the data base, if any)

In the present report, block has been taken as the smallest administrative unit for groundwater resources computation. The following sub-units have been considered for computation of various figures as per GEC-2015 methodology.

- **Hilly area and recharge worthy areas**: The area suitable from the groundwater recharge point of view has been calculated taking into consideration the area having less than 20% slope using CARTOSAT DEM data having 10 m resolution. The data was provided by North Eastern Space Application Centre, Umiam, Meghalaya.
- **Poor Water quality area:** There is no such area reported from the state of Meghalaya, hence it has not been considered.
- **Command and non-command area**: There are no major irrigation projects in the state therefore entire area is considered as non-command area.

Domestic Extraction: Due to paucity of data, the domestic extraction has been calculated on projected population for 2023, based 2011 Census data of number of households using groundwater as "Main source of drinking water".

Irrigation Extraction: This has been calculated for South West Garo Hills and West Garo Hills districts as per data provided by WR Department, Govt. of Meghalaya and MI census report.

Industrial Extraction: This has been considered, as per the information available from CGWA, only for East Khasi Hills, West Garo Hills and Ri Bhoi districts.

Recharge from rainfall by rainfall infiltration factor method

Monthly rainfall data of April 2022 to May 2023 for all the districts rain gauges stations were provided by Directorate of Agriculture, Govt. of Meghalaya.

During recharge from rainfall, normal rainfall during 1970 – 2022 collected from Agriculture Department and IMD (WRIS website) were used.

Recharge from Ground water irrigation is estimated only for South West Garo Hills and West Garo Hills District as others do not have ground water irrigation.

Recharge from tanks and Ponds is estimated by using data on water spread area provided by Fisheries Department, Soil and Water Conservation Department and C&RD Department, Govt of Meghalaya.

Groundwater loss by evaporation and transpiration was also estimated only for West Garo Hills, North Garo Hills & SW Garo Hills districts, as these districts are having good number of representative water level data.

5.2 Major changes in the present assessment:

5.2.1 Assessment unit: Prior to 2023, there were only 12 assessment unit where 11 district boundary and Greater Shillong were taken into account. In the present assessment, 39 block boundary were taken as the smallest administrative unit for dynamic groundwater resources computation.

5.2.2 Slope: Slope map prepared by the North Eastern Space Applications Centre (NESAC) were used to calculate recharge worthy area. Prior to 2023, slope map was prepared using ASTER DEM/ SRTM of 30-meter resolution data, identifying 10,64,556 hectares as recharge worthy area (slope < 20%). In 2023, NESAC provided higher resolution (10-meter) slope map based on CARTOSAT DEM data, resulting in a revised area of 817,135 hectares as recharge worthy area.

5.2.3 Principal aquifer: Prior to 2023, a principal aquifer map of Meghalaya at a scale of 1:250,000 was used. However, the present assessment employed a larger-scale (1:50,000) principal aquifer map prepared by incorporating all available NAQUIM data.

5.3 Changes, if any, applied in the original methodology proposed by GEC along with justification

Return flow from ground water has not been considered for monsoon season, as there is enough rainfall during monsoon and ground water irrigation is not practiced. There is no major or medium irrigation scheme in Meghalaya. Entire area has been considered as non-command area.

Water spread area, days of water availability (monsoon & non-monsoon) and seepage from ponds & tanks given in the methodology have been used to determine the seepage from ponds & tanks for monsoon & non-monsoon separately. Since the aquifer remains fully saturated during the periods of intensive rainfall, additional recharge from ponds & tanks during this period is negligible. Recharge from ponds and tanks during non-monsoon period are considered for 120 days. Computation factor for seepage from ponds & tanks is taken as 0.00144 m/day as per GEC-2015 methodology.

Categorization was done based on stage of extraction only, instead of stage of groundwater extraction and validation. Validation was done for West Garo Hills and South West Garo Hills Districts. North Garo Hills districts, West Khasi Hills and South West Khasi Hills districts have very scanty water level data, while water level data from East Khasi Hills, East Garo Hills, North Garo Hills and Ri Bhoi districts represent point value rather than representative value on a regional scale because these districts are mostly hilly. Hence, long term trends couldn't utilize for validation purpose.

5.4 Various norms used in the computation

The unit of computation proposed in the methodology is "watershed". However, it also recommends blocks/ tehsil as the unit for the first few years since there can be non-availability of data.

The rainfall infiltration factor recommended by GEC-2015 for unconsolidated alluvium is 0.20. This value employed during recharge estimation in parts of North, West & South West Garo Hills districts.

The major potential aquifer in the state is Unconsolidated sediments in West & South West Garo hills and in other parts it is formed by weathered residuum along with fractures/ joints in hard rocks.

5.5 Any documented field studies

During NAQUIM studies in Meghalaya, a total of 60 nos. of infiltration studies were carried out to determine rainfall infiltration factor (RIF) in different geological formations. 22 nos. of infiltration studies in East Khasi Hills show that RIF in weathered granitic and quartzite formations are 5% while in valleyfills and Tertiary formations it is 5%. 17 nos. of infiltration studies in Ri Bhoi show that RIF in weathered granitic and quartzite formations are 5% while in alluvium and valley fills it is 13%. 8 nos. of infiltration studies in East Garo Hills show that RIF in weathered Tertiary formations are 4%. 13 nos. of infiltration studies in East & West Jaintia Hills show that RIF in weathered granites and Tertiary formations are 5% while in alluvium it is 10%.

6. COMPUTATION OF GROUND WATER RESOURCES IN MEGHALAYA STATE

Ground water resources of Meghalaya state have been computed according to the methodology and norms described above. The block-wise details have been provided in the Annexures.

a. Salient features of the dynamic ground water resources assessments.

The smallest administrative unit 'block' is taken as the unit of computation. Total number of assessment units in Meghalaya is 39. The resource computations presented in this report is for the ground water year 2022 – 2023 (1st April 2022 to 31st March, 2023). Population data of 2011 collected from Census report 2011 and projected population of 2023 and 2025 were worked out. Rainfall data collected for 2022-23. Ground water abstraction structures for irrigation purposes were collected for 2022. Ground water abstraction structures for drinking and domestic structures were collected from 2011 census report.

b. Assessment sub-unit-wise method adopted for computing rainfall recharge during monsoon season (WLF/RIF).

Recharge from Rainfall has been computed separately for monsoon and non-monsoon periods for the entire state. The recharge from rainfall during monsoon season has been computed using both water level fluctuation method (WLFM) and rainfall infiltration method (RIFM). The results from the above two methods (WLFM & RIFM) have been compared using Percent Deviation (PD). After the computation of the percent deviation (PD) it is found that all the 39 assessment units were considered by RIF method.

c. Total resources of the state, existing development, balance available for future development etc.

Total ground water recharge is 1.83 BCM and Annual extractable groundwater resources is 1.51 BCM after deducting natural discharge and resultant flow. Ground water extraction for various uses has been estimated for all the assessment units of Meghalaya. Gross annual ground water extraction for all uses is 0.07 BCM and allocation for domestic and industrial supply up to year 2025 is 0.05 BCM. Balance groundwater resources available for future development are 1.43 BCM. The stage of groundwater extraction is 4.58 % and all the 39 assessment units in Meghalaya state falls under **SAFE** category.

d. Spatial variation of the Ground water recharge and development scenario in Meghalaya

Annual Extractable ground water resources in the state is 1.51 BCM where maximum annual extractable ground water resource of 0.116 BCM is found in Mawshynrut block under West Khasi Hills district while the minimum of 0.013 BCM is in Umling block under Ri bhoi district.

Ground water extraction is done mainly through dug wells and shallow tubewells from unconfined aquifer in the state. The stage of ground water extraction in Meghalaya is 4.58 %. Selsella block under West Garo Hills district is having the highest stage of ground water extraction of 35.7 % while the minimum is in Ranikor block under South West Khasi Hills district.

e. Comparison with earlier ground water resources estimate and reasons for significant departure from earlier estimates.

A comparison is made between the previous estimate as on March 2022 and present estimate based on GEC'15 as on 2023, and presented in tabular statement given below.

Comparison between ground water resources estimation for Meghalaya for previous (2021-2022) and present (2022-2023)

Sl. No.	ITEM	Year		COMPARISON
		2021-22	2022-23	
	Estimation	INGRES	INGRES	
1	Total Annual Ground Water Recharge (BCM)	1.72	1.83	0.11
2	Annual Extractable Ground Water Resources (BCM)	1.51	1.51	0
3	Irrigation extraction (BCM)	0.0026	0.02445	0.02185
4	Industrial extraction (BCM)	0.00065	0.00025	-0.0004
5	Domestic extraction (BCM)	0.0504	0.0443	-0.0061
6	Stage of GW Extraction (%)	3.55%	4.58%	1.03%
7	Provision for Domestic use (BCM)	0.058	0.05	-0.008
8	GW availability for future use (BCM)	1.45	1.43	-0.02
9	No. of SAFE Units	12	39	27
10	No. of O.E. Units	0	0	0
11	No. of Dark/ Critical units	0	0	0

The comparison depicts that there is a increase in total annual ground water recharge by 0.11 BCM. The reasons can be attributed to increase in recharge from other sources. The Ground Water Extraction for irrigation has increased from 0.0026 to 0.02445 BCM as more data was received from State government department and MI census data was also included. Industrial extraction has decreased by 0.0061 BCM because as per data received from CGWA, some industries NOC were not granted. In the current year assessment year, there is decrease in domestic extraction since projected population for domestic extraction was worked out from block-wise growth rate provided in 2011 census report which was less than the district wise growth rate as considered in the previous assessment.

Stage of Ground Water extraction has increased by 1.03% during this assessment because there was increase in irrigation extraction of ground water resources by 0.02185 BCM.

7. AUTOMATION OF ESTIMATION OF DYNAMIC GROUND WATER RESOURCES USING GEC-2015

The computation of the resource estimation of Meghalaya for the year 2022-23 is done through IN-GRES software (India Ground Water Resource Estimation System). IN-GRES is the common portal to input, estimate, analyze, and access static and dynamic groundwater resources. India GEC system will take Data Input through Excel as well as through Forms, compute various Ground water components (recharge, draft, flux, etc.), classify assessment unit into appropriate categories, and develop visibility dashboards for each of the components. System allows user to view the data in both MIS as well as GIS view. User can also download the reports in formats like CGWB, etc.

India GEC system is divided into 3 modules – Input, Computation and Output.

i. Input module – Input Module refers to the Data Entry module at an Assessment Unit level. Data Input is done via 2 methods i.e.

a. Excel based input – In this, the user needs to download District level data sheet template where he/she can fill the data at an Assessment Unit level. User now needs to upload their fully filled excel sheet into the system.

b. Form based input – In this, the user is shown a form and he/she can fill/edit the data in data sheet in an online mode. Once user is done with editing online, he/she can Submit the data file.

ii. Computation module – Computation Module refers to the ground water calculations for an assessment unit. These computations are based on GEC 2015 methodology and are used to calculate Annual Extractable Ground Water Resource, Total Current Annual Ground Water Extraction (utilization) and the percentage of ground water utilization with respect to recharge (stage of Ground Water Extraction) for an assessment unit. Based on these percentages an assessment unit is categorized into SAFE, SEMI-CRITICAL, CRITICAL AND OVEREXPLOITED categories.

iii. Output module Once categorized the data is shown in two views:

a. MIS Dashboard – MIS dashboard shows the results of the assessment for the entire India, and also State wise in tabular form. The MIS dashboard shows all type of recharges, extractions, inflows and outflows computed for both monsoon and non-monsoon periods of the year and then reflect the overall stage of extraction at the selected Geo-Zoom Level.

b. GIS Dashboard – GIS dashboard shows the data in Web Geo-Server format, implemented in interactive GIS platform allowing user to all GEC related information in the map itself. GIS view represents the data on India map and color codes each District/Assessment unit based on the categorization

Appendix – I : Government order on constitution of Committee

GOVERNMENT OF MEGHALAYA
WATER RESOURCES DEPARTMENT

NOTIFICATION

Dated: Shillong the 22nd February, 2022.

NO.WR(G)69/2010/Pt-I/192- The Governor of Meghalaya is pleased to re-constitute the **State Level Committee on Ground Water Resources Assessment** with the following members with immediate effect :-

1.	Additional Chief Secretary/Principal Secretary/ Commissioner and Secretary to the Govt. of Meghalaya, Water Resources Department.	-	Chairperson
2.	Chief Engineer, Water Resources, Shillong.	-	Member
3.	Principal Chief Conservator of Forest, Shillong.	-	Member
4.	Director, Soil & Water Conservation, Shillong.	-	Member
5.	Director, Fisheries, Shillong.	-	Member
6.	Chief Engineer, MeEPGCL, Shillong.	-	Member
7.	Director, Commerce and Industries, Shillong.	-	Member
8.	Director, Agriculture, Shillong.	-	Member
9.	Director, Horticulture, Shillong.	-	Member
10.	Chief Engineer, Public Health Engineering, Shillong.	-	Member
11.	Director, Community & Rural Development, Shillong.	-	Member
12.	Chief Executive Officer, Shillong Municipal Board, Shillong.	-	Member
13.	Chief Executive Officer, MeWDA, Shillong.	-	Member
14.	Director, Urban Affairs, Shillong.	-	Member
15.	Regional Director, CGWB, Shillong.	-	Member Secretary

- The committee may co-opt any other Members (s) Special invitees (s), if necessary.
- Expenditure on account of TA/DA to official Members of the Committee will be met from source from which they draw their salaries and that of non-members will be borne by the Department of Water Resources.

TERM OF REFERENCE:

The board terms of reference of the Committee would be as follows.

1. To estimate annual replenishable ground water resources of the state in accordance with the ground water resources estimation methodology.
2. To estimate the status of utilization of the annual replenishable ground water resource.
3. The Committee will submit its report within the time limit fixed by the Govt. of India with intimation to the State.
4. The Committee will consult the GC, MeWDA for any matter related to the State.

Sd/-(P. Shakil Ahammed, IAS)
Principal Secretary to the Govt. of Meghalaya,
Water Resources Department

Memo No.WR(G)69/2010/Pt-I/192-A **Dated Shillong: the 22nd February, 2022.**

Copy forwarded to :-

1. The P.S. to Minister i/c Water Resources Department, Meghalaya, Shillong.
2. The P.S. to the Principal Secretary to the Govt. of Meghalaya, Water Resources Department.
3. The Principal Chief Conservator of Forest, Shillong.
4. The Director, Soil & Water Conservation, Shillong
5. The Director, Fisheries, Shillong
6. The Chief Engineer, Meghalaya Power Generation Corporation Limited, Shillong.
7. The Director, Commerce and Industries, Shillong.
8. The Director, Agriculture, Shillong.
9. The Director, Horticulture, Shillong.
10. The Chief Engineer, Public Health Engineering, Shillong.
11. The Director, Community & Rural Development, Shillong.
12. The Chief Executive Officer, Shillong Municipal Board, Shillong.
13. The Chief Executive Officer, MeWDA, Shillong.
14. The Director, Urban Affairs, Shillong.
15. The Regional Director, CGWB, Shillong.
16. The Chief Engineer (WR), Meghalaya, Shillong.
17. The Director Printing and Stationery for publication in the next issue of the Meghalaya Gazette.
18. File No. WR(G)69/2010.
19. Guard File.
20. Office copy.

The Regional Director
Central Ground Water Board
Keating Road, Behind MePDCL Office,
Shillong.

By orders etc.,

Joint Secretary to the Govt. of Meghalaya,
Water Resources Department

Appendix – II: Minutes of meeting

Date: 08.09.2023

MINUTES OF MEETING OF THE STATE LEVEL COMMITTEE ON GROUND WATER RESOURCE ASSESSMENT (SLCGWRA) OF MEGHALAYA

The meeting of State Level Committee on Ground Water Resource assessment (SLCGWRA) for Assessment of Dynamic Ground Water Resource of Meghalaya as on 2023 was held on 31st August 2023 at Committee Room No. IV, Main Secretariat Building, Shillong under the Chairmanship of Shri. Sibhi. C. Sadhu, IAS, Secretary, Water Resources Department, Govt. of Meghalaya, Shillong. The list of Members who attended the meeting is enclosed as annexure I.

The Secretary, Water Resources Department, Govt. of Meghalaya, Shillong welcomed all the committee members present in the meeting and highlighted the importance of ground water resource.

Ms. D. Rabha, Sc-D & Officer In Charge, Central Ground Water Board, SUO Shillong welcomed all the representative members. She gave a brief note on the role of SLCGWRA and the meeting agenda and highlighted that assessment of Dynamic Ground Water Resource of Meghalaya has been carried out jointly by Central Ground Water Board and Water Resources Department (Nodal Department) in coordination with other Departments of the State.

With the permission of the Chair, Shri Shasinlo Kent, Scientist-C, CGWB, SUO, Shillong gave a detail powerpoint presentation on Dynamic Ground Water Resource of Meghalaya as on 2023. He pointed out some major changes opted for the current assessment viz., assessment unit taken as block (39 Nos.) instead of district, high resolution Slope map (10 m resolution; prepared by NESAC) and large scale principal aquifer map (1:50000 scale, NAQUIM data).

A detailed discussion on Dynamic Ground Water Resource of Meghalaya as on 2023 was held where various queries were addressed. The Chairperson advised the Nodal Department for compilation of all the block wise domestic ground water extraction data for better accuracy in the extraction component instead of using 2011 census data in future resource assessment. He also advised for compilation of data of all the water bodies in the state.

For the next year assessment, the Chairperson advised to convene one more meeting subsequent to the 1st SLC for reconciliation of data received/required from different line departments.

After thorough discussion, all the members of the committee agreed and accepted upon the figures of Dynamic Ground Water resource of Meghalaya as on March 2023.

The meeting ended with a vote of thanks from Ms. Anenuo Pienyu, Scientist-C of Central Ground Water Board, State Unit Office Shillong.

(Sibhi C. Sadhu, IAS)
Secretary, Water Resources Department
Government of Meghalaya

Distribution:

1. The Additional Chief Secretary/ Principal secretary/ Commissioner & Secretary to the Govt. of Meghalaya, Water Resources Department - Chairperson
2. The Regional Director, Central Ground Water Board, NER, Guwahati – Member Secretary
3. Chief Engineer, Water Resources, Govt. of Meghalaya, Shillong -Member
4. Chief Engineer, PHED, Govt. of Meghalaya, Shillong - Member
5. Principal Chief Conservator of Forests, Meghalaya, Shillong -Member
6. The Director, Fisheries, Meghalaya, Shillong -Member
7. The Director, Soil & Water Conservation, Meghalaya, Shillong -Member
8. The Director, Commerce & Industries, Meghalaya, Shillong -Member
9. Chief Engineer, MeEPGCL, Shillong -Member
10. Director, Horticulture, Govt. of Meghalaya, Shillong -Member
11. Director, Community & Rural Development, Meghalaya, Shillong -Member
12. The CEO, Shillong Municipal Board, Shillong -Member
13. The CEO, MeWDA -Member
14. Director, Urban Affairs, Meghalaya, Shillong –Member
15. Director, Agriculture, Govt. of Meghalaya, Shillong –Member

08/09/23
(D. Rabha)
Sc-D & Officer-In-Charge
CGWB, SUO Shillong
For Member Secretary of SLCGWRA

Meeting of State Level Committee on Ground Water Resource Assessment, Meghalaya as on 2023
Venue: Committee Room no. IV, Main Secretariat Building, Shillong
Date: 31st August 2023
Attendance Sheet

Sl. No.	Name & Designation	Organisation	Phone number	e-mail	Signature
1	Dr. Shakil P. Ahammed, IAS Additional Chief Secretary	Govt. of Meghalaya	0364-2224221		
2	Sibhi C Sedhu Secretary WR	Govt. of Meghalaya			
3	Z. D. Shira	Directorate Soil & water Cons. Deptt.	8837435554	megsoil 49 @ gmail. com	
4	T. Wanniang	Forest	9436999140		
5	Shri. N. Khongwei	Soil & Water Conservation	9625705346	megsoil 49@gmail.com	
6	Smt. B. M. Lindoy	JDH Horticulture	8794732863		
7	Smti M. Shira Kshir, MCS, Jt. Director	CKRD	96152-85656		
8	Sh P. V Lyngdoh	CKDD	8414921622		
9	Shri S. K. Gayan	PHE	9436112187		
10	Shri. S. Ayser	MePGCL	8787469881		

Meeting of State Level Committee on Ground Water Resource Assessment, Meghalaya as on 2023
Venue: Committee Room no. IV, Main Secretariat Building, Shillong
Date: 31st August 2023
Attendance Sheet

Sl. No.	Name & Designation	Organisation	Phone number	e-mail	Signature
11	J. F. Lyngdoh	Water Resources			
12	G. L. L. Mawnai	~~Ag~~ Horticulture	8794347692.		
13	SMT. MARIANA DKHAR. DDA (PP)	Deptt. of Agriculture	9436105202	marianadkhar6@gmail.com	31/08/2023.
14	D. Rabha, Sc-D4 OIC	CGWB, SUO, Shillong	9435733544		31/08/23
15	Shashiko Kent, Sc-C	CGWB, SUO Shillong	8732892199		31/08/23
16	Rinku Rani Das Sc-B	CGWB SUO Shillong	8876230700		Rinku Rani Das 31/08/23
17	Anemo Pienyu, Sc-C	CGWB SUO Shillong	9089447789		31/08/23
18					
19					
20					

ANNEXURE - Block wise Ground Water Resources of Meghalaya (in Ham)

Sl. No	District	Assessment Unit (Block name)	Total Area of Assessment Unit (Ha)	Recharge Worthy Area(Ha)	Total Annual Ground Water Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-Critical/Safe/Saline)
1	SOUTH WEST KHASI HILLS	Mawkyrwat	64078	21422	5253.69	525.37	4728.32	0	0	97.72705393	97.73	108.98	4619.34	2.07	safe
2	SOUTH WEST KHASI HILLS	Ranikor	70022	27115	9104.16	910.41	8193.75	0	0	34.58206803	34.59	38.31	8155.43	0.42	safe
3	SOUTH WEST GARO HILLS	Zikzak	45400	19757	2736.45	1382.06	1354.39	34.56	0	124.0851963	158.64	128.15	1191.69	11.71	safe
4	SOUTH WEST GARO HILLS	Betasing	41200	22763	4194.14	2151.89	2042.25	477.36	0	125.5085532	602.87	130.18	1434.71	29.52	safe
5	WEST GARO HILLS	Gambegre	24800	10341	2538.42	1056.18	1482.24	0	0	47.00228521	47	51.77	1430.47	3.17	safe
6	WEST GARO HILLS	Dadenggiri	61700	26181	4461.47	2960.67	1500.8	0	0	89.84504726	89.84	100.34	1400.47	5.99	safe
7	WEST GARO HILLS	Dalu	45900	21244	5496.91	2859.92	2636.99	0	0	102.2017326	102.2	112.56	2524.43	3.88	safe
8	WEST GARO HILLS	Rongram	62200	18915	3330.45	1250.27	2080.18	0	0	148.6392476	148.64	163.71	1916.47	7.15	safe
9	WEST GARO HILLS	Selsella	53500	35211	10909.34	4449.2	6460.14	1864.8	0.6	440.1849938	2305.59	496.03	4098.7	35.69	safe
10	WEST GARO HILLS	Tikrikilla	33000	15892	2999.38	991.46	2007.92	68.4	0	138.8177735	207.22	147.38	1792.14	10.32	safe
11	EAST GARO HILLS	Samanda	54700	19085	3578.05	357.81	3220.24	0	0	84.59354342	84.59	93.16	3127.08	2.63	safe
12	EAST GARO HILLS	Dambo Rongjeng	46500	15974	2685.32	268.53	2416.79	0	0	128.612816	128.61	144.63	2272.16	5.3	safe
13	EAST GARO HILLS	Songsak	43100	15156	2721.25	272.12	2449.13	0	0	118.8207036	118.82	130.59	2318.54	4.85	safe
14	EAST JAINTIA HILLS	Khliehriat	119400	50445	11096.98	1109.7	9987.28	0	0	126.3811004	126.38	142.71	9844.57	1.27	safe
15	EAST JAINTIA HILLS	Saipung	84600	32290	5856.61	585.67	5270.94	0	0	59.63892648	59.64	68.75	5202.19	1.13	safe
16	WEST KHASI HILLS	Mawthadraishan	47948	14489	4107.31	410.73	3696.58	0	0	79.62850264	79.63	89.74	3606.84	2.15	safe
17	WEST KHASI HILLS	Mairang	87729	24555	6415.52	641.55	5773.97	0	0	116.8109262	116.81	128.46	5645.51	2.02	safe
18	WEST KHASI HILLS	Mawshynrut	160878	54407	12872.67	1287.27	11585.4	0	0	145.2035831	145.21	164.21	11421.18	1.25	safe
19	WEST KHASI HILLS	Nongstoin	94045	30519	8310.36	831.04	7479.32	0	0	101.5396127	101.54	114.77	7364.55	1.36	safe
20	RI BHOI	Jirang	65940	14821	1484.16	148.42	1335.74	0	0	41.92096654	41.92	47.88	1287.86	3.138335305	safe
21	RI BHOI	Umling	59963	13744	1406.79	140.68	1266.11	0	19.4616	101.8212232	121.28	114.64	1132.01	9.578946537	safe
22	RI BHOI	Umsning	118897	40313	3729.97	373	3356.97	0	3.03	163.5802696	166.61	187.13	3166.81	4.963106611	safe

Sl. No	District	Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area(Ha)	Total Annual Ground Water Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-Critical/Safe/Saline)
23	SOUTH GARO HILLS	Baghmara	44200	15465	4796.04	479.61	4316.43	0	0	95.62062453	95.62	105.06	4211.37	2.22	safe
24	SOUTH GARO HILLS	Chokpot	43800	16686	5374.98	537.5	4837.48	0	0	48.08547047	48.09	52.64	4784.84	0.99	safe
25	SOUTH GARO HILLS	Gasuapara	42000	16366	6054.26	605.43	5448.83	0	0	56.46444348	56.47	62.26	5386.56	1.04	safe
26	SOUTH GARO HILLS	Rongara	58700	17440	7276.1	727.61	6548.49	0	0	46.29085724	46.29	52.09	6496.4	0.71	safe
27	WEST JAINTIA HILLS	Amlarem	39800	17583	3292	329.2	2962.8	0	0	30.17528312	30.18	32.51	2930.29	1.02	safe
28	WEST JAINTIA HILLS	Laskein	47640	19117	3084.82	308.48	2776.34	0	0	239.704978	239.71	276.18	2500.15	8.63	safe
29	WEST JAINTIA HILLS	Thadlaskein	90460	42486	4879.55	487.96	4391.59	0	0	308.9842835	308.98	358.6	4032.99	7.04	safe
30	NORTH GARO HILLS	Kharkutta	43500	13130	3589.02	447.39	3141.63	0	0	134.6823123	134.69	151.46	2990.16	4.29	safe
31	NORTH GARO HILLS	Resubelpara	72500	23901	6379.4	1170.22	5209.18	0	0	264.8936664	264.9	287.86	4921.31	5.09	safe
32	EAST KHASI HILLS	Mawphlang	30153	10183	2328.11	232.81	2095.3	0	0	59.22260961	59.22	66.65	2028.65	2.83	safe
33	EAST KHASI HILLS	Pynursla	41411	12059	3895.72	389.57	3506.15	0	0	16.51577783	16.51	17.61	3488.55	0.47	safe
34	EAST KHASI HILLS	Mawkynrew	34594	11292	2907.95	290.8	2617.15	0	0	41.805958	41.8	46.87	2570.29	1.60	safe
35	EAST KHASI HILLS	Khatarshnong Laitkroh	32394	12835	2970.05	297	2673.05	0	0	57.25319037	57.25	67.15	2605.9	2.14	safe
36	EAST KHASI HILLS	Mawryngkneng	28552	10564	2271.12	227.12	2044	0	0.9	104.8582033	105.75	119.77	1923.34	5.17	safe
37	EAST KHASI HILLS	Mawsynram	50964	14733	4093.1	409.31	3683.79	0	0	53.71895216	53.72	57.31	3626.48	1.46	safe
38	EAST KHASI HILLS	Mylliem	21533	8143	1525.55	152.56	1372.99	0	1.2	208.8099073	210.01	246.23	1125.56	15.30	safe
39	EAST KHASI HILLS	Shella Bholaganj	35199	10513	3122.11	312.21	2809.9	0	0	47.3742244	47.38	52	2757.89	1.69	safe

ANNEXURE 1

DYNAMIC GROUND WATER RESOURCES OF MEGHALAYA , 2023															
MEGHALAYA (in BCM)															
		Ground Water Recharge							Current Annual Ground Water Extraction						
		Monsoon Season		Non-Monsoon Season											
S.NO	NAME OF STATE/UT	Recharge from rainfall	Recharge from other Sources	Recharge from Rainfall	Recharge from other Sources	Total Annual Ground Water Recharge	Total Natural Discharges	Annual Extractable Ground Water Resource	Irrigation	Industrial	Domestic	Total	Annual GW Allocation for Domestic use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction(%)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Meghalaya	1.32	0.05	0.42	0.04	1.83	0.32	1.51	0.02	0	0.04	0.07	0.05	1.43	4.58
	Total(BCM)	1.32	0.05	0.42	0.04	1.83	0.32	1.51	0.02	0	0.04	0.07	0.05	1.43	4.58

ANNEXURE 2 - District wise Ground Water Resources of Meghalaya (in Ham)

DYNAMIC GROUND WATER RESOURCES OF MEGHALAYA, 2023																
MEGHALAYA (in Ham)																
S.NO	Name of District	Ground Water Recharge				Total Annual Ground Water Recharge	Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction				Annual GW Allocation for Domestic use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction(%)
		Monsoon Season		Non-Monsoon Season					Irrigation	Industrial	Domestic	Total			
		Recharge from rainfall	Recharge from other Sources	Recharge from Rainfall	Recharge from other Sources										
1	EAST GARO HILLS	5944.69	574.89	1795.66	669.38	8984.62	898.46	8086.16	0	0	332.03	332.02	368.38	7717.78	4.11
2	EAST JAINTIA HILLS	12480.85	91.2	4292.83	88.71	16953.59	1695.37	15258.22	0	0	186.02	186.02	211.46	15046.76	1.22
3	EAST KHASI HILLS	17237.26	386.76	5108.86	380.83	23113.71	2311.38	20802.33	0	2.1	589.56	591.64	673.59	20126.66	2.84
4	NORTH GARO HILLS	6013.23	2061.23	1325	568.96	9968.42	1617.61	8350.81	0	0	399.58	399.59	439.32	7911.47	4.79
5	RI BHOI	5042.91	133.03	1330.29	114.69	6620.92	662.1	5958.82	0	22.49	307.32	329.81	349.65	5586.68	5.53
6	SOUTH GARO HILLS	16789.14	49.99	6616	46.25	23501.38	2350.15	21151.23	0	0	246.46	246.47	272.05	20879.17	1.17
7	SOUTH WEST GARO HILLS	4684.43	165.38	1857.49	223.29	6930.59	3533.95	3396.64	511.92	0	249.59	761.51	258.33	2626.4	22.42
8	SOUTH WEST KHASI HILLS	11468.86	202.88	2625.09	61.02	14357.85	1435.78	12922.07	0	0	132.31	132.32	147.29	12774.77	1.02
9	WEST GARO HILLS	22130.06	398.92	6532.95	674.04	29735.97	13567.7	16168.27	1933.2	0.6	966.69	2900.49	1071.79	13162.68	17.94
10	WEST JAINTIA HILLS	7879.86	107.62	3194.72	74.17	11256.37	1125.64	10130.73	0	0	578.86	578.87	667.29	9463.43	5.71
11	WEST KHASI HILLS	22567.36	1316.88	7018.54	803.08	31705.86	3170.59	28535.27	0	0	443.18	443.19	497.18	28038.08	1.55
	Total(Ham)	132238.65	5488.78	41697.43	3704.42	183129.28	32368.73	150760.55	2445.12	25.19	4431.61	6901.93	4956.33	143333.88	4.58
	Total(Bcm)	1.32	0.05	0.42	0.04	1.83	0.32	1.51	0.02	0	0.04	0.07	0.05	1.43	4.58

ANNEXURE 3A

CATEGORIZATION OF BLOCKS/ MANDALS/ TALUKAS IN INDIA (2023)												
			Safe		Semi-Critical		Critical		Over-Exploited		Saline	
S.No	States / Union Territories	Total No. of Assessed Units	Nos.	%	Nos.	%	Nos.	%	Nos.	%	Nos.	%
1	MEGHALAYA	39	39	100.0	-	-	-	-	-	-	-	-
	Grand Total	39	39	100.0	-	-	-	-	-	-	-	-

ANNEXURE 3B

DYNAMIC GROUND WATER RESOURCES OF MEGHALAYA, 2023												
MEGHALAYA												
			Safe		Semi-Critical		Critical		Over-Exploited		Saline	
S.No	Name of District	Total No. of Assessed Units	No	%	No.	%	No.	%	No.	%	No.	%
1	EAST GARO HILLS	3	3	100.0	-	-	-	-	-	-	-	-
2	EAST JAINTIA HILLS	2	2	100.0	-	-	-	-	-	-	-	-
3	EAST KHASI HILLS	8	8	100.0	-	-	-	-	-	-	-	-
4	NORTH GARO HILLS	2	2	100.0	-	-	-	-	-	-	-	-
5	RI BHOI	3	3	100.0	-	-	-	-	-	-	-	-
6	SOUTH GARO HILLS	4	4	100.0	-	-	-	-	-	-	-	-
7	SOUTH WEST GARO HILLS	2	2	100.0	-	-	-	-	-	-	-	-
8	SOUTH WEST KHASI HILLS	2	2	100.0	-	-	-	-	-	-	-	-
9	WEST GARO HILLS	6	6	100.0	-	-	-	-	-	-	-	-
10	WEST JAINTIA HILLS	3	3	100.0	-	-	-	-	-	-	-	-
11	WEST KHASI HILLS	4	4	100.0	-	-	-	-	-	-	-	-
	Total	39	39	100.0	-	-	-	-	-	-	-	-

ANNEXURE 3 C

ANNUAL EXTRACTABLE RESOURCE OF ASSESSMENT UNITS UNDER DIFFERENT CATEGORIES, 2023										
S.No	State/Union Territories	Total Annual Extractable Resource of Assessed Units (in mcm)	Safe		Semi-Critical		Critical		Over-Exploited	
			Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%
1	**MEGHALAYA**	1507.61	1507.61	100	-	-	-	-	-	-
	Grand Total (in mcm)	1507.61	1507.61	100	-	-	-	-	-	-

ANNEXURE 3 D

DYNAMIC GROUND WATER RESOURCES OF MEGHALAYA, 2023										
S.No	Name of District	Total Annual Extractable Resource of Assessed Units (in mcm)	Safe		Semi-Critical		Critical		Over-Exploited	
			Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%	Total Annual Extractable Resource (in mcm)	%
1	**SOUTH WEST KHASI HILLS**	129.22	129.22	100	-	-	-	-	-	-
2	**SOUTH WEST GARO HILLS**	33.97	33.97	100	-	-	-	-	-	-
3	**WEST GARO HILLS**	161.68	161.68	100	-	-	-	-	-	-

4	**EAST GARO HILLS**	80.86	80.86	100	-	-	-	-	-	-
5	**EAST JAINTIA HILLS**	152.58	152.58	100	-	-	-	-	-	-
6	**WEST KHASI HILLS**	285.35	285.35	100	-	-	-	-	-	-
7	**RI BHOI**	59.59	59.59	100	-	-	-	-	-	-
8	**SOUTH GARO HILLS**	211.51	211.51	100	-	-	-	-	-	-
9	**WEST JAINTIA HILLS**	101.31	101.31	100	-	-	-	-	-	-
10	**EAST KHASI HILLS**	208.02	208.02	100	-	-	-	-	-	-
11	**NORTH GARO HILLS**	83.51	83.51	100	-	-	-	-	-	-
	Grand Total (in mcm)	1507.61	1507.61	100	-	-	-	-	-	-

ANNEXURE 3 E

AREA OF ASSESSMENT UNITS UNDER DIFFERENT CATEGORIES (2023)													
				Safe		**Semi-Critical**		**Critical**		**Over-Exploited**		**Saline**	
S.No	**States / Union Territories**	**Total Recharge Worthy Areaof Assessed Units (in sq km)**	**Recharge Worthy Area (in sq km)**	**Recharge Worthy Area in sq km**	**%**	**Recharge Worthy Area in sq km**	**%**	**Recharge Worthy Area in sq km**	**%**	**Recharge Worthy Area in sq km**	**%**	**Recharge Worthy Area in sq km**	**%**
1	**MEGHALAYA**	22429	8171.35	8171.35	100	-	-	-	-	-	-	-	-
	Total (in sq.km)	22429	8171.35	8171.35	100	-	-	-	-	-	-	-	-

ANNEXURE 3 F

DYNAMIC GROUND WATER RESOURCES OF MEGHALAYA, 2023												
MEGHALAYA												
S.No	Name of District	Total Recharge Worthy Area of Assessed Units (in sq.km)	Safe		Semi-Critical		Critical		Over-Exploited		Saline	
			Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%
1	**SOUTH WEST KHASI HILLS**	485.37	485.37	100.0	-	-	-	-	-	-	-	-
2	**SOUTH WEST GARO HILLS**	425.2	425.2	100.0	-	-	-	-	-	-	-	-
3	**WEST GARO HILLS**	1277.84	1277.84	100.0	-	-	-	-	-	-	-	-
4	**EAST GARO HILLS**	502.15	502.15	100.0	-	-	-	-	-	-	-	-
5	**EAST JAINTIA HILLS**	827.35	827.35	100.0	-	-	-	-	-	-	-	-
6	**WEST KHASI HILLS**	1239.7	1239.7	100.0	-	-	-	-	-	-	-	-
7	**RI BHOI**	688.78	688.78	100.0	-	-	-	-	-	-	-	-
8	**SOUTH GARO HILLS**	659.57	659.57	100.0	-	-	-	-	-	-	-	-
9	**WEST JAINTIA HILLS**	791.86	791.86	100.0	-	-	-	-	-	-	-	-
10	**EAST KHASI HILLS**	903.22	903.22	100.0	-	-	-	-	-	-	-	-
11	**NORTH GARO HILLS**	370.31	370.31	100.0	-	-	-	-	-	-	-	-
	Total (in sq.km)	8171.35	8171.0	100.0	-	-	-	-	-	-	-	-

ANNEXURE 4A

CATEGORISATION OF ASSESSMENT UNIT, 2023							
MEGHALAYA							
S.NO	Name of District	S.NO	Name of Semi-Critical Assessment Units	S.NO	Name of Critical Assessment Units	S.NO	Name of Over-Exploited Assessment Units
ABSTRACT							
Total No. of Assessed Units		Number of Semicritical Assessment Units		Number of Critical Assessment Units		Number of Over Exploited Assessment Units	
39		0		0		0	

ANNEXURE 4 B

QUALITY PROBLEMS IN ASSESSMENT UNITS, 2023							
MEGHALAYA							
S.NO	Name of District	S.NO	Name of Assessment Units affected by Fluoride	S.NO	Name of Assessment Units affected by Arsenic	S.NO	Name of Assessment Units affected by Salinity
ABSTRACT							
Total No. of Assessed Units		Number of Assessment Units affected by Fluoride		Number of Assessment Units affected by Arsenic		Number of Assessment Units affected by Salinity	
39		0		0		0	

AANEXURE 5 A

State-Wise Summary Of Assessment Units Improved Or Deteriorated From 2022 To 2023 Assessment				
S.No	Name of States / Union Territories	Number of Assessment Units Improved	Number of Assessment Units Deteriorated	Number of Assessment Units With No Change
1	MEGHALAYA	0	0	39

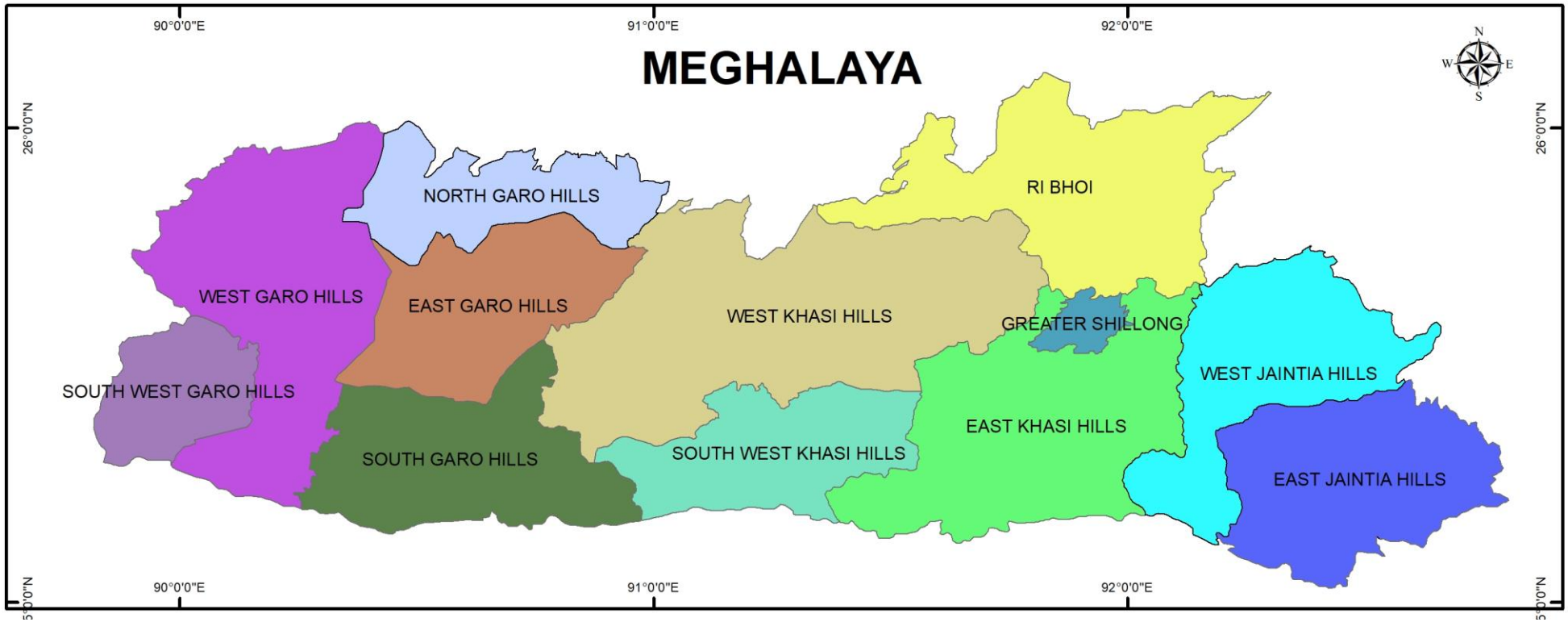
ANNEXURE 5 B

COMPARISON OF CATEGORIZATION OF ASSESSMENT UNITS (2022 & 2023)									
MEGHALAYA									
S.No	**Name of District**	**Name of Assessment Unit (district)**	**Stage of Ground Water Extraction (%) 2022**	**Categorization in 2022**	**Name of District**	**Name of Assessment Unit (Block)**	**Stage of Ground Water Extraction (%) 2023**	**Categorization in 2023**	**Remark**
1	SOUTH WEST KHASI HILLS	SOUTH WEST KHASI HILLS	1.71	Safe	SOUTH WEST KHASI HILLS	Mawkyrwat	2.07	Safe	
2					SOUTH WEST KHASI HILLS	Ranikor	0.42	Safe	
3	SOUTH WEST GARO HILLS	SOUTH WEST GARO HILLS	17.65	Safe	SOUTH WEST GARO HILLS	Zikzak	11.71	Safe	
4					SOUTH WEST GARO HILLS	Betasing	29.52	Safe	
5	WEST GARO HILLS	WEST GARO HILLS	4.15	Safe	WEST GARO HILLS	Gambegre	3.17	Safe	
6					WEST GARO HILLS	Dadenggiri	5.99	Safe	
7					WEST GARO HILLS	Dalu	3.88	Safe	
8					WEST GARO HILLS	Rongram	7.15	Safe	
9					WEST GARO HILLS	Selsella	35.69	Safe	
10					WEST GARO HILLS	Tikrikilla	10.32	Safe	

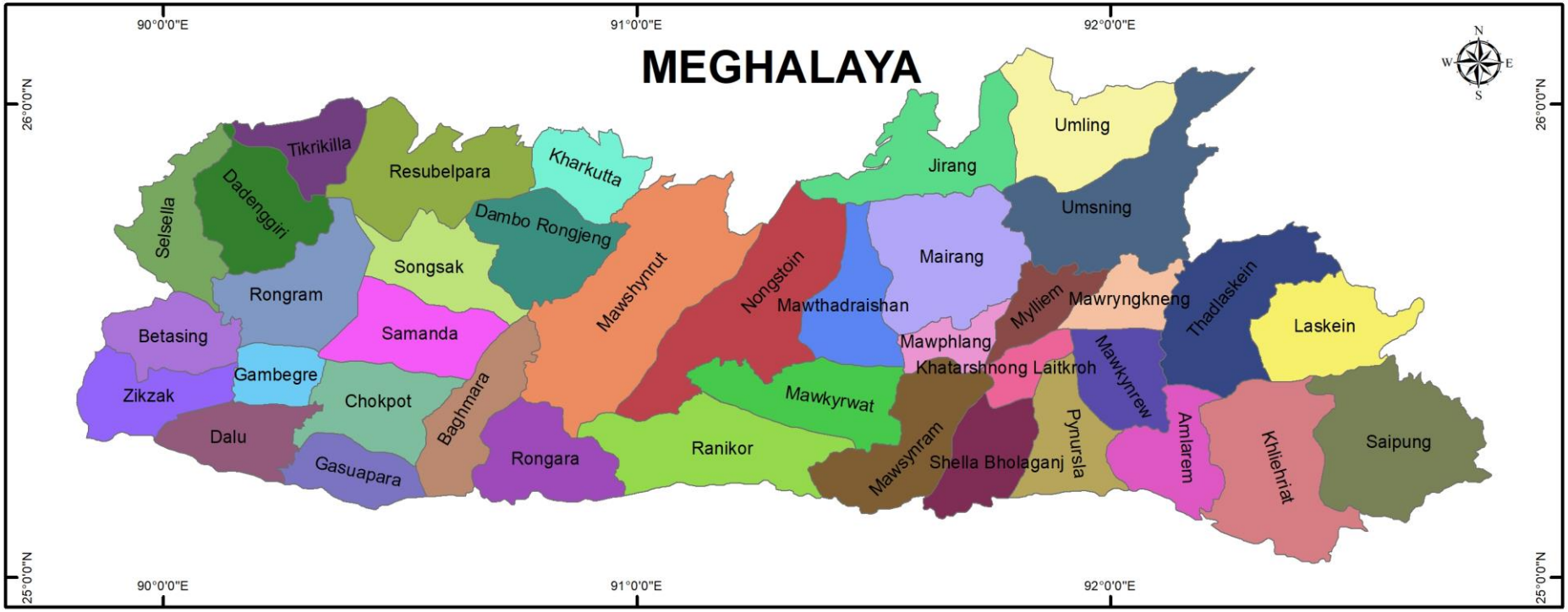
S.No	Name of District	Name of Assessment Unit	Stage of Ground Water Extraction (%) 2022	Categorization in2022	Name of District	Name of Assessment Unit	Stage of Ground Water Extraction (%) 2023	Categorization in 2023	Remark
11	EAST GARO HILLS	EAST GARO HILLS	6.93	Safe	EAST GARO HILLS	Samanda	2.63	Safe	
12					EAST GARO HILLS	Dambo Rongjeng	5.32	Safe	
13					EAST GARO HILLS	Songsak	4.85	Safe	
14	EAST JAINTIA HILLS	EAST JAINTIA HILLS	2.28	Safe	EAST JAINTIA HILLS	Khliehriat	1.27	Safe	
15					EAST JAINTIA HILLS	Saipung	1.13	Safe	
16	WEST KHASI HILLS	WEST KHASI HILLS	1.74	Safe	WEST KHASI HILLS	Mawthadraishan	2.15	Safe	
17					WEST KHASI HILLS	Mairang	2.02	Safe	
18					WEST KHASI HILLS	Mawshynrut	1.25	Safe	
19					WEST KHASI HILLS	Nongstoin	1.36	Safe	
20	RI BHOI	RI BHOI	6.17	Safe	RI BHOI	Jirang	3.14	Safe	
21					RI BHOI	Umling	9.58	Safe	
22					RI BHOI	Umsning	4.96	Safe	
23	SOUTH GARO HILLS	SOUTH GARO HILLS	1.59	Safe	SOUTH GARO HILLS	Baghmara	2.22	Safe	
24					SOUTH GARO HILLS	Chokpot	0.99	Safe	
25					SOUTH GARO HILLS	Gasuapara	1.04	Safe	
26					SOUTH GARO HILLS	Rongara	0.71	Safe	

S.No	Name of District	Name of Assessment Unit	Stage of Ground Water Extraction (%) 2022	Categorization in2022	Name of District	Name of Assessment Unit	Stage of Ground Water Extraction (%) 2023	Categorization in 2023	Remark
27	WEST JAINTIA HILLS	WEST JAINTIA HILLS	4.46	Safe	WEST JAINTIA HILLS	Amlarem	1.02	Safe	
28					WEST JAINTIA HILLS	Laskein	8.63	Safe	
29					WEST JAINTIA HILLS	Thadlaskein	7.04	Safe	
30	NORTH GARO HILLS	NORTH GARO HILLS	3.59	Safe	NORTH GARO HILLS	Kharkutta	4.29	Safe	
31					NORTH GARO HILLS	Resubelpara	5.09	Safe	
32	EAST KHASI HILLS	EAST KHASI HILLS	2.58	Safe	EAST KHASI HILLS	Mawphlang	2.83	Safe	
33					EAST KHASI HILLS	Pynursla	0.47	Safe	
34					EAST KHASI HILLS	Mawkynrew	1.60	Safe	
35					EAST KHASI HILLS	Khatarshnong Laitkroh	2.14	Safe	
36					EAST KHASI HILLS	Mawryngkneng	5.17	Safe	
37					EAST KHASI HILLS	Mawsynram	1.46	Safe	
38					EAST KHASI HILLS	Shella Bholaganj	1.69	Safe	
39		GREATER SHILLONG	12.34	Safe	EAST KHASI HILLS	Mylliem	15.30	Safe	

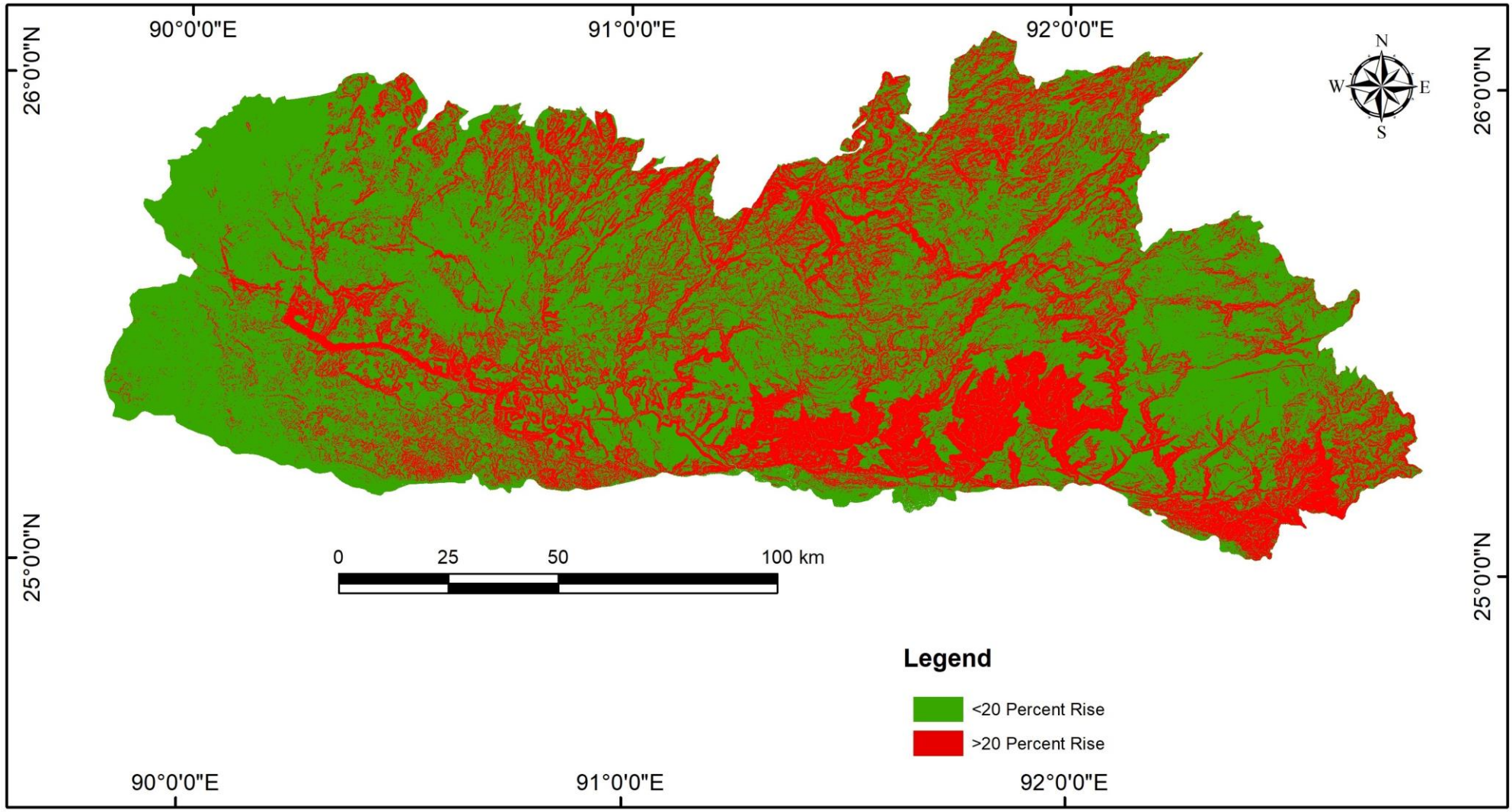
MAP 1: ASSESSMENT UNIT MAP (Prior to 2023)



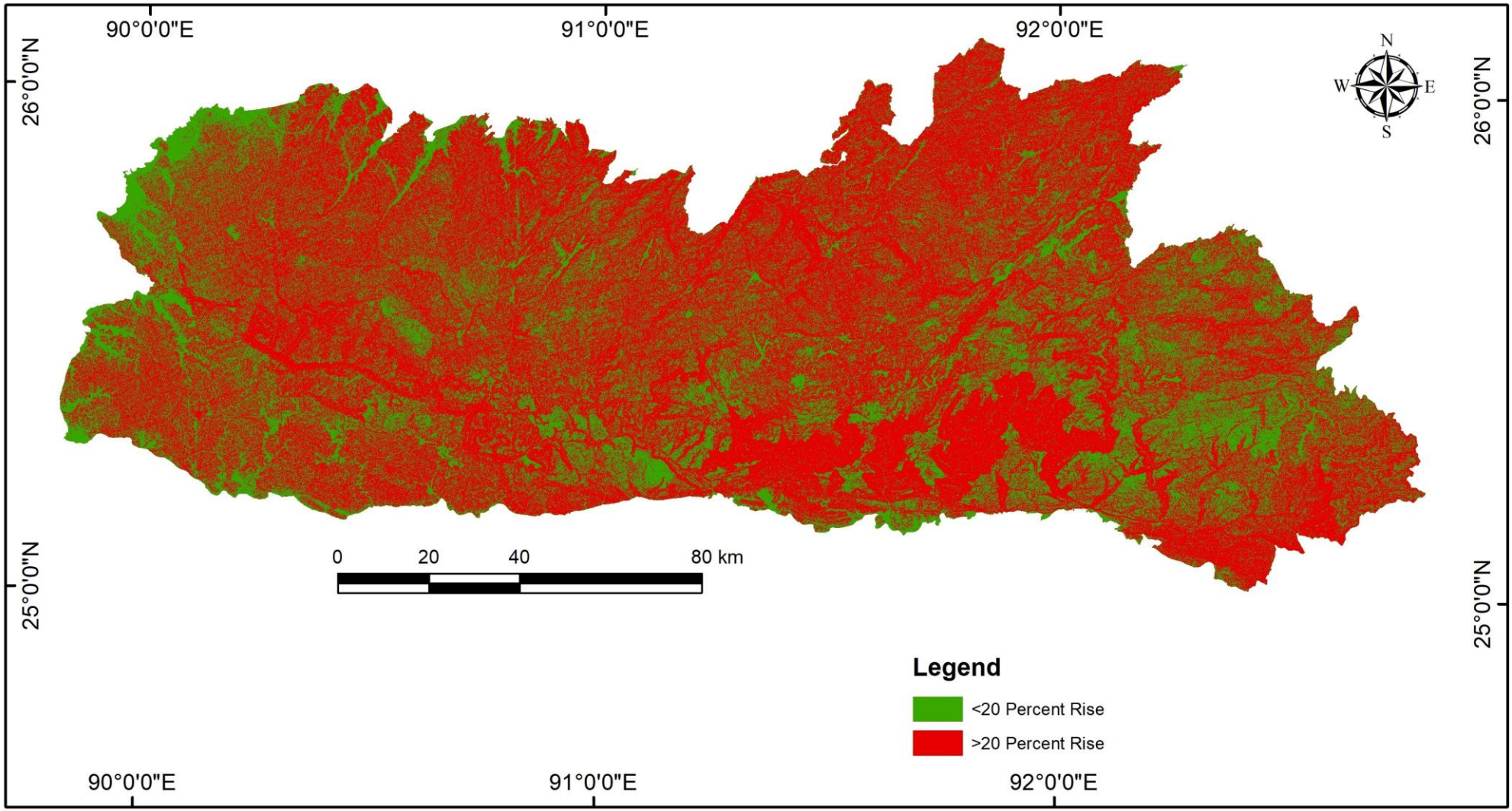
MAP 2: ASSESSMENT UNIT MAP (in 2023)



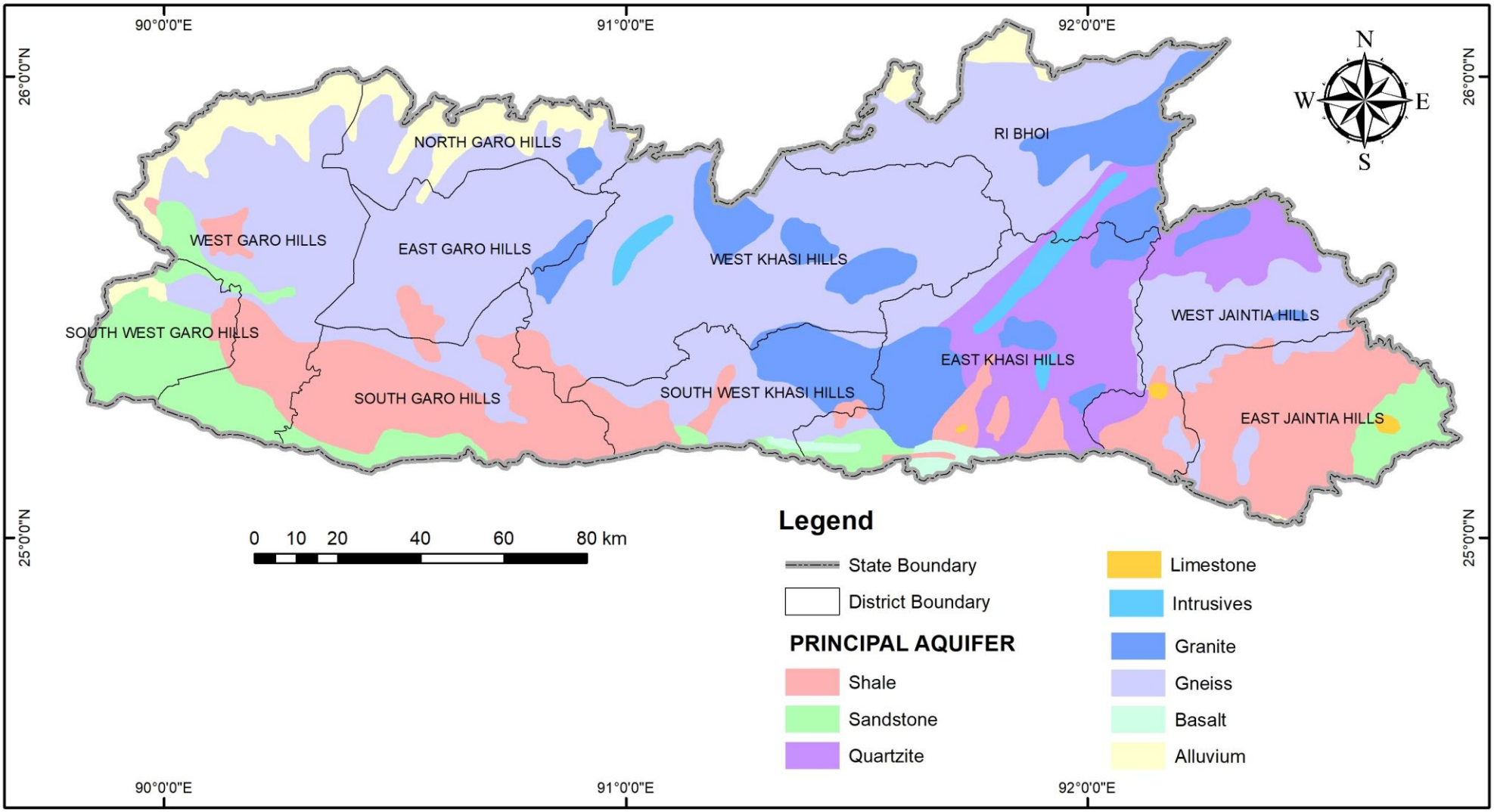
MAP 3: SLOPE MAP (30 m resolution ASTER DEM/ SRTM data)



MAP 4: SLOPE MAP (10 m resolution CARTOSAT DEM data)



MAP 5: PRINCIPAL AQUIFER MAP (1:250000 scale)



MAP 6: PRINCIPAL AQUIFER MAP (1:50000 scale)