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DYNAMIC GROUND WATER RESOURCES OF ANDAMAN AND NICOBAR, 2024

Central Ground Water Board
Department of Water Resources,
River Development & Ganga Rejuvenation
Ministry of Jal Shakti
Government of India

Kolkata
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Message

Groundwater is the key resource for India's agricultural and drinking water security. Though groundwater is dynamic and replenishable natural resource, extensive extraction is causing an alarming decline in water levels. Scientific assessment of the availability of groundwater resources provides the basic input for planning sustainable management interventions. Central Ground Water Board (CGWB), in collaboration with Andaman Public Work Department (APWD), conducts regular assessments of groundwater resources every year. These assessments serve as the basis for guiding the management and regulation of groundwater resources in the state. These assessments also serve as the foundation for planning various groundwater management interventions, which may include initiatives such as artificial recharge etc. Present assessment of groundwater resources is based on the Groundwater Estimation Methodology of 2015 (GEC-2015), which comprehensively factors in all relevant parameters contributing to groundwater recharge and extraction.

The Dynamic Groundwater Resource Assessment of 2024 (GWRA-2024) for Andaman and Nicobar Islands is a collaborative effort involving Andaman Public Work Department (APWD) and the Central Ground Water Board, Eastern Region. I extend my congratulations to all of them. I also appreciate the valuable contributions of the State Level Committee (SLC) for their guidance in timely completion of the assessment. It is very much anticipated that this compilation will prove to be of immense value to administrators, planners, and all other stakeholders engaged in formulating strategies and interventions aimed at ensuring the long-term sustainability of groundwater.

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Central Ground Water Board

PREFACE

The Andaman & Nicobar Islands comprises of arc-shaped chain of islands in the Bay of Bengal. They are characterized by undulating rugged topography, steep slope, low infiltration capacity and close proximity of hills to the sea. Entire chain of islands is occupied by varied rock types like marine sedimentary rocks, extrusive and intrusive igneous rocks and coralline limestone. Marine sedimentary rocks cover about 70% area of the total geographical area of islands. The igneous and sedimentary groups of rocks which cover the rest of the geographical area are fractured and fissured because of their active seismo-tectonic nature.

As per 2011 Census, out of 572 islands present in the Andaman and Nicobar group of islands in the Union Territory of Andaman & Nicobar Islands, about 29 are inhabited. The islands receive on an average 3000 mm rainfall per annum, but steeper slopes do not facilitate adequate recharge to the sub-surface aquifer(s).

In rural areas of Andaman group of Islands & Great Nicobar Island springs are dependable source of drinking water, while in Neil, Havelock, Long island, Little Andaman islands in Andaman group and in major parts of Nicobar group of islands, water supply is catered through dug wells. Although the major rock formation i.e. the sedimentary rock formation possesses fractures, but they do not form potential aquifers both in shallow and deeper horizons due to their non-pervasive nature, preponderance of clayey minerals often resulting in clogging of fractures. Dug wells constructed in the weathered horizons have meager yields. In the valley areas, dug wells are constructed which are used as a supplementary sources of drinking water in the rural areas of Andaman group of islands. The water supply to Port Blair city is met from the Dhanikhari Dam whose supply is often shattered with the recession of the monsoon rainfall. The scattered dug wells in the city often play a vital role to overcome the severe water crisis. These sources of ground water are becoming polluted by the anthropogenic activities. The loss in surface area in some of the highly earthquake devastated islands during 26th December 2004 have made possible changes in freshwater volume in the islands.

Scientific utilization of groundwater in this Island territory needs periodic assessment of ground water resources, to manage changing demography, irrigation use and emerging tourism sector. This also warrants an evaluation of the availability, demand and projected demand scenarios of ground water in the islands. However, ground water being at the state of constant flow, assessment procedure becomes highly complicated involving several variables, which are not possible to measure directly. Nevertheless, the effort towards estimation of ground water resources is also to obtain a synoptic view of the existing status of ground water scenario of the A&N islands, which is pivotal for formulation of developmental strategies and proper planning.

As per the present assessment, the total Annual Ground Water Recharge of the A&N Islands have been assessed as 0.38 bcm and Annual Extractable Ground Water Recharge is assessed as 0.34 bcm. The Annual Ground Water extraction is 0.0071 bcm, which translates to a Stage of Ground Water Extraction of 2.08 %. Out of 36 assessment units (Islands), one (01) is Hilly, thirty-five (35) are 'Safe' and one (01) is 'Saline'. Additionally, the GWRE figures obtained from these assessment units were clubbed into their respective administrative blocks and further into respective districts to obtain the final computation of the whole Union Territory. There is no significant change with respect to 2022 assessment. The figures have been duly ratified, approved and adopted by the State Level Committee (SLC) via Online Meeting, held on 07.10.2024.

This report is the outcome of the efforts made by Shri Dr. Indranil Roy, Scientist-'D' (Hydrogeology), and Dr Nilamoni Barman, Scientist- 'C' (Hydrometeorology), Central Ground Water Board, Eastern Region with technical contribution, co-operation and timely inputs from APWD, Andaman & Nicobar Administration

Place : Kolkata
Date :24.01.2025

(**Dr. Anadi Gayen**)
Regional Director
Central Ground Water Board, Eastern Region, Kolkata
& Member Secretary, SLC for GWRE 2023, A & N Islands

Content

DYNAMIC GROUND WATER RESOURCES OF ANDAMAN AND NICOBAR, 2024

AT A GLANCE

Total Annual Ground Water Recharge	37965.72 ham
Annual Extractable Ground Water Resources	34169.14 ham
Annual Ground Water Extraction	706.42 ham
Stage of Ground Water Extraction	2.08%

CATEGORIZATION OF ASSESSMENT UNITS

(Blocks/ Mandals/ Taluks)

Sl.No	Category	Number of Assessment Units		Recharge worthy Area		Annual Extractable Ground Water Resource	
		Number	**%**	**in lakh sq. km**	%	**(in bcm)**	%
1	Safe	35	97.2%	4106.14	35%	0.341	90.4%
2	Semi Critical	NA	NA	NA	NA	NA	NA
3	Critical	NA	NA	NA	NA	NA	NA
4	Over-Exploited	NA	NA	NA	NA	NA	NA
5	Saline	1	2.7%	8.28	0.07%	0.003	89%
	TOTAL	**36**		**4114.42**		**0.344**	

EXECUTIVE SUMMARY

India is the largest user of groundwater in the world with a fourth of the total global withdrawal. Indian cities cater to about 48% of its water supply from groundwater. Hence, there is dire need to know the updated resource position for proper management of the groundwater resource. Groundwater Resource Assessment refers to the process of evaluating the quantity and quality of groundwater to determine its sustainability and usage. In India, State Ground Water Departments and Central Ground Water Board carry out Ground Water Resource Assessment at periodical intervals as a joint exercise under the guidance of the respective State Level Committee and under the overall supervision of the Central Level Expert Group (CLEG). The assessment process involves computation of dynamic ground water resources or Annual Extractable Ground Water Resource, Total Current Annual Ground Water Extraction (utilization) and the percentage of utilization with respect to annual extractable resources (Stage of Ground Water Extraction). The assessment units (blocks) are categorized based on Stage of Ground Water Extraction, which are then validated with long-term water level trends. The assessment prior to that of year 2017 were carried out following Ground Water Estimation Committee (GEC) 97 Methodology, whereas from 2017 onwards assessment are based on norms and guidelines of the GEC 2015 Methodology. Previous estimates of groundwater resources in West Bengal used GEC'97 methodology in 2004, 2008-09, 2010-11, and 2012-13, and the GEC'15 methodology in 2021-22 and 2022-23.

Present estimation of groundwater resources in Andaman and Nicobar Islands for the current assessment year (2024) started as per instruction of CHQ, CGWB referring Ministry of Jal Shakti notification. The State Level Committee for Ground Water Assessment (SLGWAC) formed "Groundwater Resource Assessment Cell" and "Working Group" for Dynamic Groundwater Resources Re-Assessment of Andaman and Nicobar Islands vide Order No.3462, dated 09.11.2018. The working group finalized the report in consultation of other members of the committee and prepared the report. Under the Chairmanship of Secretary, APWD, Govt. of Andaman and Nicobar, SLGWAC approved the report as an outcome of the meeting dated 07.10.2024. Further, CLEG reviewed and approved the groundwater resource assessment of West Bengal on October 07, 2024.

The ground water resource assessment (in 2024) for the State of West Bengal is carried out as per GEC 2015 guidelines through 'IN-GRES', with blocks as primary assessment units. IN-GRES is a software/web-based application developed by Central Ground Water Board (CGWB) in collaboration with Indian Institute of Technology Hyderabad for assessment of ground water resources.

Present assessment covered all 09 blocks of Andaman and Nicobar islands. The estimated total annual groundwater recharge is 0.38 billion cubic meters (bcm), while the annual extractable groundwater resource is 0.34 bcm. Estimated current annual groundwater extraction for all uses is 00.0071 bcm, resulting in a stage of groundwater extraction (SGWE) of 2.08%. Based on the present assessment categorization scheme:

- 35 islands (sub-assessment units) are classified as Safe;
- 01 island is saline;

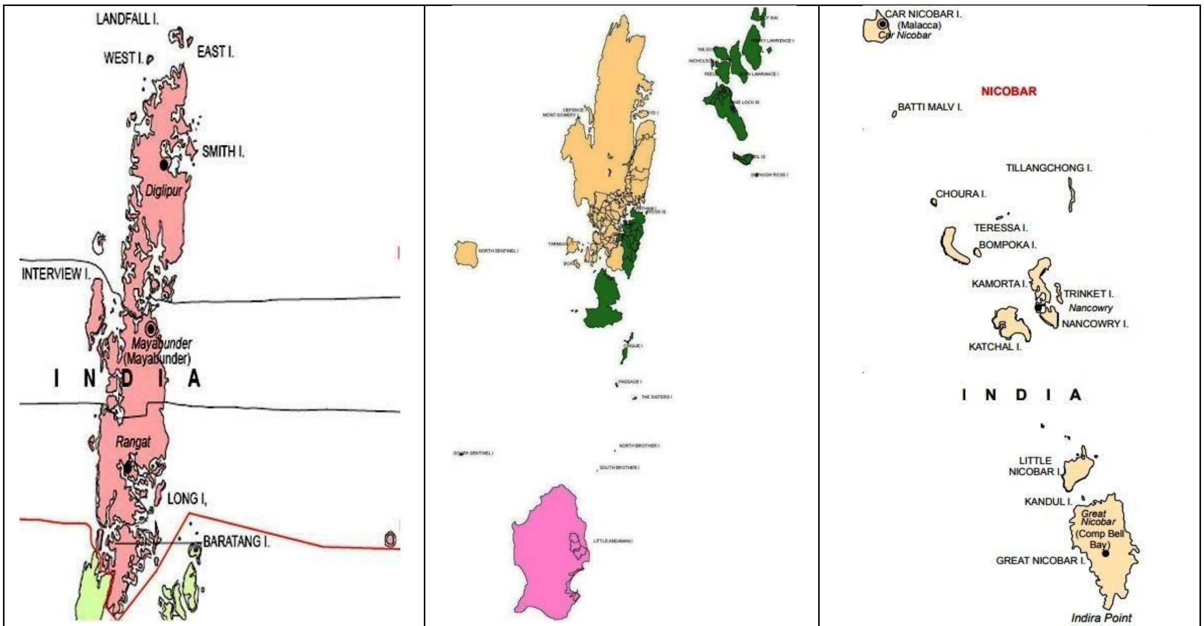
Compared to the previous assessment in 2023, the 2024 assessment shows an increase in the SGWE from 1.37% to 2.08%, primarily attributed to increase in tourism and few industries in Port Blair, Mayabundar and Diglipur area.

CHAPTER-1

INTRODUCTION

1.1 Background for estimating the total ground water resources of the Union Territory

The Union Territory of Andaman and Nicobar Islands forms North - South trending archipelago in the far flung maritime areas of Bay of Bengal. It lies between the North Latitudes of 6° and 14° East Longitudes of 92° and 94°, covering an approximate geographical area of 8,249 sq. km. There are three (3) Districts comprising nine (9) Blocks/Tehsils. The islands form two major groups, popularly known as Andaman Group or Northern Group of Islands which constitutes Andaman District where as the other group is called Nicobar or Southern Group of Islands constitute the Nicobar District. Andaman and Nicobar Group of Islands constitute this Union Territory(Figure– 1.1). As per 2011 census the population of Andaman & Nicobar Island is 3,80,591.



North & Middle Andaman District	**South Andaman District**	**Nicobar District**

Figure–1.1: Administrative map showing District wise major islands of Andaman and Nicobar Islands

The Andaman & Nicobar Islands comprises of arc-shaped chain of islands in the Bay of Bengal. They are characterized by undulating rugged topography, steep slope, low infiltration capacity and close proximity of hills to the sea. Entire chains of islands are occupied by varied rock types like marine sedimentary rocks, extrusive and intrusive igneous rocks and coralline limestone. Marine sedimentary rocks cover about 70% area of the total geographical area of islands. The igneous and sedimentary groups of rocks which cover the rest of the geographical area are fractured and fissured because of their active seismo-tectonic nature.

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In rural areas of Andaman group of Islands & Great Nicobar Island springs are dependable source of drinking water, while in Neil, Havelock, Long island, Little Andaman islands in Andaman group and in major parts of Nicobar group of islands, water supply is catered through dug wells. Although the major rock formation i.e. the sedimentary rock formation possesses fractures, but they do not form potential aquifers both in shallow and deeper horizons due to their non-pervasive nature, preponderance of clayey minerals often resulting in clogging of fractures. Dug wells constructed in the weathered horizons have meager yields. In the valley areas, dug wells are constructed which are used as a supplementary sources of drinking water in the rural areas of Andaman group of islands. The water supply to Port Blair city is met from the Dhanikhari Dam whose supply is often shattered with the recession of the monsoon rainfall. The scattered dug wells in the city often play a vital role to overcome the severe water crisis.

With passage of time - these sources of ground water are becoming polluted by the anthropogenic activities. The loss in surface area in some of the highly earthquake devastated islands during 26th December 2004 have made possible changes in freshwater volume in the islands.

Scientific utilization of groundwater in this Island territory needs periodic assessment of ground water resources, to manage changing demography, irrigation use and emerging tourism sector. This also warrants an evaluation of the availability, demand and projected demand scenarios of ground water in the islands. However, ground water being at the state of constant flow, assessment procedure becomes highly complicated involving several variables, which are not possible to measure directly. Nevertheless, the effort towards estimation of ground water resources is also to obtain a synoptic view of the existing status of ground water scenario of the A&N islands, which is pivotal for formulation of developmental strategies and proper planning.

Administrative Base map showing major islands of Andaman and Nicobar group of islands is shown in Figure-1.1 and Administrative set-up of Andaman and Nicobar Islands is depicted in Table-1.1.

Table-1.1: Administrative set-up of Andaman and Nicobar Islands

District	Name of Block/Tehsil	Islands
North and Middle Andaman	Mayabunder	North Andaman (Mayabunder Tehsil) Stewart Island Aves Island Interview Island
	Rangat	Middle Andaman North Passage Island Long Island Porlob Island Baratang Island Strait Island
	Diglipur	Peel island Narcondam Island East Island North Andaman (Diglipur Tehsil) Smith Island
South Andaman	Port Blair	Havelock Island John Lawrence Island Neil Island South Andaman (Port Blair Tehsil) Rutland Island North Sentinel Island Little Andaman Island
	Ferrargunj	South Andaman (Ferraganj Tehsil) Flat Bay Island Viper Island
Nicobar	Car Nicobar	Car Nicobar
	Nancowry	Chowra Tillangchang Teressa Bampooka Katchal Kamorta Nancowry Trinket Little Nicobar Kondul Pulo Milo Great Nicobar

1.1 Constitution of state-level committee for ground water resources estimation

By considering similarity of purpose, the Andaman and Nicobar Administration is of view to continue with earlier committee formed for dynamic water assessment 2017 & 2020 vide order No. 3462, dated 09.11.2018, in connection with reassessment of Dynamic

Ground Water Resource 2020 as desired by Ministry of water Resources, River Development & Ganga Rejuvenation, Central Ground Water Board vide Letter No. 29-20/2018-PWD/1266, dated 03.12.2020. In addition to this, it was decided that henceforth, this committee will act as regular State Level Committee (SLC) for all future periodic re-assessment of Ground Water Resources in Andaman & Nicobar Islands. This was communicated by Andaman Nicobar State Water and Sanitation Mission of APWD vide their Letter No. 1-20/ANSWSM/CGWB/2021-22/402 Dated 18.02.2022. The composition of the Committee is as under:

1.	Principal Secretary (PWD)	-	Chairman
2.	Secretary (Department of Science & Technology)	-	Member
3.	Chief Engineer, APWD	-	Member
4.	Superintending Hydrogeologist, CGWB	-	Member
5.	Director (Agriculture)	-	Member
6.	Director (Industries)	-	Member
7.	Director (ANSWSM), CE's Office, APWD	-	Member
8.	Representative from NABARD	-	Member
9.	Regional Director, CGWB	-	Member Secretary

- In A & N Islands, the resource is calculated by CGWB in the absence of R & D Department on GW in A & N Administration. CGWB renders all needful help in matter of Water Resource Development and Management, particularly GW to A & N Administration. APWD acts as the Nodal Agency of the U/T in matters of Ground Water.
- Since ground water is a scarce commodity in A & N Islands, as also in view of extreme population pressure on the Islands due to tourism boom, CGWB, Govt. of India has recommended GW Resource estimation in A & N Islands at a regular interval as in other parts of India.
- DoWR, RD & GR, MoJS, GoI had earlier desired to calculate the GW Resources of the entire country including A & N Islands.
- As per this norm, the State/UT-wise Dynamic Groundwater Resources are being estimated at regular interval on annual basis.
- The basic groundwater resource assessment unit is an Administrative block. In some cases i.e. in few north-eastern states, where block boundaries are not defined, the

assessment is done as per watershed basis.

- In A & N Islands, it is done island-wise for the inhabited islands. GWRE 2023 onwards, these primary assessment units are then clubbed into their respective administrative blocks and then subsequently into their respective districts and finally to the UT Level.

- The GW Resources of A & N Islands, being assessed, need to be put forward before a committee for their understanding it as also to know the status of GW Resource development in various inhabited Island.

- In A & N Islands, APWD is the nodal Stake holder Department beside others. Accordingly the name and head of various stake holder departments are proposed for constitution of a committee with the approval of the competent authority in A & N Administration.

- In view of above the task was given by DoWR, RD & GR, MoJS, GoI to CGWB for the needful.

- A & N Island falls under the jurisdiction of CGWB, Eastern Region, Kolkata, and in consultation with APWD, the calculation of Dynamic Groundwater Resources of A & N Islands was completed and placed before the empowered SLC on 07.10.2024, wherein it was unanimously approved and adopted.

CHAPTER 2

GROUND WATER RESOURCE ESTIMATION METHODOLOGY

Ground water resource as in 2024 have been estimated following the guidelines mentioned in the GEC 2015 methodology using appropriate assumptions depending on data availability. The principal attributes of GEC 2015 methodology are given below:

It is also important to add that as it is advisable to restrict the groundwater development as far as possible to annual replenishable resources, the categorization also considers the relation between the annual replenishment and groundwater development. An area devoid of ground water potential may not be considered for development and may remain safe whereas an area with good groundwater potential may be developed and may become over exploited over a period. Thus, water augmentation efforts can be successful in such areas, where the groundwater potential is high and there is scope for augmentation.

2.1. Ground Water Assessment of Unconfined Aquifer

Though the assessment of ground water resources includes assessment of dynamic and in-storage resources, the development planning should mainly focus on dynamic resource as it gets replenished on an annual basis. Changes in static or in-storage resources normally reflect long-term impacts of ground water mining. Such resources may not be replenishable annually and may be allowed to be extracted only during exigencies with proper planning for augmentation in the succeeding excess rainfall years.

2.1.1. Assessment of Annually Replenishable or Dynamic Ground Water Resources

The methodology for ground water resources estimation is based on the principle of water balance as given below –

$$\boldsymbol{Inflow - Outflow = Change\ in\ Storage(of\ an\ aquifer)} \ldots\ldots (\mathbf{1})$$

Equation (1) can be further elaborated as –

$$\boldsymbol{\Delta S = R_{RF} + R_{STR} + R_C + R_{SWI} + R_{GWI} + R_{TP} + R_{WCS} \pm VF \pm LF - GE - T - E - B} \ldots\ldots (\mathbf{2})$$

Where,

ΔS - Change is storage

R_{RF} - Rainfall recharge

R_{STR} - Recharge from stream channels

R_C - Recharge from canals

R_{SWI} - Recharge from surface water irrigation

R_{GWI} - Recharge from ground water irrigation

R_{TP} - Recharge from Tanks & Ponds

R_{WCS} - Recharge from water conservation structures

VF - Vertical flow across the aquifer system

LF - Lateral flow along the aquifer system (through flow)

GE - Ground Water Extraction

T - Transpiration

E - Evaporation

B - Base flow

Due to lack of data for all the components in most of the assessment units, at present the water budget has been assessed based on major components only, taking into consideration certain reasonable assumptions. The estimation has been carried out using lumped parameter estimation approach keeping in mind that data from many more sources if available may be used for refining the assessment.

2.1.1.1. Rainfall Recharge

Ground water recharge has been estimated on ground water level fluctuation and specific yield approach since this method considers the response of ground water levels to ground water input and output components. In units or subareas where adequate data on ground water level fluctuations are not available, ground water recharge is estimated using rainfall infiltration factor method only. The rainfall recharge during non-monsoon season has been estimated using rainfall infiltration factor method only.

2.1.1.1.1. Ground Water Level Fluctuation Method

The ground water level fluctuation method is used for assessment of rainfall recharge in the monsoon season. The ground water balance equation in non-command areas is given by

$$\boldsymbol{\Delta S = R_{RF} + R_{STR} + R_{SWI} + R_{GWI} + R_{TP} + R_{WCS} \pm VF \pm LF - GE - T - E - B \ldots\ldots\ldots\ldots\ldots\ldots\ldots..(3)}$$

Where,

ΔS - Change is storage

R_{RF} - Rainfall recharge

R_{STR} - Recharge from stream channels

R_{SWI} - Recharge from surface water irrigation

R_{GWI} - Recharge from ground water irrigation

R_{TP} - Recharge from Tanks& Ponds

R_{WCS} - Recharge from water conservation structures

VF - Vertical flow across the aquifer system

LF - Lateral flow along the aquifer system (through flow)

GE - Ground water extraction

T - Transpiration

E - Evaporation

B - Base flow

Whereas the water balance equation in command area have another term i.e., Recharge due to canals (R_C) and the equation is as follows:

$$\boldsymbol{\Delta S = R_{RF} + R_{STR} + R_C + R_{SWI} + R_{GWI} + R_{TP} + R_{WCS} \pm VF \pm LF - GE - T - E - B} \dots\dots\dots\dots..(\mathbf{4})$$

The change in storage has been estimated using the following equation:

$$\boldsymbol{\Delta S = \Delta h \times A \times S_Y} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.\dots\dots\dots\dots\dots\dots..(\mathbf{5})$$

Where,

ΔS - Change is storage

Δh - rise in water level in the monsoon season

A - Area for computation of recharge

S_Y - Specific Yield

Substituting the expression in equation (5) for storage increase ΔS in terms of water level fluctuation and specific yield, the equations (3) & (4) becomes (6) & (7) for non-command and command sub-units,

$$\boldsymbol{R_{RF} = \Delta h \times A \times S_Y - R_{STR} - R_{SWI} - R_{GWI} - R_{TP} - R_{WCS} \pm VF \pm LF + GE + T + E + B} \dots\dots\dots\dots\dots..(\mathbf{6})$$

$$\boldsymbol{R_{RF} = \Delta h \times A \times S_Y - R_{STR} - R_C - R_{SWI} - R_{GWI} - R_{TP} - R_{WCS} \pm VF \pm LF + GE + T + E + B} \dots\dots\dots.(\mathbf{7})$$

Where base flow/ recharge to/from streams have not been estimated, the same is assumed to be zero. The rainfall recharge obtained by using equation (6) and (7) provides the recharge in any particular monsoon season for the associated monsoon season rainfall. This estimate has been normalized for the normal monsoon season rainfall as per the procedure indicated below.

Normalization of Rainfall Recharge

Let R_i be the rainfall recharge and r_i be the associated rainfall. The subscript "i" takes values 1 to N where N is the number of years for which data is available. This should be at least 5. The rainfall recharge, R_i is obtained as per equation (6) & equation (7) depending on the sub-unit for which the normalization is being done.

After the pairs of data on R_i and r_i have been obtained as described above, a normalisation procedure is carried out for obtaining the rainfall recharge corresponding to the normal monsoon season rainfall. Let r(normal) be the normal monsoon season rainfall obtained as the average of recent 30 to 50 years of monsoon season rainfall. Two methods are possible for the normalisation procedure. The first method is based on a linear relationship between recharge and rainfall of the form

$$\boldsymbol{R = ar} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{8})$$

Where, R = Rainfall recharge during monsoon season, r = Monsoon season rainfall
a = a constant

The computational procedure is followed in the first method is as given below:

$$\boldsymbol{R_{RF}(normal)} = \frac{\sum_{i=1}^{N} [\boldsymbol{R_i} \frac{\boldsymbol{r(normal)}}{\boldsymbol{r_i}}]}{\boldsymbol{N}} \ldots\ldots\ldots\ldots (\mathbf{9})$$

Where, R_{RF}(normal) - Normalized Rainfall Recharge in the monsoon season, R_i- Rainfall Recharge in the monsoon season for the i^{th}year, r(normal) - Normal monsoon season rainfall, r_i- Rainfall in the monsoon season for the i^{th} year, N - No. of years for which data is available

The second method is also based on a linear relation between recharge and rainfall. However, this linear relationship is of the form,

$$\boldsymbol{R_{RF}(normal)} = \boldsymbol{a} \times \boldsymbol{r(normal)} + \boldsymbol{b} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{10})$$

Where,

R_{RF}(normal) - Normalized Rainfall Recharge in the monsoon season, r(normal) – Normal monsoon season rainfall, a and b - Constants.

The two constants ‘a’ and ‘b’ in the above equation are obtained through a linear regression analysis. The computational procedure has been followed in the second method is as given below:

$$\boldsymbol{a = \frac{NS_4 - S_1S_2}{NS_3 - S_1^2}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{11})$$

$$\boldsymbol{b = \frac{S_2 - aS_1}{N}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (\mathbf{12})$$

Where,

$$\boldsymbol{S_1 = \sum_{i=1}^{N} r_i\ ,\ \ S_2 = \sum_{i=1}^{N} R_i\ ,\ \ S_3 = \sum_{i=1}^{N} r_i^2\ ,\ \ S_4 = \sum_{i=1}^{N} R_i r_i}$$

2.1.1.1.2. Rainfall Infiltration Factor Method

The rainfall recharge estimation based on Water level fluctuation method reflects actual field conditions since it takes into account the response of ground water level. However the ground water extraction estimation included in the computation of rainfall recharge using water level fluctuation approach is often subject to uncertainties. Therefore, the rainfall recharge obtained from water level fluctuation approach has been compared with that estimated using rainfall infiltration factor method. Recharge from rainfall is estimated by using the following relationship –

$$\boldsymbol{R_{RF} = RFIF \times A \times \frac{(R - a)}{1000}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (\mathbf{13})$$

Where,

R_{RF} - 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 considered while estimating ground water recharge using rainfall infiltration factor method. The minimum threshold limit is in accordance with the relation shown in equation (13) 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. Thus, 10% of Normal annual rainfall has been taken as minimum rainfall threshold and 3000 mm as maximum rainfall limit. While computing the rainfall recharge, 10% of the normal annual rainfall has been deducted from the monsoon rainfall and balance rainfall is considered for computation of rainfall recharge. The same recharge factor is used for both monsoon and non-monsoon rainfall, with the condition that the recharge due to non-monsoon rainfall is taken as zero, if the normal rainfall during the non-monsoon season is less than 10% of normal annual rainfall. In using the method based on the specified norms, recharge due to both monsoon and non-monsoon rainfall has been estimated for normal rainfall, based on recent 30 to 50 years of data.

2.1.1.1.3. Percent Deviation

After computing the rainfall recharge for normal monsoon season rainfall using the ground water level fluctuation method and rainfall infiltration factor method these two estimates is compared with each other. A term, Percent Deviation (PD) which is the difference between the two expressed as a percentage of the later is computed as

$$\boldsymbol{PD = \frac{R_{RF}(normal, wtfm) - R_{RF}(normal, rifm)}{R_{RF}(normal, rifm)} \times 100} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{14})$$

Where,

R_{RF} (normal, wlfm) = Rainfall recharge for normal monsoon season rainfall estimated by the ground water level fluctuation method

R_{RF} (normal, rifm) = Rainfall recharge for normal monsoon season rainfall estimated by the rainfall infiltration factor method

The rainfall recharge for normal monsoon season rainfall is finally adopted as per the criteria given below:

- If PD is greater than or equal to -20%, and less than or equal to +20%, R_{RF} (normal) is taken as the value estimated by the ground water level fluctuation method.
- If PD is less than -20%, R_{RF} (normal) is taken as equal to 0.8 times the value estimated by the rainfall infiltration factor method.
- If PD is greater than +20%, R_{RF} (normal) is taken as equal to 1.2 times the value estimated by the rainfall infiltration factor method.

2.1.1.2. Recharge from Other Sources

Recharge from other sources constitutes recharges from canals, surface water irrigation, ground water irrigation, tanks & ponds and water conservation structures in command areas where as in non-command areas it constitutes the recharge due to surface water irrigation, ground water irrigation, tanks & ponds and water conservation structures. The methods of estimation of recharge from different sources are used in the assessment as follows.

Sl. No	Source	Estimation Formula	Parameters
1	Recharge from Canals	$R_C = WA \times SF \times Days$	R_C = Recharge from Canals WA = Wetted Area SF = Seepage Factor Days = Number of Canal Running Days
2	Recharge from Surface Water Irrigation	$R_{SWI} = AD \times Days \times RFF$	R_{SWI} = Recharge due to applied surface water irrigation AD = Average Discharge Days = Number of days water is discharged to the Fields RFF = Return Flow Factor
3	Recharge from Ground Water Irrigation	$R_{GWI} = GE_{IRR} \times RFF$	R_{GWI} = Recharge due to applied ground water irrigation GE_{IRR} = Ground Water Extraction for Irrigation RFF = Return Flow Factor
4	Recharge due to Tanks & Ponds	$R_{TP} = AWSA \times N \times RF$	R_{TP} = Recharge due to Tanks & Ponds AWSA = Average Water Spread Area N = Number of days Water is available in the Tank/Pond RF = Recharge Factor
5	Recharge due to Water Conservation Structures	$R_{WCS} = GS \times RF$	RWCS = Recharge due to Water Conservation Structures GS = Gross Storage = Storage Capacity multiplied by number of fillings. RF = Recharge Factor

2.1.1.3. Evaporation and Transpiration

Evaporation is estimated for the aquifer in the assessment unit if water levels in the aquifer are within the capillary zone. For areas with water levels within 1.0mbgl, evaporation is estimated using the evaporation rates available for other adjoining areas. If depth to water level is more than 1.0mbgl, the evaporation losses from the aquifer is taken as zero.

Transpiration through vegetation has been estimated if water levels in the aquifer are within the maximum root zone of the local vegetation. If water levels are within 3.5mbgl, transpiration is estimated using the transpiration rates available for other areas. If it is greater than3.5m bgl, the transpiration has been taken as zero.

2.1.1.4. Recharge During Monsoon Season

The sum of normalized monsoon rainfall recharge and the recharge from other sources and lateral and vertical flows into & out of the sub unit and stream inflows & outflows during monsoon season is the total recharge/ accumulation during monsoon season for the sub unit. Similarly, this is to be computed for all the sub units available in the assessment unit.

2.1.1.5. Recharge During Non-Monsoon Season

The rainfall recharge during non-monsoon season is estimated using rainfall infiltration factor Method only when the non-monsoon season rainfall is more than 10% of normal annual rainfall. The sum of non-monsoon rainfall recharge and the recharge from other sources and lateral and vertical flows into & out of the sub unit and stream inflows & outflows during non-monsoon season is the total recharge/ accumulation during non-monsoon season for the sub unit. Similarly, this is to be computed for all the sub units available in the assessment unit.

2.1.1.6. Total Annual Ground Water Recharge

The sum of the recharge/ accumulations during monsoon and non-monsoon seasons is the total annual ground water recharge/ accumulations for the sub unit. Similarly, this is computed for all the sub units available in the assessment unit.

2.1.1.7. Annual Extractable Ground Water Resource (EGR)

The Annual Extractable Ground Water Resource (EGR) is computed by deducting the Total Annual Natural Discharge from Total Annual Ground Water Recharge. In the water level fluctuation method, a significant portion of base flow is already accounted for by taking the post monsoon water level one month after the end of rainfall. The base flow in the remaining non-monsoon period is likely to be small, especially in hard rock areas. In the assessment units, where river stage data are not available and neither the detailed data for quantitative assessment of the natural discharge are available, allocation of unaccountable natural discharges to 5% or 10% of annual recharge is considered. If the rainfall recharge is assessed using water level fluctuation method this has been taken 5% of the annual recharge and if it is assessed using rainfall infiltration factor method, 10% of the annual recharge is considered. The balance is account for Annual Extractable Ground Water Resources (EGR).

2.1.1.8. Estimation of Ground Water Extraction

Ground water draft or extraction is assessed as follows.

$$\boldsymbol{GE_{ALL} = GE_{IRR} + GE_{DOM} + GE_{IND}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{15})$$

Where,

GE_{ALL} = Ground water extraction for all uses

GE_{IRR} = Ground water extraction for irrigation

GE_{DOM} = Ground water extraction for domestic uses

GE_{IND} = Ground water extraction for industrial uses

2.1.1.8.1. Ground Water Extraction for Irrigation (GE_{IRR})

The methods for estimation of ground water extraction are as follows.

Unit Draft Method: **–** In this method, season-wise unit draft of each type of well in an assessment unit is estimated. The unit draft of different types (eg. Dug well, Dug cum bore well, shallow tube well, deep tube well, bore well etc.) is multiplied with the number of wells of that particular type to obtain season-wise ground water extraction by that particular structure.

Crop Water Requirement Method: **–** For each crop, the season-wise net irrigation water requirement is determined. This is then multiplied with the area irrigated by ground water abstraction structures. The database on crop area is obtained from Revenue records in Tehsil office, Agriculture Census and also by using Remote Sensing techniques.

Power Consumption Method: **–**Ground water extraction for unit power consumption (electric) is determined. Extraction per unit power consumption is then multiplied with number of units of power consumed for agricultural pump sets to obtain total ground water extraction for irrigation.

2.1.1.8.2. Ground Water Extraction for Domestic Use (GE_{DOM})

There are several methods for estimation of extraction for domestic use(GEDOM). Some of the commonly adopted methods are described here.

Unit Draft Method: – In this method, unit draft of each type of well is multiplied by the number of wells used for domestic purpose to obtain the domestic ground water extraction.
Consumptive Use Method: – In this method, population is multiplied with per capita consumption usually expressed in litre per capita per day (lpcd). It can be expressed using following equation.

$$\boldsymbol{GE_{DOM} = Population \times Consumptive\ Requirement \times L_g \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(16)}$$

Where,
L_g = Fractional Load on Ground Water for Domestic Water Supply.
The Load on Ground water can be obtained from the Information based on Civic water supply agencies in urban areas.

2.1.1.8.3. Ground Water Extraction for Industrial Use (GE_{IND})

The commonly adopted methods for estimating the extraction for industrial use are as below:

Unit Draft Method: - In this method, unit draft of each type of well is multiplied by the number of wells used for industrial purpose to obtain the industrial ground water extraction.
Consumptive Use Pattern Method: – In this method, water consumption of different industrial units is determined. Numbers of Industrial units which are dependent on ground water are multiplied with unit water consumption to obtain ground water extraction for industrial use.

$$\boldsymbol{GE_{IND} = Number\ of\ Industrial\ Units \times Unit\ Water\ Consumption \times L_g \ldots\ldots\ldots\ldots\ldots\ldots(17)}$$

Where,
L_g = Fractional load on ground water for industrial water supply.
The load on ground water for industrial water supply can be obtained from water supply agencies in the Industrial belt.

Ground water extraction obtained from different methods need to be compared and based on field checks, the seemingly best value may be adopted. At times, ground water extraction obtained by different methods may vary widely. In such cases, the value matching the field situation should be considered. The storage depletion during a season, where other recharges are negligible can be taken as ground water extraction during that particular period.

2.1.1.9. Stage of Ground Water Extraction

The stage of ground water extraction is defined by,

$$\textit{Stage of GW Extraction} = \frac{\textit{Existing Gross GW Extraction for all Uses}}{\textit{Annual Extractable GW Resources}} \times \mathbf{100} \dots\dots\dots\dots (\mathbf{18})$$

The existing gross ground water extraction for all uses refers to the total of existing gross ground water extraction for irrigation and all other purposes. The stage of ground water extraction should be obtained separately for command areas, non-command areas and poor ground water quality areas.

2.1.1.10. Validation of Stage of Ground Water Extraction

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

Long term Water Level trends are prepared for a minimum period of 10 years for both pre-monsoon and post-monsoon period. 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

2.1.1.11 Categorization of Assessment Unit

2.1.1.10.1. Categorization of Assessment Unit Based on Quantity

The categorization based on status of ground water quantity is defined by Stage of Ground Water Extraction as given below:

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

2.1.1.10.2. Categorization of Assessment Unit Based on Quality

As it is not possible to categorize the assessment units in terms of the extent of quality hazard, based on the available water quality monitoring mechanism and database on ground water quality, the Committee recommends that each assessment unit, in addition to the Quantity based categorization (safe, semi-critical, critical and over-exploited) should bear a quality hazard identifier. 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 has been tagged with the particular Quality hazard.

2.1.1.11. Allocation of Ground Water Resource for Utilisation

The Annual Extractable Ground Water Resources are to be apportioned between domestic, industrial and irrigation uses. Among these, as per the National Water Policy, requirement for domestic water supply is to be accorded priority. This requirement based on population has been projected to the year 2025, per capita requirement of water for domestic use, and relative load on ground water for urban and rural water supply. In situations where adequate data is not available to make this estimate, the following empirical relation has been utilized.

$$\boldsymbol{Alloc = 22 \times N \times L_g mm\ per\ year} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(\mathbf{19})$$

Where,

Alloc = Allocation for domestic water requirement

N = population density in the unit in thousands per sq. km.

L_g= fractional load on ground water for domestic water supply (≤ 1.0)

2.1.1.12. Net Annual Ground Water Availability for Future Use

The water available for future use is obtained by deducting the allocation for domestic use and current extraction for Irrigation and Industrial uses from the Annual Extractable Ground Water Recharge. The resulting ground water potential is termed as the net annual ground water availability for future use. The Net annual ground water availability for future use is calculated separately for non-command areas and command areas. As per the recommendations of the R&D Advisory committee, the ground water available for future use can never be negative. If it becomes negative, the future allocation of Domestic needs can be reduced to current extraction for domestic use. Even then if it is still negative, then the ground water available for future uses has been projected as zero.

2.1.1.13. Additional Potential Resources under Specific Conditions

2.1.1.13.1. Potential Resource Due to Spring Discharge

Spring discharge occurs 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. Thus, Spring Discharge is a form of ‘Annual Extractable Ground Water Recharge’. It is a renewable resource, though has not been used for Categorisation. Spring discharge measurement has been carried out by volumetric measurement of discharge of the springs. Spring discharges multiplied with time in days of each season will give the quantum of spring resources available during that season.

$$\boldsymbol{Potential\ ground\ water\ resource\ due\ to\ springs} \\ = \boldsymbol{Q \times No.of days} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{20})$$

Where, Q = Spring Discharge; No of days = No of days spring yields.

2.1.1.13.2. Potential Resource in Waterlogged and Shallow Water Table Areas

In the area where the ground water level is less than 5m below ground level or in waterlogged areas, the resources up to 5m below ground level are potential and would be available for development in addition to the annual recharge in the area. The computation of potential resource to ground water reservoir in shallow water table areas has been done by adopting the following equation:

$$\boldsymbol{Potential\ groundwater\ resource\ in\ shallow\ water\ table\ areas}$$
$$= (\mathbf{5} - \boldsymbol{D}) \times \boldsymbol{A} \times \boldsymbol{S_Y} \ldots\ldots\ldots\ldots (\mathbf{21})$$

Where,

D = Depth to water table below ground surface in pre-monsoon period in shallow aquifers.

A = Area of shallow water table zone.

S_Y = Specific Yield

2.1.1.13.3. Potential Resource in Flood Prone Areas

Ground water recharge from a flood plain is mainly the function of the following parameters-

- Areal extent of flood plain
- Retention period of flood
- Type of sub-soil strata and silt charge in the river water which gets deposited and controls seepage

Since collection of data on all these factors is time taking and difficult, in the meantime, the potential resource from flood plain may be estimated on the same norms as for ponds, tanks and lakes. This has been calculated over the water spread area and only for the retention period using the following formula.

$$\boldsymbol{Potential\ groundwater\ resource\ in\ Flood\ Prone\ Areas}$$
$$= \mathbf{1.4} \times \boldsymbol{N} \times \frac{\boldsymbol{A}}{\mathbf{1000}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{22})$$

Where,

N = No. of Days Water is Retained in the Area

A = Flood Prone Area

2.1.1.14. Apportioning of Ground Water Assessment from Watershed to Development Unit

Where the assessment unit is a watershed, there is a need to convert the ground water assessment in terms of an administrative unit such as block/ taluka/ mandal. This has been done as follows.

A block may comprise of one or more watersheds, in part or full. First, the ground water assessment in the subareas, command, non-command and poor ground water quality areas of the watershed has been converted into depth unit (mm), by dividing the annual recharge by the respective area. The contribution of this subarea of the watershed to the block, is now calculated by multiplying this depth with the area in the block occupied by this sub-area.

The total ground water resource of the block has been presented separately for each type of sub-area, namely for command areas, non-command areas and poor ground water quality areas, as in the case of the individual watersheds.

2.2. Ground Water Assessment in Urban Areas

The Assessment of Ground Water Resources in urban areas is similar to that of rural areas. Because of the availability of draft data and slightly different infiltration process and recharge due to other sources, the following few points are to be considered.

- Even though the data on existing ground water abstraction structures are available, accuracy is somewhat doubtful and individuals cannot even enumerate the well census in urban areas. Hence the difference of the actual demand and the supply by surface water sources as the withdrawal from the ground water resources has been considered for the assessment.

- The urban areas are sometimes concrete jungles and rainfall infiltration is not equal to that of rural areas unless and until special measures are taken in the construction of roads and pavements. Hence, 30% of the rainfall infiltration factor has been taken into consideration for urban areas as an adhoc arrangement till field studies in these areas are done and documented field studies are available.

- Because of the water supply schemes, there are many pipelines available in the urban areas and the seepages from these channels or pipes are huge in some areas. Hence this component has been included in the other resources and the recharge has also been considered. The percent losses have been collected from the individual water supply agencies, 50% of which has been considered as recharge to the ground water system.

- In the urban areas in India, normally, there is no separate channels either open or sub surface for the drainage and flash floods. These channels also recharge to some extent the ground water reservoir. As on today, there is no documented field study to assess the recharge. The seepages from the sewerages, which normally contaminate the ground water resources with nitrate also contribute to the quantity of resources and hence same percent as in the case of water supply pipes has been taken as norm for the recharge on the quantity of sewerage when there is sub surface drainage system. If estimated flash flood data is available, the same percent has been used on the quantum of flash floods to estimate the recharge from the flash floods.

- Urban areas with population more than 10 lakhs, has been considered as urban assessment unit while assessing the dynamic ground water resources.

2.3. Ground Water Assessment in Water Level Depletion Zones

There are areas where ground water level shows a decline even in the monsoon season. The reasons for this may be any one of the following: (a) There is a genuine depletion in the ground water regime, with ground water extraction and natural ground water discharge in the monsoon season (outflow from the region and base flow) exceeding the recharge. (b) There may be an error in water level data due to inadequacy of observation wells.

If it is concluded that the water level data is erroneous, recharge assessment has been made based on rainfall infiltration factor method. If, on the other hand, water level data is assessed as reliable, the ground water level fluctuation method has been applied for recharge estimation. As ΔS in equation 3& 4 is negative, the estimated recharge will be less than the gross ground water extraction in the monsoon season. It must be noted that this recharge is the gross recharge minus the natural discharges in the monsoon season. The immediate conclusion from such an assessment in water depletion zones is that the area falls under the over-exploited category which requires micro level study.

2.4. The Assessment Norms

2.4.1. Specific Yield

Recently under Aquifer Mapping Project, Central Ground Water Board has classified all the aquifers into 14 Principal Aquifers which in turn were divided into 42 Major Aquifers. Hence, it is required to assign Specific Yield values to all these aquifer units. The values recommended in the ***Table-2.1*** has been followed in the present assessments, unless sufficient data based on field studies are available to justify the minimum, maximum or other intermediate values.

Table-2.1: Norms Recommended for Specific Yield

Sl. No.	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
1	Alluvium	AL01	Younger Alluvium (Clay/Silt/Sand/ Calcareous concretions)	Quaternary	10	8	12
2	Alluvium	AL02	Pebble / Gravel/ Bazada/ Kandi	Quaternary	16	12	20
3	Alluvium	AL03	Older Alluvium (Silt/Sand/Gravel/Lithomargic clay)	Quaternary	6	4	8
4	Alluvium	AL04	Aeolian Alluvium (Silt/ Sand)	Quaternary	16	12	20
5	Alluvium	AL05	Coastal Alluvium (Sand/Silt/Clay)	Quaternary	10	8	12
6	Alluvium	AL06	Valley Fills	Quaternary	16	12	20
7	Alluvium	AL07	Glacial Deposits	Quaternary	16	12	20
8	Laterite	LT01	Laterite / Ferruginous concretions	Quaternary	2.5	2	3
9	Basalt	BS01	Basic Rocks (Basalt) - Weathered, Vesicular or Jointed	Mesozoic to Cenozoic	2	1	3
10	Basalt	BS01	Basic Rocks (Basalt) - Massive Poorly Jointed	Mesozoic to Cenozoic	0.35	0.2	0.5
11	Basalt	BS02	Ultra Basic - Weathered, Vesicular or Jointed	Mesozoic to Cenozoic	2	1	3
12	Basalt	BS02	Ultra Basic - Massive Poorly Jointed	Mesozoic to Cenozoic	0.35	0.2	0.5
13	Sandstone	ST01	Sandstone/Conglomerate	Upper Palaeozoic to Cenozoic	3	1	5
14	Sandstone	ST02	Sandstone with Shale	Upper Palaeozoic to Cenozoic	3	1	5
15	Sandstone	ST03	Sandstone with shale/ coal beds	Upper Palaeozoic to Cenozoic	3	1	5
16	Sandstone	ST04	Sandstone with Clay	Upper Palaeozoic to Cenozoic	3	1	5
17	Sandstone	ST05	Sandstone/Conglomerate	Proterozoic to Cenozoi	3	1	5
18	Sandstone	ST06	Sandstone with Shale	Proterozoic to Cenozoi	3	1	5
19	Shale	SH01	Shale with limestone	Upper Palaeozoic to Cenozoic	1.5	1	2
20	Shale	SH02	Shale with Sandstone	Upper Palaeozoic to Cenozoic	1.5	1	2
21	Shale	SH03	Shale, limestone and sandstone	Upper Palaeozoic to Cenozoic	1.5	1	2
22	Shale	SH04	Shale	Upper Palaeozoic to Cenozoic	1.5	1	2
23	Shale	SH05	Shale/Shale with Sandstone	Proterozoic to Cenozoi	1.5	1	2
24	Shale	SH06	Shale with Limestone	Proterozoic to Cenozoi	1.5	1	2
25	Limestone	LS01	Miliolitic Limestone	Quarternary	2	1	3
26	Limestone	LS01	KarstifiedMiliolitic Limestone	Quarternary	10	5	15
27	Limestone	LS02	Limestone / Dolomite	Upper Palaeozoic to Cenozoic	2	1	3
28	Limestone	LS02	Karstified Limestone / Dolomite	Upper Palaeozoic to Cenozoic	10	5	15
29	Limestone	LS03	Limestone/Dolomite	Proterozoic	2	1	3
30	Limestone	LS03	Karstified Limestone/Dolomite	Proterozoic	10	5	15
31	Limestone	LS04	Limestone with Shale	Proterozoic	2	1	3

Sl. No.	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
32	Limestone	LS04	Karstified Limestone with Shale	Proterozoic	10	5	15
33	Limestone	LS05	Marble	Azoic to Proterozoic	2	1	3
34	Limestone	LS05	Karstified Marble	Azoic to Proterozoic	10	5	15
35	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.) - Weathered , Jointed	Mesozoic to Cenozoic	1.5	1	2
36	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.)-Massive or Poorl Fractured	Mesozoic to Cenozoic	0.35	0.2	0.5
37	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) Weathered, Jointed	Proterozoic to Cenozoic	3	2	4
38	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) Massive, Poorly Fractured	Proterozoic to Cenozoic	0.35	0.2	0.5
39	Schist	SC01	Schist - Weathered, Jointed	Azoic to Proterozoic	1.5	1	2
40	Schist	SC01	Schist - Massive, Poorly Fractured	Azoic to Proterozoic	0.35	0.2	0.5
41	Schist	SC02	Phyllite	Azoic to Proterozoic	1.5	1	2
42	Schist	SC03	Slate	Azoic to Proterozoic	1.5	1	2
43	Quartzite	QZ01	Quartzite - Weathered, Jointed	Proterozoic to Cenozoi	1.5	1	2
44	Quartzite	QZ01	Quartzite - Massive, Poorly Fractured	Proterozoic to Cenozoi	0.3	0.2	0.4
45	Quartzite	QZ02	Quartzite - Weathered, Jointed	Azoic to Proterozoic	1.5	1	2
46	Quartzite	QZ02	Quartzite- Massive, Poorly Fractured	Azoic to Proterozoic	0.3	0.2	0.4
47	Charnockite	CK01	Charnockite - Weathered, Jointed	Azoic	3	2	4
48	Charnockite	CK01	Charnockite - Massive, Poorly Fractured	Azoic	0.3	0.2	0.4
49	Khondalite	KH01	Khondalites, Granulites - Weathered, Jointed	Azoic	1.5	1	2
50	Khondalite	KH01	Khondalites, Granulites - Mssive, Poorly Fractured	Azoic	0.3	0.2	0.4
51	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Weathered, Jointed	Azoic	1.5	1	2
52	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Massive, Poorly Fractured	Azoic	0.3	0.2	0.4
53	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Weathered, Jointed	Azoic to Proterozoic	1.5	1	2
54	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Massive, Poorly Fractured	Azoic to Proterozoic	0.3	0.2	0.4
55	Gneiss	GN02	Gneiss -Weathered, Jointed	Azoic to Proterozoic	3	2	4
56	Gneiss	GN02	Gneiss-Massive, Poorly Fractured	Azoic to Proterozoic	0.3	0.2	0.4
57	Gneiss	GN03	Migmatitic Gneiss - Weathered, Jointed	Azoic	1.5	1	2
58	Gneiss	GN03	Migmatitic Gneiss - Massive, Poorly Fractured	Azoic	0.3	0.2	0.4

Sl. No.	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
59	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Weathered, Jointed	Proterozoic to Cenozoic	2	1	3
60	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	0.35	0.2	0.5
61	Intrusive	IN02	Ultrabasics (Epidiorite, Granophyre etc.) - Weathered, Jointed	Proterozoic to Cenozoic	2	1	3
62	Intrusive	IN02	Ultrabasics (Epidiorite, Granophyre etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	0.35	0.2	0.5

2.4.2. Rainfall Infiltration Factor

The values mentioned in ***Table-2.2*** has been used in the present assessment. The recommended Rainfall Infiltration Factor values has been used for assessment, unless sufficient data based on field studies are available to justify the minimum, maximum or other intermediate values.

Sl. No.	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
1	Alluvium	AL01	Younger Alluvium (Clay/Silt/Sand/ Calcareous concretions)	Quaternary	22	20	24
2	Alluvium	AL02	Pebble / Gravel/ Bazada/ Kandi	Quaternary	22	20	24
3	Alluvium	AL03	Older Alluvium (Silt/Sand/Gravel/Lithomargic clay)	Quaternary	22	20	24
4	Alluvium	AL04	Aeolian Alluvium (Silt/ Sand)	Quaternary	22	20	24
5	Alluvium	AL05	Coastal Alluvium (Sand/Silt/Clay) -East Coast	Quaternary	16	14	18
5	Alluvium	AL05	Coastal Alluvium (Sand/Silt/Clay) - West Coast	Quaternary	10	8	12
6	Alluvium	AL06	Valley Fills	Quaternary	22	20	24
7	Alluvium	AL07	Glacial Deposits	Quaternary	22	20	24
8	Laterite	LT01	Laterite / Ferruginous concretions	Quaternary	7	6	8
9	Basalt	BS01	Basic Rocks (Basalt) - Vesicula or Jointed	Mesozoic to Cenozoic	13	12	14
9	Basalt	BS01	Basic Rocks (Basalt) - Weathered	Mesozoic to Cenozoic	7	6	8
10	Basalt	BS01	Basic Rocks (Basalt) - Massive Poorly Jointed	Mesozoic to Cenozoic	2	1	3
11	Basalt	BS02	Ultra Basic - Vesicular or Jointed	Mesozoic to Cenozoic	13	12	14
11	Basalt	BS02	Ultra Basic - Weathered	Mesozoic to Cenozoic	7	6	8
12	Basalt	BS02	Ultra Basic - Massive Poorly Jointed	Mesozoic to Cenozoic	2	1	3

Sl. No.	Principal Aquifer	Major Aquifers Code	Major Aquifers Name	Age	Recommended (%)	Minimum (%)	Maximum (%)
13	Sandstone	ST01	Sandstone/Conglomerate	Upper Palaeozoic to Cenozoic	12	10	14
14	Sandstone	ST02	Sandstone with Shale	Upper Palaeozoic to Cenozoic	12	10	14
15	Sandstone	ST03	Sandstone with shale/ coal beds	Upper Palaeozoic to Cenozoic	12	10	14
16	Sandstone	ST04	Sandstone with Clay	Upper Palaeozoic to Cenozoic	12	10	14
17	Sandstone	ST05	Sandstone/Conglomerate	Proterozoic t Cenozoic	6	5	7
18	Sandstone	ST06	Sandstone with Shale	Proterozoic t Cenozoic	6	5	7
19	Shale	SH01	Shale with limestone	Upper Palaeozoic to Cenozoic	4	3	5
20	Shale	SH02	Shale with Sandstone	Upper Palaeozoic to Cenozoic	4	3	5
21	Shale	SH03	Shale, limestone and sandstone	Upper Palaeozoic to Cenozoic	4	3	5
22	Shale	SH04	Shale	Upper Palaeozoic to Cenozoic	4	3	5
23	Shale	SH05	Shale/Shale with Sandstone	Proterozoic t Cenozoic	4	3	5
24	Shale	SH06	Shale with Limestone	Proterozoic t Cenozoic	4	3	5
25	Limestone	LS01	Miliolitic Limestone	Quarternary	6	5	7
27	Limestone	LS02	Limestone / Dolomite	Upper Palaeozoic to Cenozoic	6	5	7
29	Limestone	LS03	Limestone/Dolomite	Proterozoic	6	5	7
31	Limestone	LS04	Limestone with Shale	Proterozoic	6	5	7
33	Limestone	LS05	Marble	Azoic to Proterozoic	6	5	7
35	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.) - Weathered , Jointed	Mesozoic to Cenozoic	7	5	9
36	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.)-Massive or Poorl Fractured	Mesozoic to Cenozoic	2	1	3
37	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) Weathered, Jointed	Proterozoic to Cenozoic	11	10	12
38	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) Massive, Poorly Fractured	Proterozoic to Cenozoic	2	1	3
39	Schist	SC01	Schist - Weathered, Jointed	Azoic to Proterozoic	7	5	9

Sl. No.	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
40	Schist	SC01	Schist - Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
41	Schist	SC02	Phyllite	Azoic to Proterozoic	4	3	5
42	Schist	SC03	Slate	Azoic to Proterozoic	4	3	5
43	Quartzite	QZ01	Quartzite - Weathered, Jointed	Proterozoic t Cenozoic	6	5	7
44	Quartzite	QZ01	Quartzite - Massive, Poorly Fractured	Proterozoic t Cenozoic	2	1	3
45	Quartzite	QZ02	Quartzite - Weathered, Jointed	Azoic to Proterozoic	6	5	7
46	Quartzite	QZ02	Quartzite- Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
47	Charnockite	CK01	Charnockite - Weathered, Jointed	Azoic	5	4	6
48	Charnockite	CK01	Charnockite - Massive, Poorly Fractured	Azoic	2	1	3
49	Khondalite	KH01	Khondalites, Granulites - Weathered, Jointed	Azoic	7	5	9
50	Khondalite	KH01	Khondalites, Granulites - Mssive, Poorly Fractured	Azoic	2	1	3
51	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Weathered, Jointed	Azoic	7	5	9
52	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Massive, Poorly Fractured	Azoic	2	1	3
53	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Weathered, Jointed	Azoic to Proterozoic	7	5	9
54	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
55	Gneiss	GN02	Gneiss -Weathered, Jointed	Azoic to Proterozoic	11	10	12
56	Gneiss	GN02	Gneiss-Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
57	Gneiss	GN03	Migmatitic Gneiss - Weathered, Jointed	Azoic	7	5	9
58	Gneiss	GN03	Migmatitic Gneiss - Massive, Poorly Fractured	Azoic	2	1	3
59	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Weathered, Jointed	Proterozoic to Cenozoic	7	6	8
60	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	2	1	3
61	Intrusive	IN02	Ulrta Basics (Epidiorite, Granophyre etc.) - Weathered, Jointed	Proterozoic to Cenozoic	7	6	8
62	Intrusive	IN02	Ulrta Basics (Epidiorite, Granophyre etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	2	1	3

2.4.3. Norms for Canal Recharge

The Norms suggested in ***Table-2.3*** has been used for estimating the recharge from Canals, where sufficient data based on field studies are not available.

Table-2.3: Norms Recommended for Recharge due to Canals

Formation	Canal Seepage factor ham/day/million square meters of wetted area		
	Recommended	Minimum	Maximum
Unlined canals in normal soils with some clay content along with sand	17.5	15	20
Unlined canals in sandy soil with some silt content	27.5	25	30
Lined canals in normal soils with some clay content along with sand	3.5	3	4
Lined canals in sandy soil with some silt content	5.5	5	6
All canals in hard rock area	3.5	3	4

2.4.4. Irrigation Recharge Norms

The Recommended Norms are presented in ***Table-2.4***.

Table-2.4: Norms Recommended for Recharge from Irrigation

DTW m bgl	Ground Water		Surface Water	
	Paddy	Non-paddy	Paddy	Non-paddy
$\leq$ 10	45.0	25.0	50.0	30.0
11	43.3	23.7	48.3	28.7
12	40.4	22.1	45.1	26.8
13	37.7	20.6	42.1	25.0
14	35.2	19.2	39.3	23.3
15	32.9	17.9	36.7	21.7
16	30.7	16.7	34.3	20.3
17	28.7	15.6	32.0	18.9
18	26.8	14.6	29.9	17.6
19	25.0	13.6	27.9	16.4
20	23.3	12.7	26.0	15.3
21	21.7	11.9	24.3	14.3
22	20.3	11.1	22.7	13.3
23	18.9	10.4	21.2	12.4
24	17.6	9.7	19.8	11.6
$\geq$ 25	20.0	5.0	25.0	10.0

2.4.5. Norms for Recharge due to Tanks & Ponds

As the data on the field studies for computing recharge from Tanks & Ponds are very limited, for Seepage from Tanks & Ponds has been used as 1.4 mm / day in the present assessment.

2.4.6. Norms for Recharge due to Water Conservation Structures

The data on the field studies for computing recharge from Water Conservation Structures are very limited, hence, the norm recommended by GEC-2015 for the seepage from Water Conservation Structures is 40% of gross storage during a year which means 20% during monsoon season and 20% during non-monsoon Season is adopted.

2.4.7. Unit Draft

The methodology recommends to use well census method for computing the ground water draft. The norm used for computing ground water draft is the unit draft. The unit draft can be computed by field studies. This method involves selecting representative abstraction structure and calculating the discharge from that particular type of structure and collecting the information on how many hours of pumping is being done in various seasons and number of such days during each season. The Unit Draft during a particular season is computed using the following equation:

$$\boldsymbol{Unit\ Draft = Discharge\ in\ m^3/hr \times No.of\ pumping\ hours\ in\ a\ day \times No.of\ days} \ldots\ldots\ldots (\mathbf{29})$$

But the procedure that is being followed for computing unit draft does not have any normalization procedure. Normally, if the year in which one collects the draft data in the field is an excess rainfall year, the abstraction from ground water will be less. Similarly, if the year of the computation of unit draft is a drought year the unit draft will be high. Hence, there is a requirement to devise a methodology that can be used for the normalization of unit draft figures. The following are the two simple techniques, which are followed for normalization of Unit Draft. Areas where, unit draft values for one rainfall cycle are available for at least 10 years second method shown in equation 31 is followed or else the first method shown in equation 30 has been used.

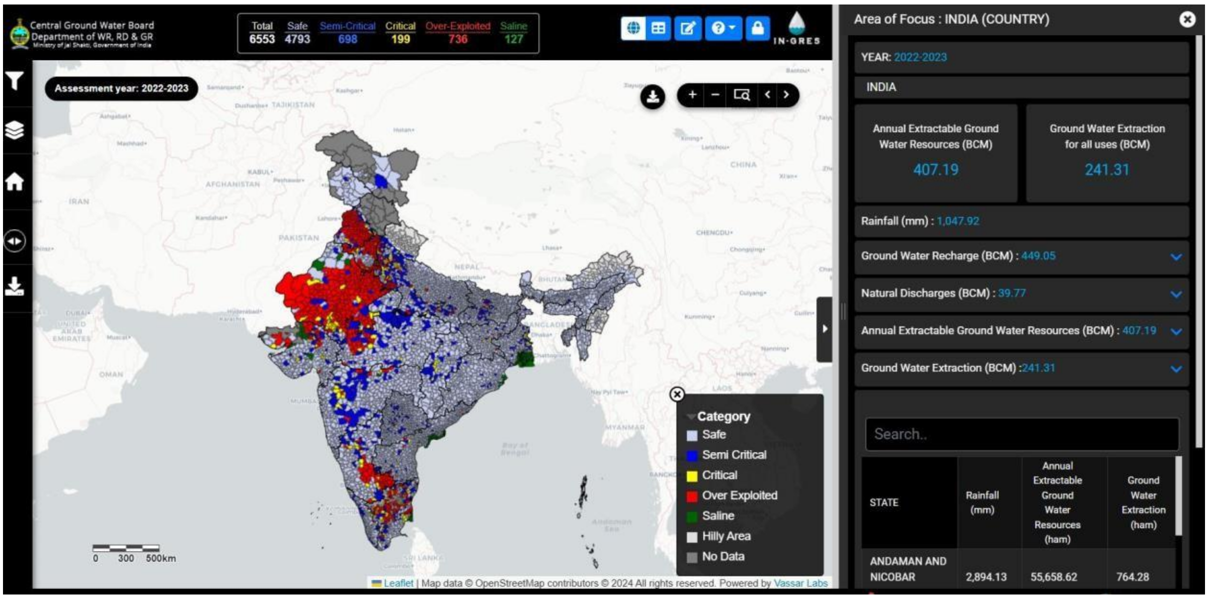
$$\boldsymbol{Normalised\ Unit\ Draft = \frac{Unit\ Draft \times Rainfall\ for\ the\ year}{Normal\ Rainfall}} \ldots\ldots\ldots (\mathbf{30})$$

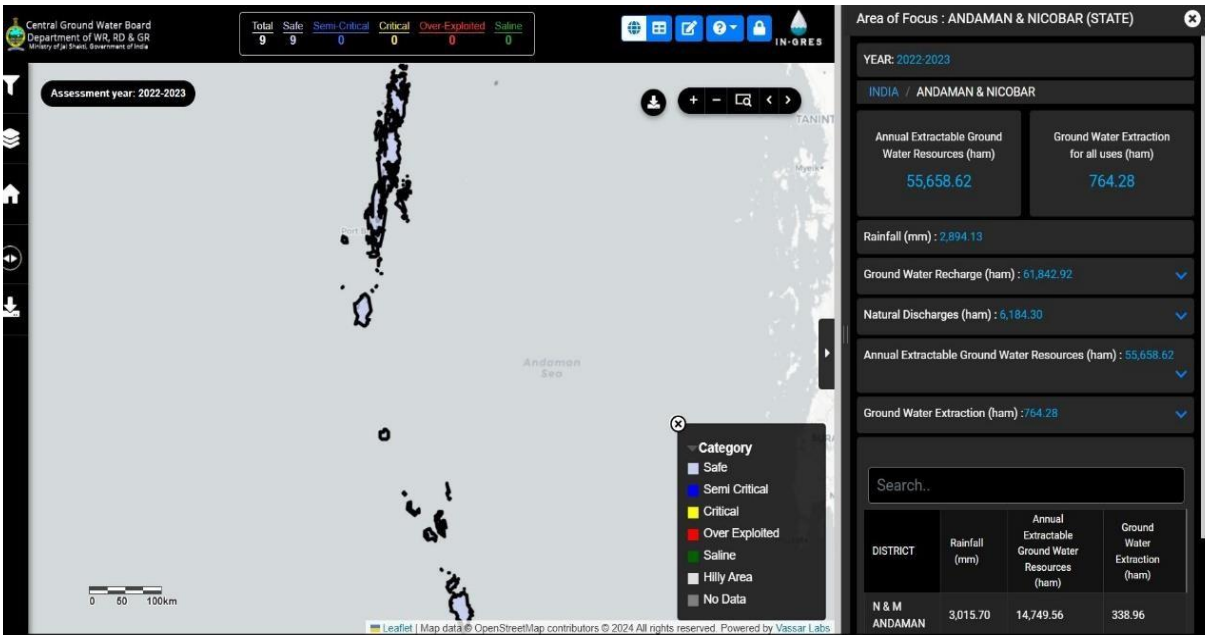
$$\boldsymbol{Normalised\ Unit\ Draft = \frac{\sum_{i=1}^{n} Unit\ Draft_i}{Number\ of\ Years}} \ldots\ldots\ldots (\mathbf{31})$$

2.5. India -Groundwater Resource Estimation System (IN-GRES)

"INDIA-GROUNDWATER RESOURCE ESTIMATION SYSTEM (IN-GRES) is a Software/Web-based Application developed by CGWB in collaboration with IIT-Hyderabad. It provides common and standardized platform for Ground Water Resource Estimation for the entire country and its pan-India operationalization (Central and State Governments). The system takes 'Data Input' through Excel as well as Forms, compute various ground water components (recharge, extraction etc.) and classify assessment units into appropriate categories (safe, semi-critical, critical and over-exploited). The Software uses GEC 2015 Methodology for estimation and calculation of Groundwater resources. It allows for unique and homogeneous representation of groundwater fluxes as well as categories for all the assessment units (AU) of the country.

URL of IN-GRES →http://ingres.iith.ac.in




Central Ground Water Board
Department of WR, RD & GR
Total 9
Safe 9
Semi-Critical 0
Critical 0
Over-Exploited 0
Saline 0
IN-GRES
Assessment year: 2022-2023
Andaman Sea
Category
Safe
Semi Critical
Critical
Over Exploited
Saline
Hilly Area
No Data
0 50 100km
Leaflet | Map data © OpenStreetMap contributors © 2024 All rights reserved. Powered by Vassar Labs
Area of Focus : ANDAMAN & NICOBAR (STATE)
YEAR: 2022-2023
INDIA / ANDAMAN & NICOBAR
Annual Extractable Ground Water Resources (ham)
55,658.62
Ground Water Extraction for all uses (ham)
764.28
Rainfall (mm) : 2,894.13
Ground Water Recharge (ham) : 61,842.92
Natural Discharges (ham) : 6,184.30
Annual Extractable Ground Water Resources (ham) : 55,658.62
Ground Water Extraction (ham) : 764.28
Search..
DISTRICT
Rainfall (mm)
Annual Extractable Ground Water Resources (ham)
Ground Water Extraction (ham)
N & M ANDAMAN
3,015.70
14,749.56
338.96

CHAPTER 3

HYDROGEOLOGICAL SETUP

3.1 Climate

Andaman Islands enjoy typical tropical climate all through the year. With an average temperature of around 23°C (minimum) and not exceeding 30°C (maximum), Andaman Islands are hot and humid generally. Relative humidity ranges from 79% to 89%, average wind speed is 7 to 10 km/hr, maximum temperature varies between 27° to 33°C and minimum temperature fluctuates between 21° to 25° C. Evaporation rate is very high, i.e. 1500-1800 mm/year because of the location of the archipelago close to the equator i.e. 6°N to 14°N. The high humidity levels are tempered by the sea breeze that springs up making the climate pleasant throughout the day, more so especially in the evenings. In spite of copious rainfall, the islands face acute scarcity of fresh water especially in the years of recession of monsoon.

Table 3.1. District wise normal and actual rainfall during monsoon and non-monsoon seasons

District	Normal RF (mm)		Actual RF 2023 (mm)	
	Monsoon	Non-Monsoon	Monsoon	Non-Monsoon
NICOBAR	1207.2	1598.0	1739.2	1116.8
N & M ANDAMAN	1757.2	1258.5	2410.2	740.7
SOUTH ANDAMAN	1757.2	1258.5	2517.7	832.7
UT	1573.9	1371.7	2222.4	896.7

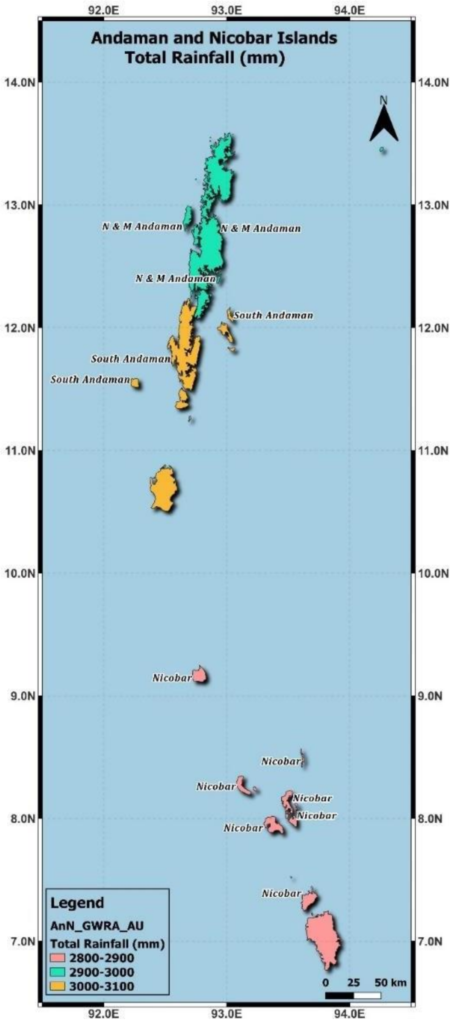


Fig.3.1 District wise annual total rainfall in 2023 over Andaman & Nicobar Islands

3.2 Physiography & Drainage

More than 300 islands make up the Andamans. North, Middle, and South Andaman, known collectively as Great Andaman, are the main islands; others include Landfall Island, Interview Island, the Sentinel Islands (where the Sentinelese tribes live), Ritchie's Archipelago, and Rutland Island. The 10-degree channel which is about 145 km long separates Little Andaman in the south from the Nicobar Islands.

The Nicobars consists of 19 islands. Among the most prominent is Car Nicobar in the north; Kamorta, Katchal, and Nancowry in the centre of the chain; and Great Nicobar in the south. About 90 miles to the southwest of Great Nicobar lies the north- western tip of Sumatra, Indonesia.

Both the Andaman and Nicobar groups are formed by the above-sea extensions of submarine ridges of mountains and are a part of a great island arc. The highest peak is 2,418 feet at Saddle Peak on North Andaman, followed by Mount Thullier at 2,106 feet on Great Nicobar and Mount Harriet at 1,197 feet on South Andaman. Barren island, the only known active Volcano in south Asia lies in the Andaman sea. In the late 20th and early 21st centuries, there were volcanic eruptions on Barren Island.

Terrain of the Union Territory is rough, with hills and narrow longitudinal valleys. Flat land is scarce and is confined to a few valleys, such as the Betapur on Middle Andaman and Diglipur on North Andaman.

The terrain of the Nicobar is more diverse than that of the Andamans. Some of the Nicobar Islands, such as Car Nicobar, have flat coral-covered surfaces with offshore coral formations that prevent most ships from anchoring. Other islands, such as Great Nicobar, are hilly and contain numerous fast-flowing streams. Great Nicobar is the only island in the territory with a significant amount of fresh surface water.

Perennial streams of the status of major rivers are absent in the Andaman and Nicobar group of Islands. The major Perennial streams in South Andaman district are Dhanikhari, Mithakhari, Burmanala, Premanala, Prothrapurnala, Kamsarat Nala, Sona Phar nala etc. In North-Middle Andaman district Kalpong Nala, Korang nala, Betapur nala, Rangat nala, Sankar Nala etc are the important perennial streams. In Nicobar District, Galathea and Alexandria rivers, Dhillon Nala, Magar Nala all in Great Nicobar island are the main drainage channels. Streams are rudimentary in Car Nicobar island while in Chowra, Kondul and Pillow Millo islands the drainage channels are obscured. However, incipient to moderately developed drainage channels are available in Little Nicobar and in all the other islands of Nancowrie group.

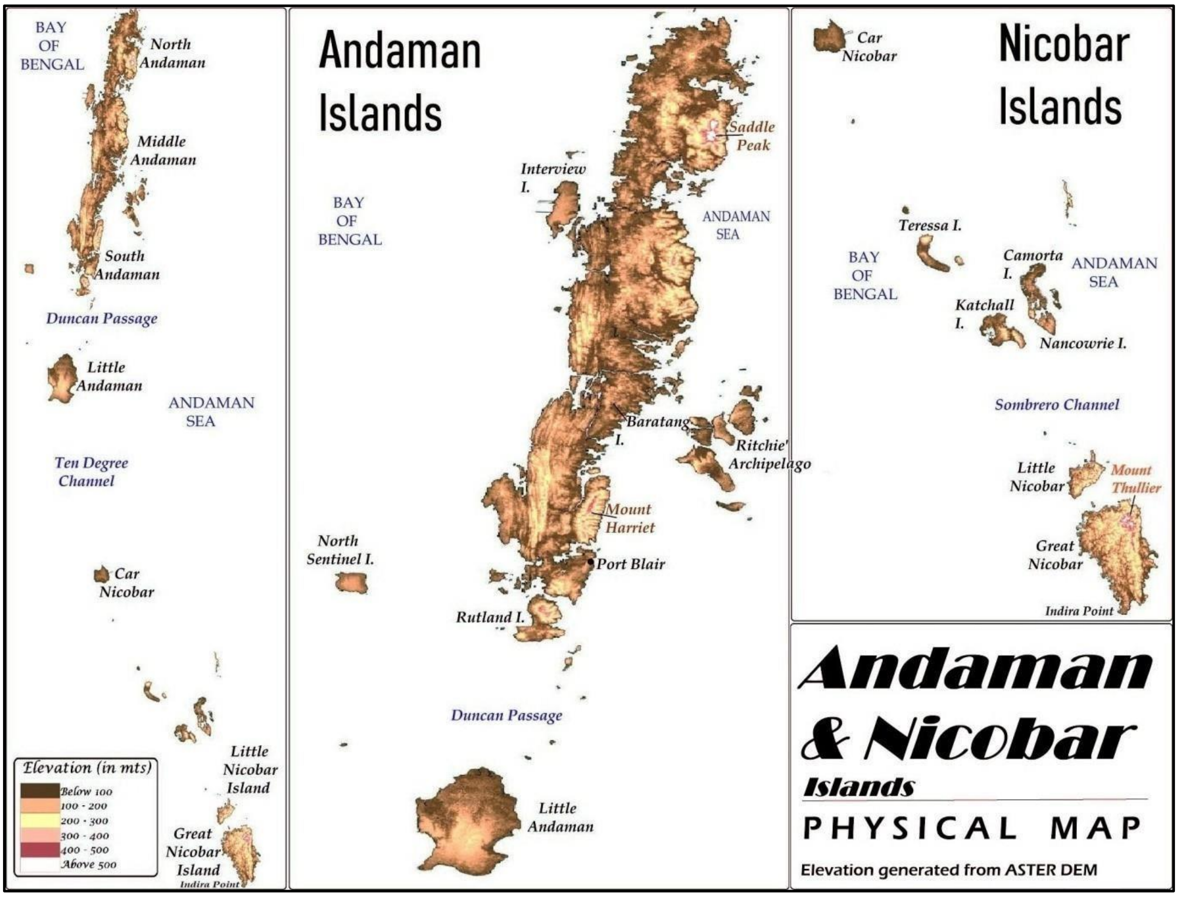


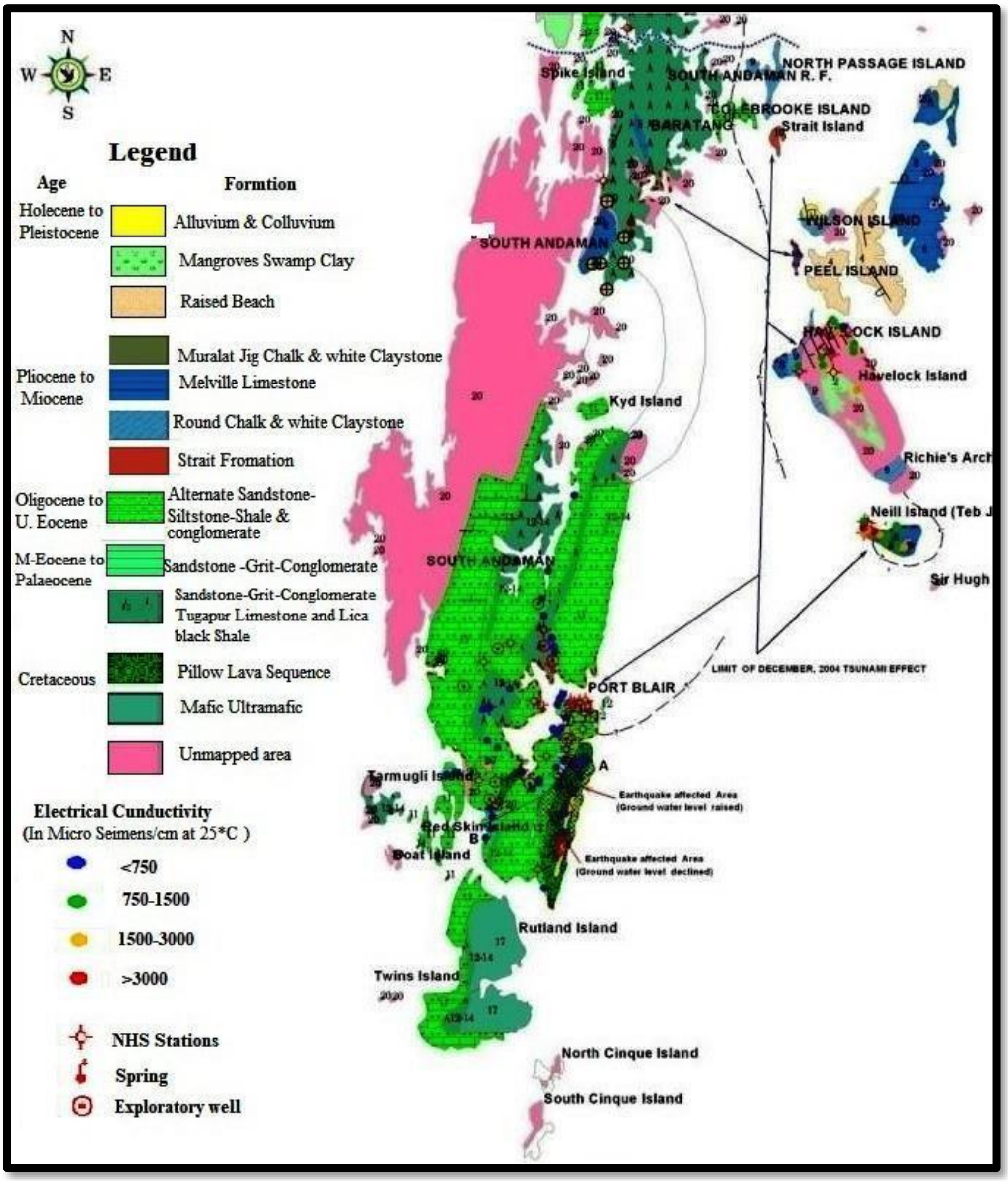
Figure-3.2: Physiographic map of Andaman & Nicobar Islands

3.3 Geology

Geologically marine sedimentary group of rocks comprising shale, sandstone, grit and conglomerate; extrusive and intrusive igneous rocks (volcanic and ultramafic) and coralline atolls and limestone occupy the entire geographical area. Amongst these, the sedimentary origin formations are most pervasive and occupies nearly 70% of the geographical area of the islands while the igneous origin formations covers nearly 15% while the rest 15% goes to the coralline and limestone formations. All these rock formations have been subjected to chain of tectonically active zone, evident from the occurrence of shallow and deep focus earthquakes in the islands. Because of tectonic activity, the Igneous and Sedimentary group of rocks are highly fractured and fissured. These fracturing in hard rock form conduits for movement of ground water in the deeper horizon. The geology of the islands is highly varied within a small distance.

Late Cretaceous igneous rocks, the ophiolite suite, marine sedimentary rocks of Paleocene to Oligocene age and Recent to Sub-Recent beach sand, mangrove clay, alluvium and coral rags are predominant in the area. The Ophiolite suite of rocks comprises of a wide variety of acidic to ultrabasic plutonic rocks and their equivalent basic volcanic rocks occur in sporadic patches in both Andaman and Nicobar Group of Islands.

Other rock types, white clay beds and raised coralline limestone are of late Pliocene to Pleistocene age. The rocks of this group are generally rendered good aquifers due to krastification. The ophiolite and marine sedimentaries have undergone different phases of folding, faulting. The area is considered to be orogenically active even today. The generalized geological map is shown in Figure-2.4 and the geological succession of Andaman and Nicobar Islands is given in Table-2.1.



Figure–3.3: Geological map of Andaman & Nicobar Islands

Table-3.2: Generalized Geological Succession of Andaman & Nicobar Islands

Age	Group	Formation
Recent to sub-Recent	Quaternary Holocene Group	Beach sands, Mangrove clay, Alluvium, Coral rags and Shell limestone, loosely consolidated pebble beds
~~	**Unconformity**	~~~~~~~~~~~~~~~~
Pleistocene to Late Pliocene	Nicobar Group	Shell limestone, Sandstone, Claystone, etc.
Miocene	Archipelago Group (Upper)	White claystone, Melville Limestone
~~	**Unconformity**	~~~~~~~~~~~~~~~~
Oligocene to Paleocene	Andaman Flysh , Mithakhari Group	Thinly bedded alternations of Sandstones and siltstones, grit, conglomerate, Limestones, black Shales with olistiliths.
~~	**Unconformity**	~~~~~~~~~~~~~~~~
Late Cretaceous	Ophiolite Group	Dyke swarms, acidic suite,Pillow lava with radiolarian chert and ultramafic suite.

Hydro-geologically, there are three major formations in the Andaman and Nicobar Group of Islands:

- Porous formation consist of beach sand with coral rags and shale,
- Thin cover of alluvium in the valleys and foot hills adjacent to valleys
- Moderately thick pebbly valley fill deposits (colluvium) in the narrow inter-montane valley constitute the water table aquifer.

The thickness of beach sand and alluvial deposits ranges between 3 to 6 m. and sometimes ranges up to 9 m. In Great Nicobar the thickness is thinner, only 2 to 2.5 m. The colluvial deposits in narrow inter-montane valley e.g., Beadnabad valley have much higher potentiality. One bore well of 152 mm diameter was drilled by CGWB down to 16.50 mbgl tapping the total thickness of the saturated colluvial deposits and yielded 72 m^3/hr. and pumping for 500 minutes did not show any deterioration in chemical quality. The drawdown was recorded as 5.67 m and Transmissivity was calculated as 127m^2/day. The well could cater to the domestic need of 10000 rural populations.

The fissured formation consists of the Upper Cretaceous Ophiolite Suite of rocks including the basic volcanics, the ultrabasic and intermediate to acid plutonic rocks. Based on the compactness and fracturing of these rocks as revealed by exploratory drilling carried out in parts of the island the rocks are again classified as consolidated group and semi consolidated group. The fractured upper Cretaceous igneous rocks and the Lower Tertiary conglomerate, grits, graded sandstone (greywacke) and their weathered upper mantle form the aquifers, the weathered mantle is seldom 3 to 4 m thick but adjacent to the valleys it is about 6 m. The saturated thickness of the weathered mantle and the immediately underlying shallow fracture zones form the water table aquifer. Deeper fracture zones within 60 m below ground level form semi-confined to confined aquifer. The generalized geological succession of Andaman & Nicobar Islands has been given in Table-2.1 and Geology and Hydro-geological map of the islands is shown in Figure–2.5.

The fractured volcanic rocks at places e.g. Brichganj, Hamfreganj are not productive as the yield of the tube wells were in the order of 1.18 m^3/hr and 0.52 m^3/hr, respectively. It appears that the fractured volcanic rocks are most productive where they are intruded by the ultrabasics. The area covered by the fractured sedimentary rocks, 13 exploratory bore holes were drilled and 2 bore holes were found successful i.e. at Potheropore and Dithaman Tank. At both the places Mithakari Sandstones and Shales were encountered, the productive fracture zones at Prothrapore between 25 to 60 meter, but yielded 17 m^3/hr water which is brackish. The borehole at Dilthaman Tank yielded very less but EC value was less and water potable. The boreholes drilled at other places in the sedimentary rocks through dark grey shale of Mithakari Group were found dry.

It is apparent from the study that the weathered sandstone are poor aquifers whereas the weathered volcanic rocks act as moderate to good aquifers at suitable locales. Results of 18 exploratory bore wells in South Andaman show that the deeper fractures imparting secondary porosity and permeability are restricted within 60 m bgl in sedimentary rocks and within 52.7 m in the volcanic and the intermediate plutonic rocks. The most productive fracture zones are in the volcanic rocks as noticed at Calicut in the depth range of 14-20 m, and 45-52 m where an intrusion of ultrabasic rock (Serpentinites) was noticed. The yield of the bore well was recorded as 44.67 m^3/hr, draw down after 500 minutes of pumping was 8.23 m, Transmissivity was calculated and found to be 39.6 m^2/day.

The area covered by semi consolidated Lower Tertiary sedimentary rocks in the Great Nicobar Island were also explored and found the thin bedded fine grained sand stone – clay stone alternation cannot be properly termed as aquifers. The maximum discharge obtained by tapping 31 m thick fine grained, soft argillaceous sand stone within 20 - 92 m bgl, was 187 litres/hr and quality of water was found good. Better discharge has been found in the same Island, but the quality of water was brackish (EC : 4503 µS/cm at 25° C).

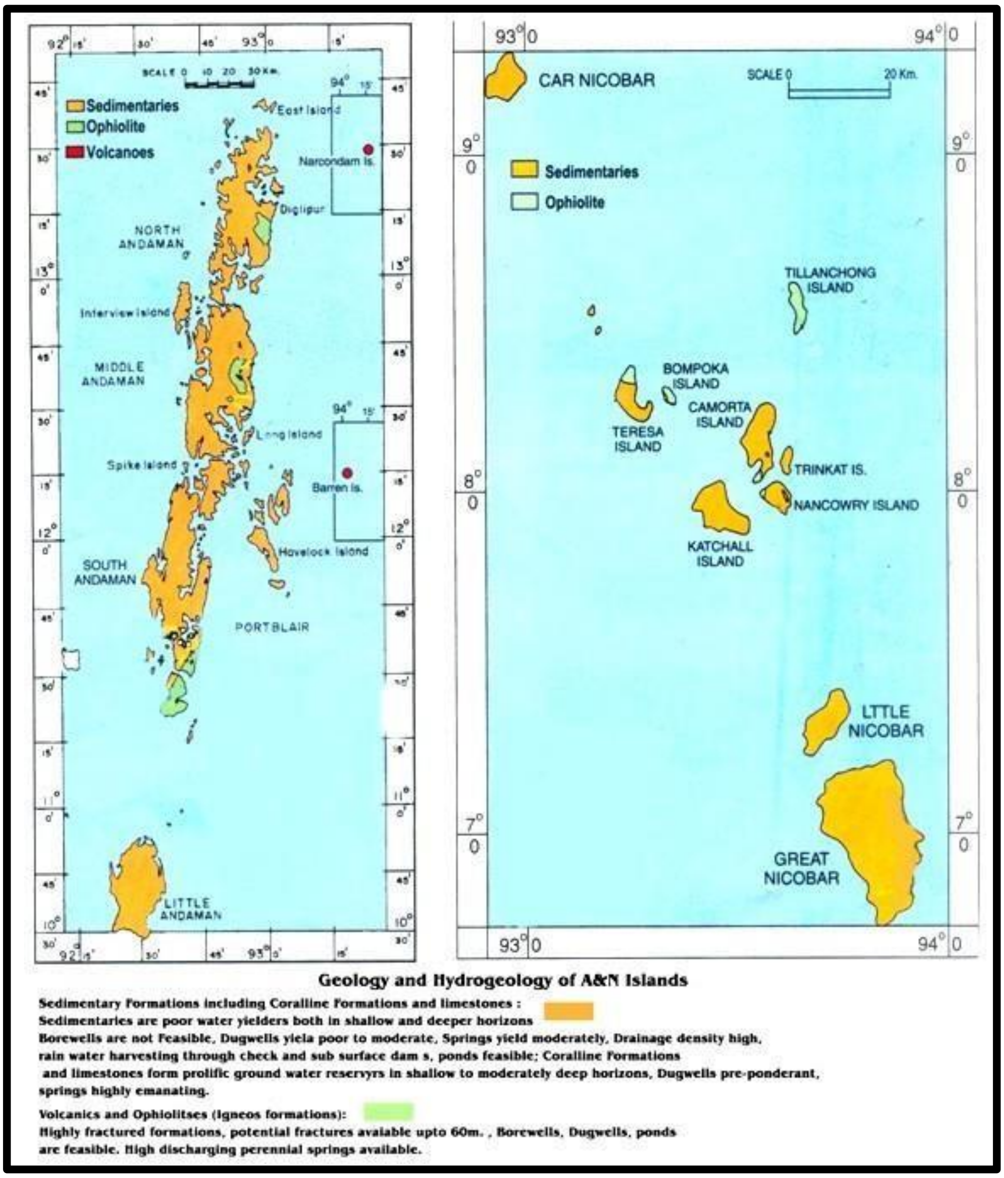
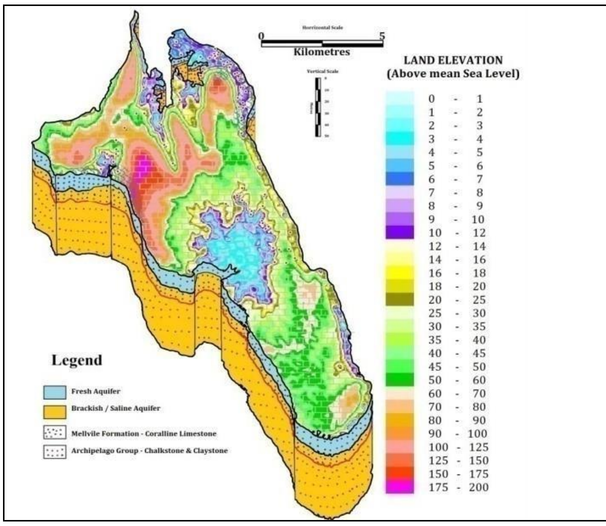
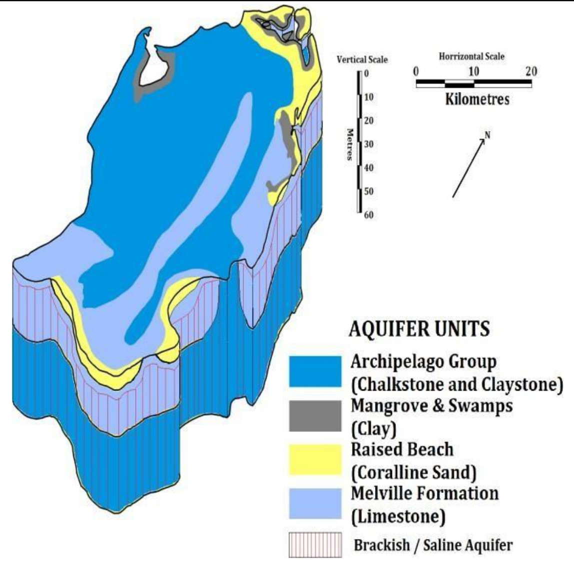


Figure – 3.4: Geology and Hydrogeology of Andaman & Nicobar Islands



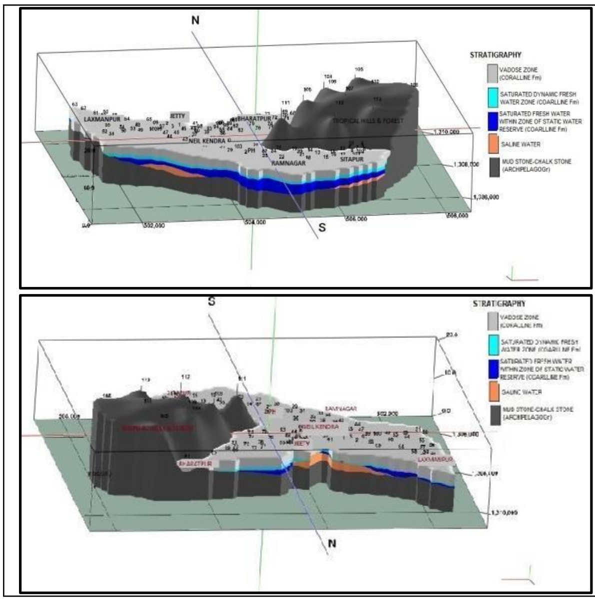
- Two aquifer groups occur down to the depth of 60mbgl.
- **Shallow aquifer (A1):** occurs up to depth of 30 mbgl; Yield potential: 5- 25 lps.
- **Deeper aquifer (A2):** occurs in the depth span of 45-60 mbgl; Yield potential: Negligible – 12 lps

Figure 3.5: Aquifer Disposition in Havelock Island



- Only Eastern part Explored in details
- Two aquifer groups occur down to the depth of 60mbgl.
- **Shallow aquifer (A1):** occurs up to depth of 25 mbgl; 2 Sub-Aquifers, Middle Aquifer is Fresh overlain by thin top Saline Aquifers. Yield potential: 5-15 lps.
- **Deeper aquifer (A2):** occurs in the depth span of 30-60 mbgl; Yield potential: Negligible - Hardly explored
- Fractures and cavernous Limestones have been detected in Geophysical surveys upto 120mbgl

Figure -3.6: Aquifer disposition in Little Andaman Island



- Two aquifer groups occur down to the depth of 60mbgl.
- **Shallow aquifer (A1):** occurs up to depth of 30 mbgl; 3 Sub-Aquifers, Middle Aquifer is Fresh and sandwiched between top and bottom Saline Aquifers. Yield potential: 5-10 lps.
- **Deeper aquifer (A2):** occurs in the depth span of 30-60 mbgl; Yield potential: Negligible – 5 lps; Hardly explored

Figure - 3.7: Aquifer disposition in Neil Island

3.4 Ground water level conditions – water level, fluctuation, trend

In sedimentary rock in valleys and adjacent to Bays, depth of dug wells are generally restricted to 3.5 to 4 m bgl, depth to water level in the dug wells in valleys 2.5 to 2.75 m, and in the igneous rock in same physiographic unit depth to water level generally less than 3 mbgl, with a seasonal fluctuation around 1.5 to 2.5 m. Sp. Capacity of lower Tertiary

Sandstone, was found very low in the range of 1.12 to 2.61 lpm/m, in the weathered volcanic rock sp. Capacity values was in the order of 0.79 and 9.55 lpm/m.

During pre-monsoon in 2023, minimum water level 0.01 mbgl at Rangachang in South Andaman and maximum of 6.17 mbgl at Calicut (Tube-well) in South Andaman have been recorded; during post-monsoon 2023, maximum water level of 10.52 mbgl at Calicut (Tube Well) in South Andaman and a minimum of 0.01 mbgl in Port Blair in South Andaman have been recorded. Average depth to water level in respective islands is as follows:

Table 3.3: Average depth to water level in different islands

Islands	South Andaman	Middle Andaman	North Andaman	Long Island	Havelock Island	Neil Island
Pre-monsoon 2023	2.23	1.97	2.56	2.02	2.45	3.61
Post-monsoon 2023	1.18	0.76	0.65	0.83	1.16	2.1
Fluctuation 2023	1.05	1.21	1.91	0.99	1.29	1.51

In order to study the behavior of ground water regime with time and space in Andaman & Nicobar Islands, 112 Hydrograph Monitoring Stations were established in seven islands, viz. South Andaman, North Andaman, Middle Andaman, Long Island, Havelock Island and Neil Island. Periodic water level measurements are being taken 2 times in the year, for pre-monsoon period during May and for the post-monsoon period during December.

3.5 Ground water quality

The quality of ground water throughout the island is neutral to alkaline as envisaged from the analytical results of water samples collected from the existing monitoring stations and reference wells (all dug wells). It is generally of the calcium bicarbonate type, and the bicarbonate content varies from 91 to 427 ppm greatly predominates over the chloride content varying between 14-202 ppm. Computation of the chloride-bicarbonate ratio of ground water from the islands show that the ratio varies between 0.1 to 0.2 which indicates that there has been no large scale saline water intrusion at any place in the islands. In general, the ground water is fresh with low mineralization having Electrical Conductivity (EC) ranging from 292 to 1120 μS /cm at 25° C, baring a few cases eg.1340 μS/cm at 25° C at Marina Park, (South Andaman) and at Sitanagar, (North Andaman), > 200 μS /cm at Saitankhari (South Andaman). Iron concentration in ground water are mostly within the permissible limit, except Namunanagar (1.36 ppm), Light House (2.15 ppm), at Annicut (2.59 ppm). As the islands are located in scattered manner, preparation of EC map is not logical in this hydro-geological set up.

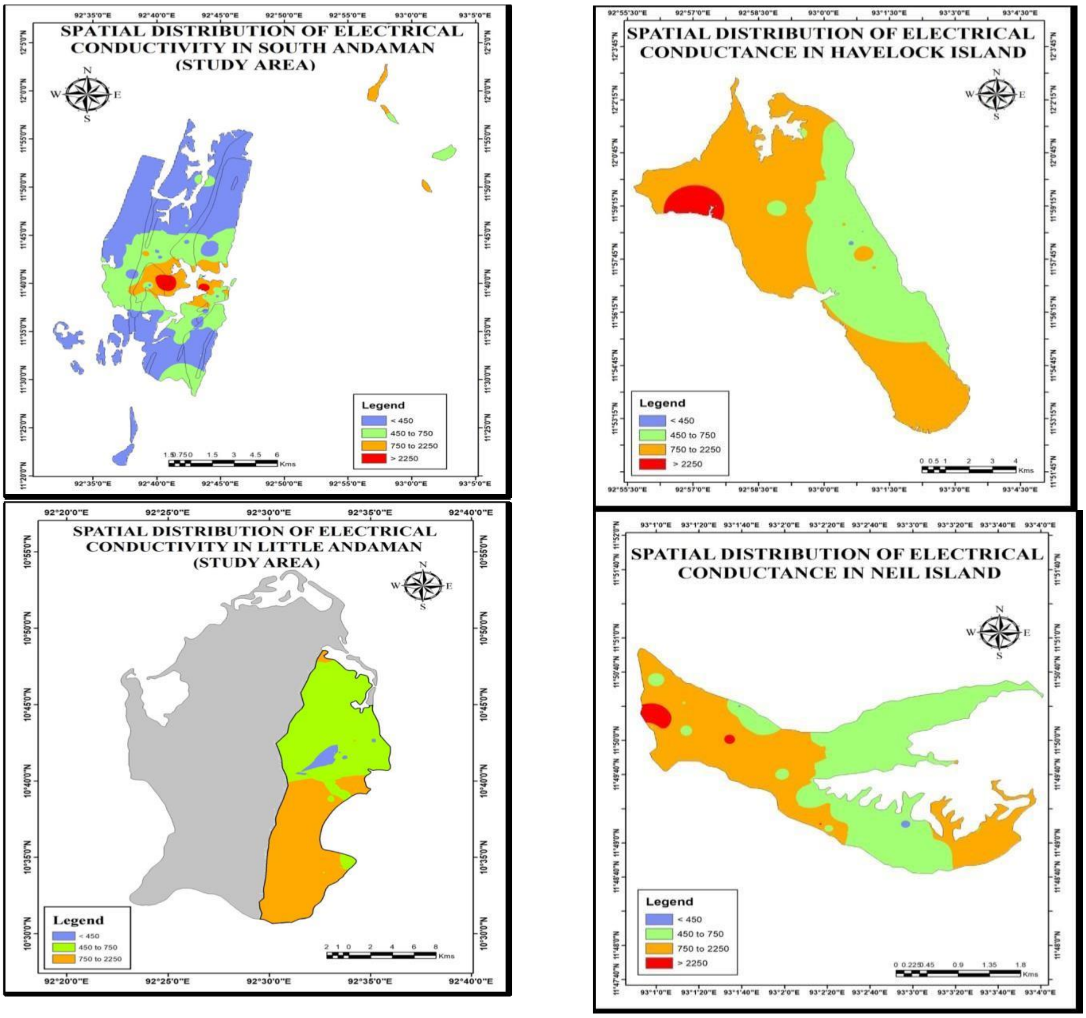


Figure-3.8: Spatial variation in Ground Water Quality in A & N Islands

CHAPTER-4

GROUND WATER LEVEL SCENARIO

4.1 Ground water level conditions – water level, fluctuation, trend

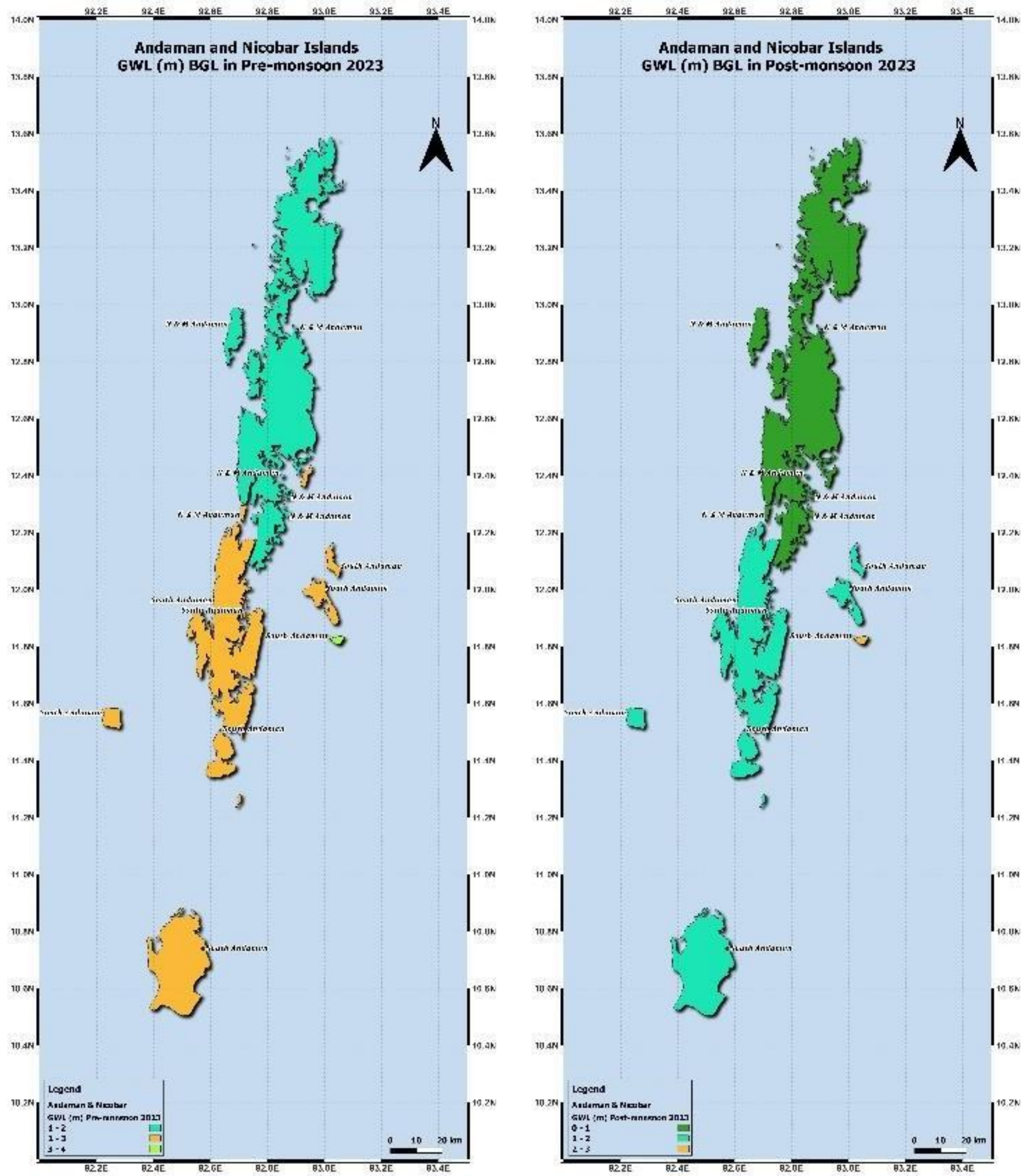
In sedimentary rock in valleys and adjacent to Bays, depth of dug wells are generally restricted to 3.5 to 4 m bgl, depth to water level in the dug wells in valleys 2.5 to 2.75 m, and in the igneous rock in same physiographic unit depth to water level generally less than 3 mbgl, with a seasonal fluctuation around 1.5 to 2.5 m. Sp. Capacity of lower Tertiary Sandstone, was found very low in the range of 1.12 to 2.61 lpm/m, in the weathered volcanic rock sp. Capacity values was in the order of 0.79 and 9.55 lpm/m.

During pre-monsoon in 2023, minimum water level 0.01 mbgl at Rangachang in South Andaman and maximum of 6.17 mbgl at Calicut (Tube-well) in South Andaman have been recorded; during post-monsoon 2023, maximum water level of 10.52 mbgl at Calicut (Tube Well) in South Andaman and a minimum of 0.01 mbgl in Port Blair in South Andaman have been recorded. Average depth to water level in respective islands is as follows:

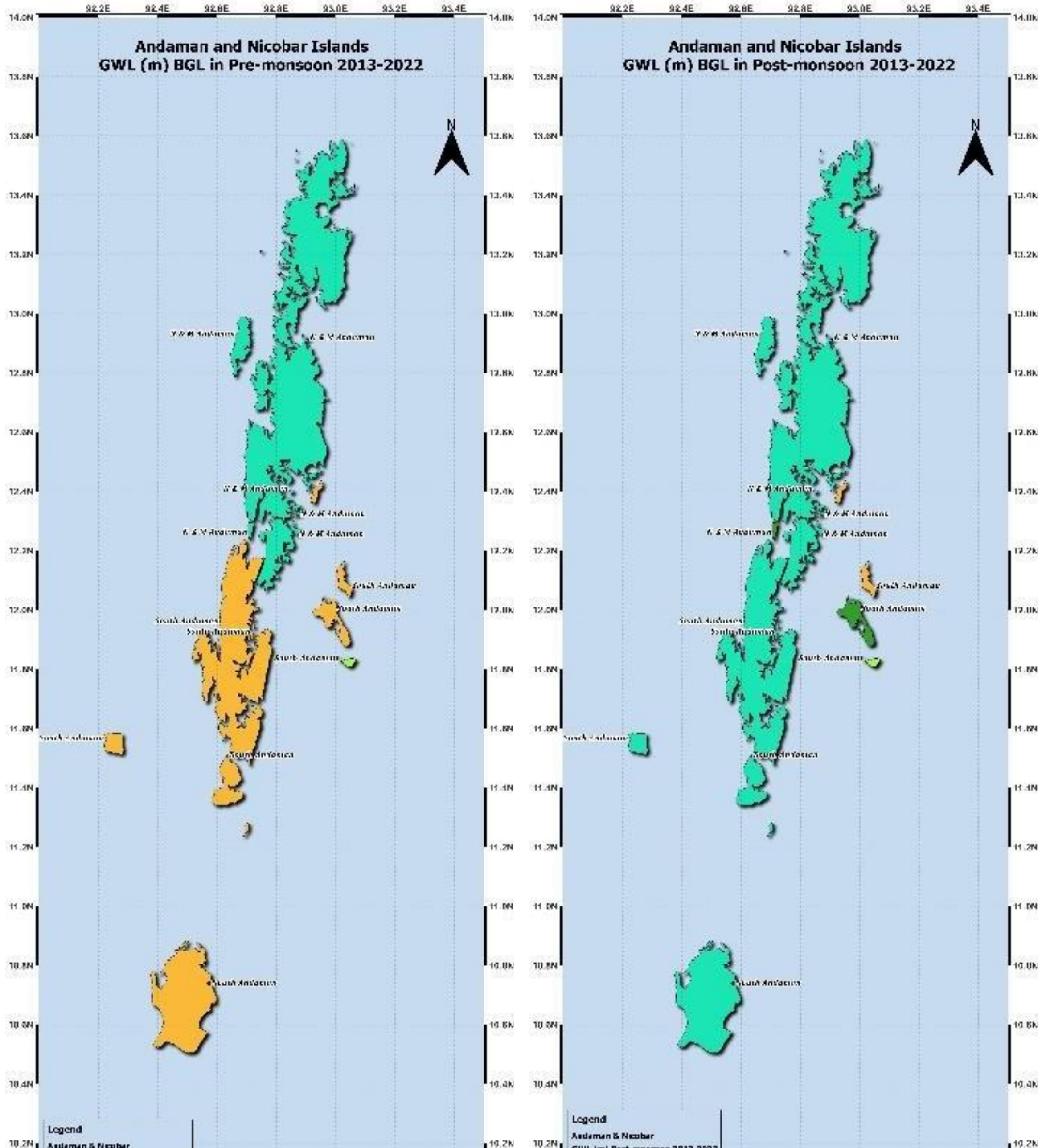
Table 4.1: Average depth to water level in different islands

Season	GWL (in meter) BGL					
	South Andaman	Middle Andaman	North Andaman	Long Island	Havelock Island	Neil Island
Pre-monsoon 2023	2.23	1.97	2.56	2.02	2.45	3.61
Post-monsoon 2023	1.18	0.76	0.65	0.83	1.16	2.1
Pre-monsoon 2022	1.8	0.9	0.9	1.1	1	3
Post-monsoon 2022	1.3	1	0.6	1.1	1.1	2
Pre-monsoon 2013-2022	2.03	1.71	1.72	2.28	2.36	3.87
Post-monsoon 2013-2022	1.18	1.04	0.81	1.52	0.82	2.56
Fluctuation 2023	1.05	1.21	1.91	0.99	1.29	1.51
Fluctuation 2022	0.5	0.1	0.3	00	0.1	1
Fluctuation 2013-2022	0.8	0.7	0.9	0.8	1.5	1.3

In order to study the behavior of ground water regime with time and space in Andaman & Nicobar Islands, 112 Hydrograph Monitoring Stations were established in seven islands, viz. South Andaman, North Andaman, Middle Andaman, Long Island, Havelock Island and Neil Island. Periodic water level measurements are being taken 2 times in the year, for pre-monsoon period during May and for the post-monsoon period during December.



Figure–4.1: GWL during pre- and post-monsoon season in 2023 over Andaman and Nicobar Islands



Figure–4.2: Decadal (2013-2022) mean GWL during pre- and post-monsoon seasons over Andaman and Nicobar Islands

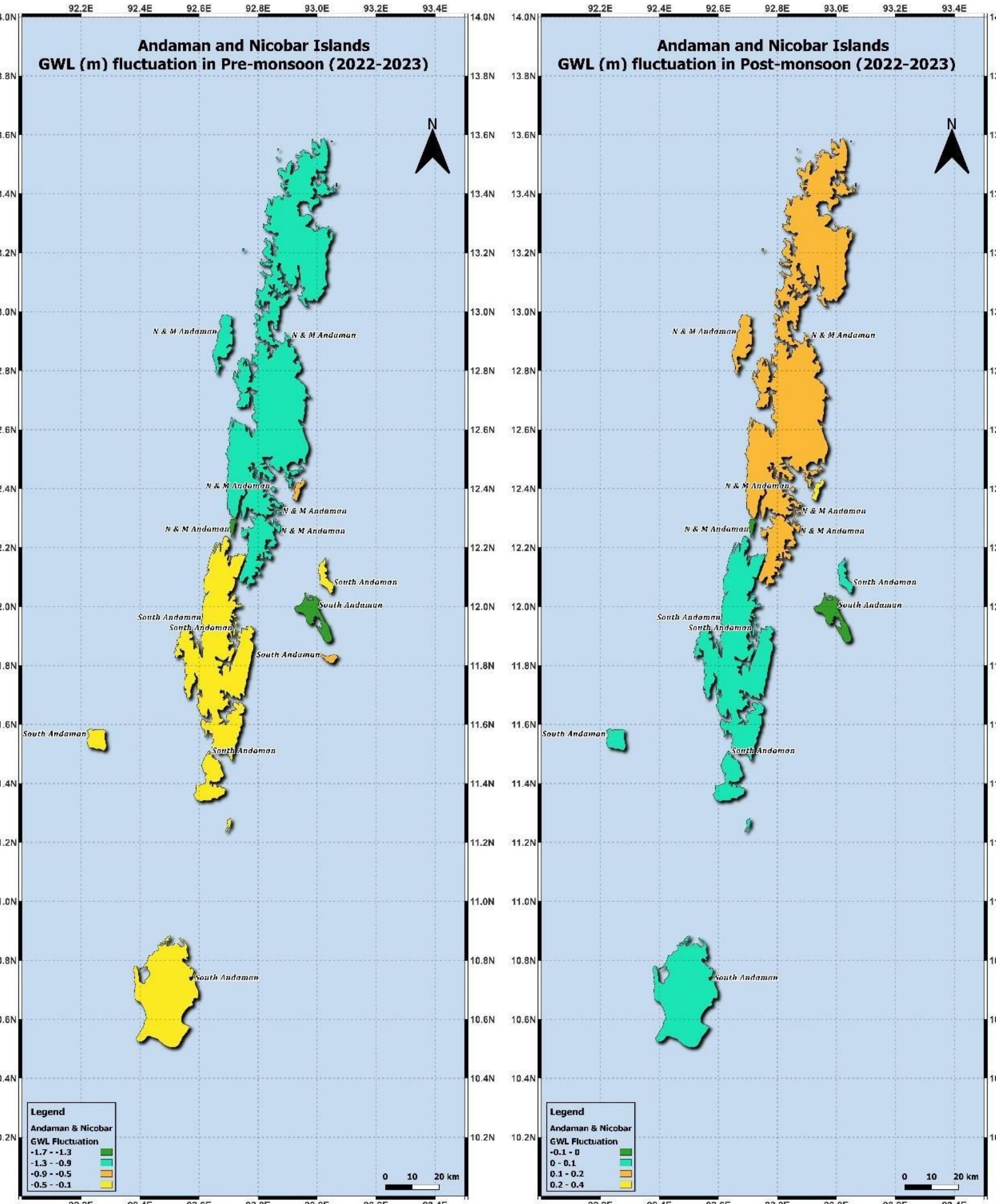
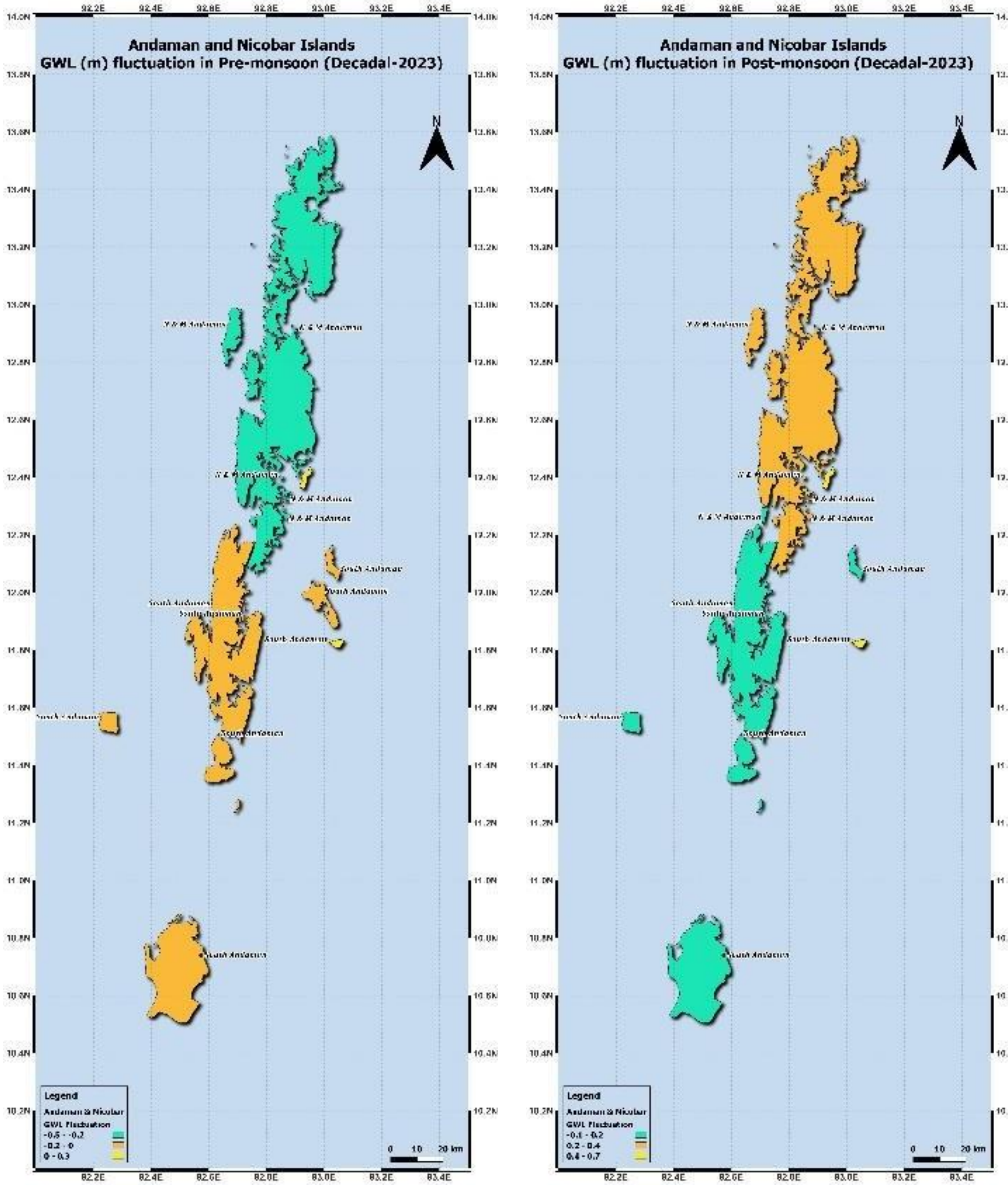


Figure 4.3: Fluctuation of GWL during pre- and post-monsoon season 2022-2023 over Andaman and Nicobar Islands



Figure–4.4: GWL fluctuation pre- and post-monsoon (Decadal (2013-2022) mean - 2023) season over Andaman and Nicobar Islands

CHAPTER 5

GROUND WATER RESOURCES

5.1 Computation of Ground Water Resources in Andaman and Nicobar Islands

5.1.1. Salient features of the dynamic ground water resources assessments including the type assessment units, total number of assessment units in the state, base-year of collection of data, year of projection of data

- Assessment Unit: Inhabited islands of Andaman and Nicobar Islands.
- Assessment Sub Unit: Non-Command area in the 36 Islands (29 inhabited islands) of Andaman and Nicobar group of islands.
- Total number of Assessment Units in Andaman and Nicobar islands:
- 36 Islands (29 inhabited islands)
- Total Number of sub units: 36 Islands (29 inhabited islands) - all of
- which are Non-command areas.
- Base Year of Data Collection:2023-2024 (As on 31.03.2024)

Table–5.1: Island wise Recharge worthy area in Andaman & Nicobar Island

District	Tehsil	Island/ Assessment Uni	Area(Ha)				
			Geographical Area	Hilly Area	Recharge Worthy Area	Non Command Area	Poor Ground Water Quality Area
North and Middle	Diglipur	East Island	611.00	305.00	306.00	306.00	0.00
		Narcondam Island	681.00	320.00	361.00	361.00	0.00
		North Andaman	137599.00	113825.00	23774.00	23774.00	0.00
		Smith Island	2470.00	1579.00	891.00	891.00	0.00
		Block Total	**141361.00**	**116029.00**	**25332.00**	**25332.00**	**0.00**
	Mayabunder	Aves Island	20.00	4.00	16.00	16.00	0.00
		Interview Island	13300.00	10500.00	2800.00	2800.00	0.00
		Stewart Island	723.00	360.00	363.00	363.00	0.00
		Block Total	**14043.00**	**10864.00**	**3179.00**	**3179.00**	**0.00**
	Rangat	Baratang Island	29760.00	21560.00	8200.00	8200.00	0.00
		Long Island	1790.00	688.00	1102.00	1102.00	0.00
		Middle Andaman	153550.00	134837.00	18713.00	18713.00	0.00
		North Passage Island	2196.00	1190.00	1006.00	1006.00	0.00
		Porlob Island	845.00	538.00	307.00	307.00	0.00
		Strait Island	601.00	400.00	201.00	201.00	0.00
		Block Total	**188742.00**	**159213.00**	**29529.00**	**29529.00**	**0.00**
		DISTRICT TOTAL	**499550.00**	**412999.00**	**86551.00**	**86551.00**	**0.00**
Nicobar	Car Nicobar	Car Nicobar Island	12691.00	5690.00	7001.00	7001.00	0.00
		Block Total	**12691.00**	**5690.00**	**7001.00**	**7001.00**	**0.00**
	Great Nicobar	Great Nicobar Island	1004454.00	94411.00	10043.00	94411.00	0.00
		Kondul Island	466.00	123.00	343.00	343.00	0.00
		Little Nicobar Island	15902.00	12800.00	3102.00	3102.00	0.00
		Pulo Milo Island	129.00	34.00	95.00	95.00	0.00
		Block Total	**120951.00**	**107411.00**	**13583.00**	**97951.00**	**0.00**

	Nancowry	Bampooka Island	1346.00	840.00	506.00	506.00	0.00
		Chowra Island	828.00	0.00	828.00	0.00	828.00
		Kamorta Island	18803.00	12802.00	6001.00	6001.00	0.00
		Katchal Island	17430.00	11000.00	6430.00	6430.00	0.00
		Nancowrie Island	6682.00	5500.00	1182.00	1182.00	0.00
		Teressa Island	10126.00	9010.00	1116.00	1116.00	0.00
		Tillangchang Island	1683.00	981.00	702.00	702.00	0.00
		Trinket Island	3626.00	2900.00	726.00	726.00	0.00
		Block Total	**60524.00**	**43033.00**	**38075.00**	**16663.00**	**828.00**
		DISTRICT TOTAL	**327808.00**	**156134.00**	**227395.00**	**226567.00**	**828.00**
South Andaman	**Ferrarganj**	Ferrargunj	338.81	338.81	0.00	0.00	0.00
		Flatbay Island	936.00	606.00	330.00	330.00	0.00
		Viper Island	50.00	26.00	24.00	24.00	0.00
		Block Total	**1324.81**	**970.81**	**354.00**	**354.00**	**0.00**
	Little Andaman	Little Andaman	73439.00	68649.00	4790.00	4790.00	0.00
		Block Total	**73439.00**	**68649.00**	**4790.00**	**4790.00**	**0.00**
	Port Blair	Havelock Island	11393.00	7560.00	3833.00	3833.00	0.00
		John Lawrence Island	4198.00	3190.00	1008.00	1008.00	0.00
		Neil Island	1890.00	647.00	1243.00	1243.00	0.00
		North Sentinnel Island	5967.00	5060.00	907.00	907.00	0.00
		Peel Island	435.00	250.00	185.00	185.00	0.00
		Rutland Island	13717.00	7710.00	6007.00	6007.00	0.00
		South Andaman	134820.00	121623.00	13197.00	13197.00	0.00
		Block Total	**172420.00**	**146040.00**	**26380.00**	**26380.00**	**0.00**
		DISTRICT TOTAL	**321947.62**	**285279.62**	**36668.00**	**36668.00**	**0.00**
		STATE TOTAL	**1149305.62**	**854412.62**	**410614.00**	**349786.00**	**828.00**

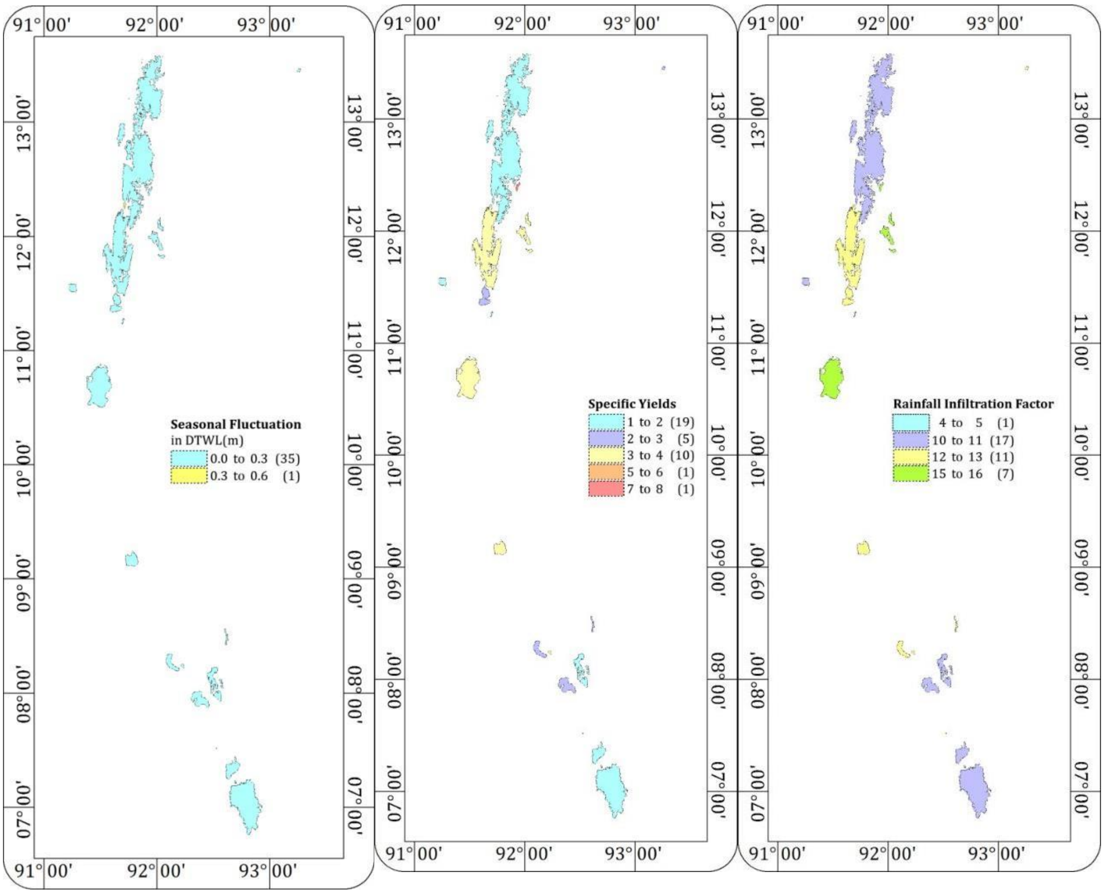
5.1.2. Assessment sub-unit-wise method adopted for computing rainfall recharge during monsoon season (WLF/RIF)

Rainfall infiltration (RIF) method has been adopted for computing rainfall recharge during monsoon as well as non-monsoon.

Table–5.2: Input variables used in GWRE 2024 in Andaman & Nicobar Island

Sl	DISTRICT	Block/ Tehsil	Island/ Assessment Unit Name	Normal Annual Rainfall	Specific Yield	Rainfall Infiltration Factor
				(mm)	(Normative)	(Normative)
1	N & M Andaman	Diglipur	East Island	3015.7	1	10
2			Narcondam Island	3015.7	1	10
3			North Andaman	3015.7	2	12
4			Smith Island	3015.7	1	10
5		Mayabunder	Aves Island	3015.7	3	12
6			Interview Island	3015.7	1	4
7			Stewart Island	3015.7	1	10
8		Rangat	Baratang Island	3015.7	1	12
9			Long Island	3015.7	1	10
10			Middle Andaman	3015.7	7	15
11			North Passage Island	3015.7	1	15
12			Porlob Island	3015.7	1	10
13			Strait Island	3015.7	3	12
14		Car Nicobar	Car Nicobar Island	2805.2	3	12
15		Great Nicobar	Great Nicobar Island	2805.2	1	10
16			Kondul Island	2805.2	3	12
17			Little Nicobar Island	2805.2	1	10

Sl	DISTRICT	Block/ Tehsil	Island/ Assessment Unit Name	Normal Annual Rainfall	Specific Yield	Rainfall Infiltration Factor
				(mm)	(Normative)	(Normative)
18	Nicobar		Pulo Milo Island	3015.7	1	10
19		Nancowry	Bampooka Island	2805.2	3	12
20			Chowra Island	2805.2	5	15
21			Kamorta Island	2805.2	1	10
22			Katchal Island	2805.2	2	10
23			Nancowrie Island	2805.2	1	10
24			Teressa Island	2805.2	2	12
25			Tillangchang Island	2805.2	2	12
26			Trinket Island	2805.2	1	10
27	South Andaman	Ferrarganj	Flatbay Island	3015.7	1	10
28			Viper Island	3015.7	1	10
29			Little Andaman	3015.7	3	15
30		Little Andaman	Havelock Island	3015.7	3	15
31		Port Blair	John Lawrence Island	3015.7	3	15
32			Neil Island	3015.7	3	15
33			North Sentinnel Island	3015.7	1	10
34			Peel Island	3015.7	1	10
35			Rutland Island	2805.2	2	12
36			South Andaman	3015.7	3	12



Figure–5.1: **Spatial Distribution of Input variables used in GWRE 2023 in A & N Islands a) Seasonal Fluctuation in Depth to Water Level, b) Specific Yield (Normative) c) Rainfall Infiltration Factor (Normative)**

5.2 Annual Ground Water Recharge

For estimation of dynamic ground water resources of Andaman and Nicobar islands, Rainfall infiltration Factor (RIF) has been adopted for computation. Total 36 Islands (29 inhabited islands) have been taken into account for ground water resource calculation. These 36 islands are belonging to three districts namely North & Middle Andaman district, South Andaman district and Nicobar district. For three districts stage of ground water development ranges from 0.28 % to 3.44 %, with the overall Stage of Ground Water Abstraction being pegged at 2.08% . Out of all the assessed islands – 1 is Hilly, 1 is Saline (Poor Ground Water Quality Area) and rest are classified under Safe category.

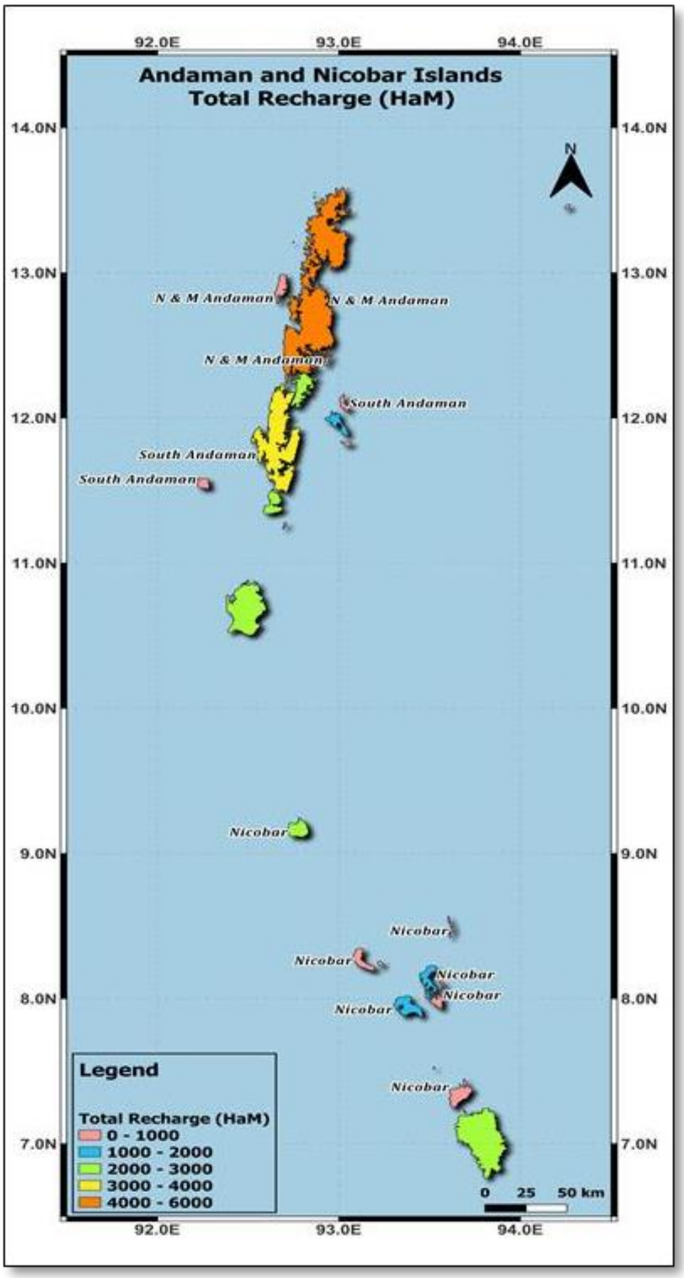
5.2.1 Spatial variation of the Ground water recharge and development scenario in the State/ district-wise:

District wise variations of recharge from rainfall during monsoon have been assessed. Total annual recharge in the Andaman and Nicobar Island is estimated as **37965.72 ham** and total natural discharges is calculated as **3796.58 ham**. Net ground water availability (annual extractable ground water resources) of the island is estimated as **34169.14 ham.**

Table–5.3: Computed Recharge(GWRE 2024) in Andaman & Nicobar Island

District	Block	ISLAND	Rainfall (mm)	GW recharge (Ham)			Annual Ground water Recharge (ham)	Environmental Flows (ham)	Annual Extractable Ground water Resource (ham)
				Rainfall Recharge	Tanks and Ponds	Total			
N & M Andaman	Diglipur	East Island	2913.3	89.14	0	89.14	89.14	8.92	80.22
		Narcondam Island	2913.3	126.2	0	126.2	126.2	12.62	113.58
		North Andaman	2913.3	6030.09	96.48	6126.57	6126.57	612.65	5513.92
		Smith Island	2913.3	311.49	0	311.49	311.49	31.15	280.34
		Block Total		**6556.92**	**96.48**	**6653.4**	**6653.4**	**665.34**	**5988.06**
	Mayabunder	Aves Island	2913.3	1.87	0.84	2.71	2.71	0.27	2.44
		Interview Island	2913.3	815.72	0	815.72	815.72	81.57	734.15
		Stewart Island	2913.3	126.9	0	126.9	126.9	12.69	114.21
		Block Total		**944.49**	**0.84**	**945.33**	**945.33**	**94.53**	**850.8**
	Rangat	Baratang Island	2913.3	2388.91	10.81	2399.72	2399.72	239.98	2159.74
		Long Island	2913.3	419.27	0.07	419.34	419.34	41.93	377.41
		Middle Andaman	2913.3	4746.4	43.54	4789.94	4789.94	478.99	4310.95
		North Passage Island	2913.3	439.62	0.16	439.78	439.78	43.98	395.8
		Porlob Island	2913.3	89.44	0	89.44	89.44	8.95	80.49
		Strait Island	2913.3	70.27	0	70.27	70.27	7.03	63.24
		Block Total		**8153.91**	**54.58**	**8208.49**	**8208.49**	**820.86**	**7387.63**
		District Total		**15655.32**	**151.9**	**15807.22**	**15807.22**	**1580.73**	**14226.49**

District	Block	ISLAND	Rainfall (mm)	GW recharge (Ham)			Annual Ground water Recharge (ham)	Environmental Flows (ham)	Annual Extractable Ground water Resource (ham)
				Rainfall Recharge	Tanks and Ponds	Total			
Nicobar	Car Nico	Car Nicobar Island	2805.2	2356.7	0.1	2356.8	2356.8	235.68	2121.12
		Block Total		**2356.7**	**0.1**	**2356.8**	**2356.8**	**235.68**	**2121.12**
	Great Nicobar	Great Nicobar Island	2805.2	2817.26	15.6	2832.86	2832.86	283.29	2549.57
		Kondul Island	2805.2	115.46	0.16	115.62	115.62	11.56	104.06
		Little Nicobar Islan	2805.2	870.17	0	870.17	870.17	87.02	783.15
		Pulo Milo Island	2805.2	31.98	0	31.98	31.98	3.2	28.78
		Block Total		**3834.87**	**15.76**	**3850.63**	**3850.63**	**385.07**	**3465.56**
	Narcowry	Bampooka Island	2805.2	170.33	0	170.33	170.33	17.03	153.3
		Chowra Island	2805.2	348.4	0	348.4	348.4	34.84	313.56
		Kamorta Island	2805.2	1683.4	0.02	1683.42	1683.42	168.35	1515.07
		Katchal Island	2805.2	1803.74	0	1803.74	1803.74	180.37	1623.37
		Nancowrie Island	2805.2	331.57	0.2	331.77	331.77	33.18	298.59
		Teressa Island	2805.2	375.67	0.02	375.69	375.69	37.57	338.12
		Tillangchang Island	2805.2	236.31	0	236.31	236.31	23.63	212.68
		Trinket Island	2805.2	203.65	0.04	203.69	203.69	20.37	183.32
		Block Total		**5153.07**	**0.28**	**5153.35**	**5153.35**	**515.34**	**4638.01**
		District Total		**11344.64**	**16.14**	**11360.78**	**11360.78**	**1136.09**	**10224.69**
South Andaman	Little Andaman	Little Andaman	3015.7	2166.78	0	2166.78	2166.78	216.67	1950.11
		Block Total		**2166.78**	**0**	**2166.78**	**2166.78**	**216.67**	**1950.11**
	Port Blair	Havelock Island	3015.7	1531.81	0.32	1532.13	1532.13	153.21	1378.92
		John Lawrence Island	3015.7	455.98	0.41	456.39	456.39	45.64	410.75
		Neil Island	3015.7	496.75	0	496.75	496.75	49.68	447.07
		North Sentinnel Isla	3015.7	273.53	5.82	279.35	279.35	27.93	251.42
		Peel Island	3015.7	55.79	0	55.79	55.79	5.58	50.21
		Rutland Island	3015.7	2173.84	6.65	2180.49	2180.49	218.05	1962.44
		South Andaman	3015.7	3516.02	7.26	3523.28	3523.28	352.33	3170.95
		Block Total		**8503.72**	**20.46**	**8524.18**	**8524.18**	**852.42**	**7671.76**
	Ferrarganj	Flatbay Island	3015.7	99.52	0	99.52	99.52	9.95	89.57
		Viper Island	3015.7	7.24	0	7.24	7.24	0.72	6.52
		Block Total		**106.76**	**0**	**106.76**	**106.76**	**10.67**	**96.09**
		District Total		**10777.26**	**20.46**	**10797.72**	**10797.72**	**1079.76**	**9717.96**
		Ut Total		**37777.22**	**188.5**	**37965.72**	**37965.72**	**3796.58**	**34169.14**



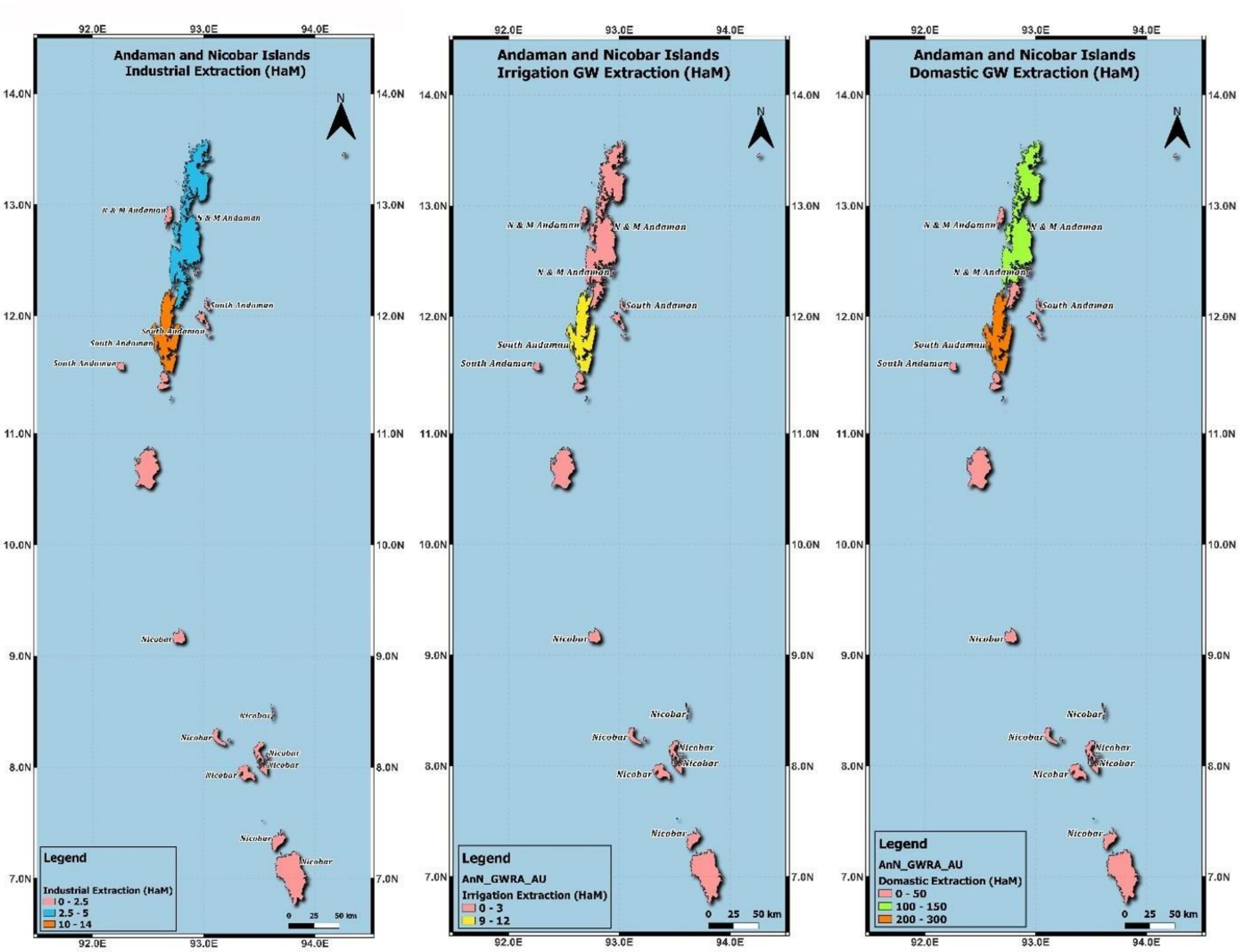
Figure–5.2: Spatial Distribution of computed Total Recharge in GWRE 2024 in A & N Islands

5.3. Annual Total Ground Water Extraction

Table–5.4: Computed GW extraction (GWRE 2024) in Andaman & Nicobar Island

District	Block	ISLAND	Annual Extractable Ground water Resource (ham)	Extraction				Allocation of Ground Water Resource for Domestic Utilisation for projected year 2025 (ham)	Net Annual Ground Water Availability for Future Use (ham)	Stage of Ground Water Extraction (%)	Categorization of Assessment Unit
				Domestic	Industrial	Irrigation	Total				
N & M Andaman	Diglipur	East Island	80.22	0.04015	0	0	0.04	0.04	80.18	0.0	safe
		Narcondam Island	113.58	0.04015	0	0	0.04	0.04	113.54	0.0	safe
		North Andaman	5513.92	104.1411	3.38	0.054	107.58	108.45	5402.03	2.0	safe
		Smith Island	280.34	1.46949	0	0	1.47	1.53	278.81	0.5	safe
		Block Total	**5988.06**	**105.6909**	**3.38**	**0.054**	**109.13**	**110.06**	**5874.56**	**1.6**	**safe**
	Mayabunder	Aves Island	2.44	0.004015	0	0	0	0.01	2.43	0.0	safe
		Interview Island	734.15	0.036135	0	0	0.03	0.04	734.12	0.0	safe
		Stewart Island	114.21	0.004015	0	0	0	0.01	114.2	0.0	safe
		Block Total	**850.8**	**0.044165**	**0**	**0**	**0.03**	**0.06**	**850.75**	**0.0**	**safe**
	Rangat	Baratang Island	2159.74	13.92001	4.51	0	18.43	14.5	2140.73	0.9	safe
		Long Island	377.41	2.525435	0.82	0	3.34	2.63	373.97	0.9	safe
		Middle Andaman	4310.95	136.2008	4.41	0.75	141.36	141.83	4163.96	3.3	safe
		North Passage Island	395.8	0.00803	0	0	0.01	0.01	395.79	0.0	safe
		Porlob Island	80.49	0	0	0	0	0	80.49	0.0	safe
		Strait Island	63.24	0.09636	0	0	0.09	0.1	63.15	0.1	safe
		Block Total	**7387.63**	**152.7507**	**9.74**	**0.75**	**163.23**	**159.07**	**7218.09**	**2.0**	**safe**
		District Total	**14226.49**	**258.4857**	**13.12**	**0.804**	**272.39**	**269.19**	**13943.4**	**1.7**	**safe**
Nicobar	Car Nicobar	Car Nicobar Island	2121.12	43.67517	0.195	0.1984	44.08	45.48	2075.24	2.1	safe
		Block Total	**2121.12**	**43.67517**	**0.195**	**0.1984**	**44.08**	**45.48**	**2075.24**	**1.9**	**safe**
	Great Nicobar	Great Nicobar Island	2549.57	19.69759	0.14	0.0294	19.87	20.51	2528.89	0.8	safe
		Kondul Island	104.06	0	0	0	0	0	104.06	0.0	safe
		Little Nicobar Islan	783.15	0.736753	0	0	0.73	0.77	782.39	0.1	safe
		Pulo Milo Island	28.78	0.04818	0	0	0.05	0.05	28.73	0.2	safe
		Block Total	**3465.56**	**20.48252**	**0.14**	**0.0294**	**20.65**	**21.33**	**3444.07**	**0.5**	**safe**
	Narcowry	Bampooka Island	153.3	0	0	0	0	0	153.3	0.0	safe
		Chowra Island	313.56	3.109618	0	0	3.1	0	0	0.0	salinity
		Kamorta Island	1515.07	9.027728	0.133	0.009	9.17	9.4	1505.53	0.6	safe
		Katchal Island	1623.37	4.733685	0.132	0.006	4.86	4.93	1618.31	0.3	safe
		Nancowrie Island	298.59	2.495323	0.133	0.0102	2.63	2.6	295.86	0.9	safe
		Teressa Island	338.12	6.572555	0.19	0	6.76	6.84	331.09	2.0	safe
		Tillangchang Island	212.68	0.092345	0	0	0.09	0.1	212.58	0.0	safe
		Trinket Island	183.32	0	0	0	0	0	183.32	0.0	safe
		Block Total	**4638.01**	**26.03125**	**0.588**	**0.0252**	**26.61**	**23.87**	**4299.99**	**0.5**	**safe**
		District Total	**10224.69**	**90.18895**	**0.923**	**0.253**	**91.34**	**90.68**	**9819.3**	**0.8**	**safe**

South Andaman	Little Andama	Little Andaman	1950.11	46.08016	0.24	0.232	46.55	47.98	1901.66	2.4	safe
		Block Total	**1950.11**	**46.08016**	**0.24**	**0.232**	**46.55**	**47.98**	**1901.66**	**2.1**	**safe**
	Port Blair	Havelock Island	1378.92	15.45976	0.009	0.009	15.48	16.1	1362.8	1.1	safe
		John Lawrence Island	410.75	0	0	0	0	0	410.75	0.0	safe
		Neil Island	447.07	7.441803	0.006	0.006	7.44	7.75	439.32	1.7	safe
		North Sentinnel Isla	251.42	0.036135	0	0	0.03	0.04	251.39	0.0	safe
		Peel Island	50.21	0	0	0	0	0	50.21	0.0	safe
		Rutland Island	1962.44	0.849173	0	0	0.85	0.89	1961.55	0.0	safe
		South Andaman	3170.95	248.5707	13.36	10.4	272.33	258.85	2888.34	8.6	safe
		Block Total	**7671.76**	**272.3575**	**13.375**	**10.415**	**296.13**	**283.63**	**7364.36**	**3.5**	**safe**
	Ferrarganj	Flatbay Island	89.57	0.012045	0	0	0.01	0.01	89.56	0.0	safe
		Viper Island	6.52	0	0	0	0	0	6.52	0.0	safe
		Block Total	**96.09**	**0.012045**	**0**	**0**	**0.01**	**0.01**	**96.08**	**0.0**	**safe**
		District Total	**9717.96**	**318.4497**	**13.615**	**10.647**	**342.69**	**331.62**	**9362.1**	**3.2**	**safe**
		Ut Total	**34169.14**	**667.1244**	**27.658**	**11.704**	**34169**	**691.49**	**33124.8**	**2.08**	**Safe**



Figure–5.3: Spatial Distribution of Domestic, industrial and irrigational GW Extraction in GWRE 2024 in A & N Islands

Table–5.4: Computed GW extraction component (GWRE 2024) in Andaman & Nicobar Island

Extraction component	Water quantity
Irrigation (Ham)	11.7
Domestic (Ham)	667.1
Industrial (Ham)	27.7

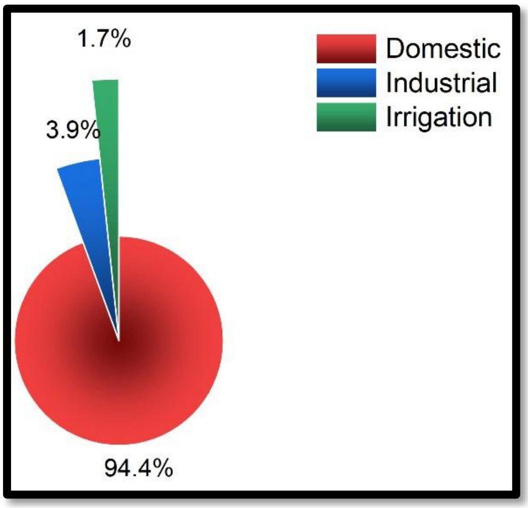
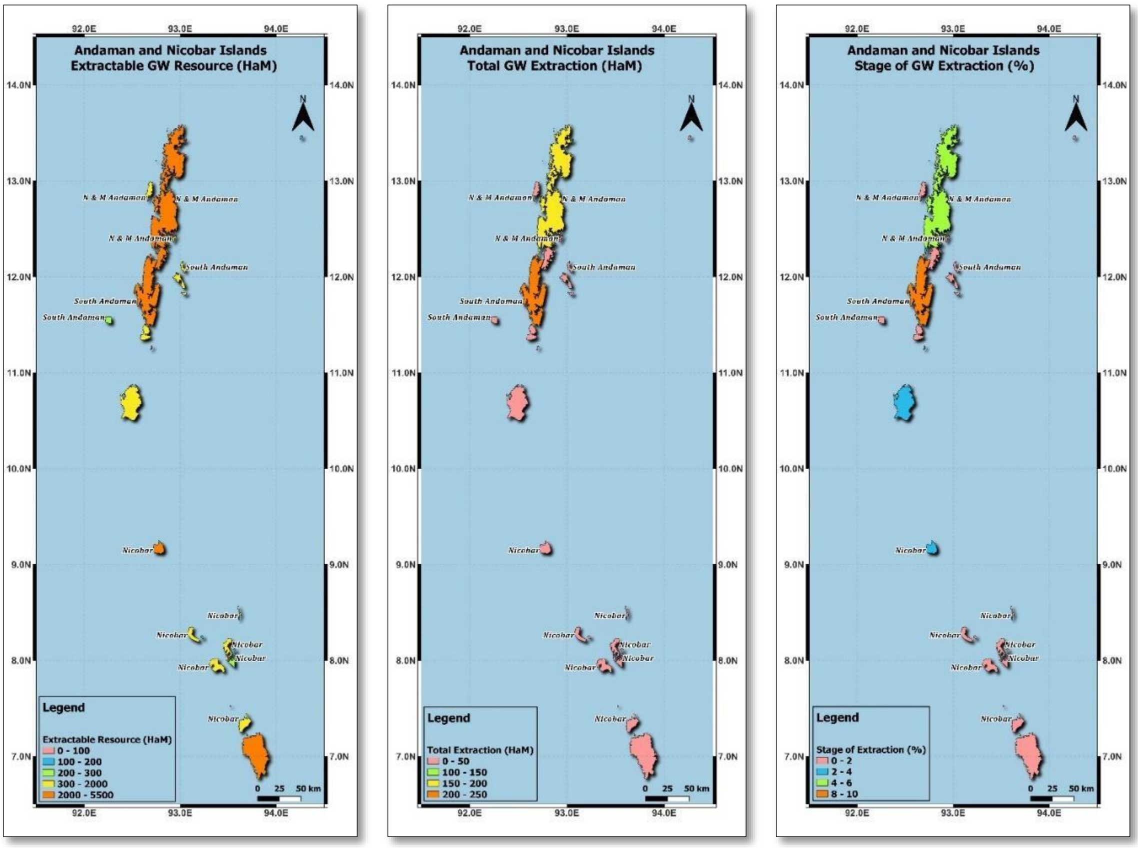


Figure-5.4 Pie diagram of GW extraction components in 2023



Figure–6.5: Spatial Distribution of Extractable GW Resource, Total GW Extraction and Stage of GW Extraction in GWRE 2024 in A & N Islands

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

The loss in surface area in some of the highly earthquake devastated islands have made possible changes in freshwater volume in the islands. In 11 (Eleven) islands parts of their area have been submerged due to tsunami/earthquake effect. It is important to note that parts of the Andaman group of islands and the entire Nicobar group of islands were subsided during the plate collision and submerged. Net availability of ground water resources have been increased in comparison to the values obtained in previous ground water resource estimation in the islands in 2004, 2011, 2013, 2017, 2020, 2022, & 2023.

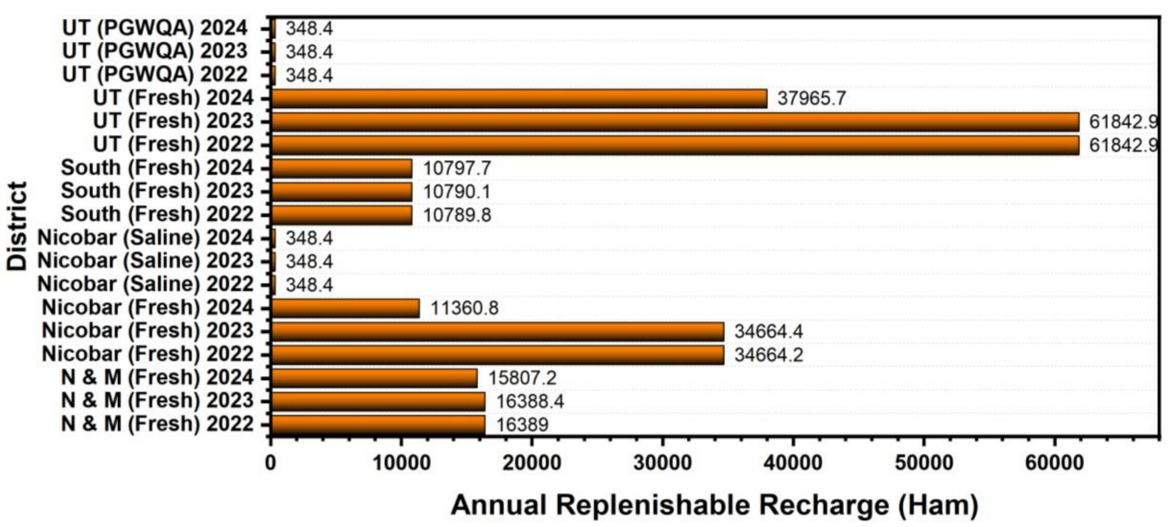
Table–5.4: Comparison between GWRE in Andaman & Nicobar Island over time

Assessment year

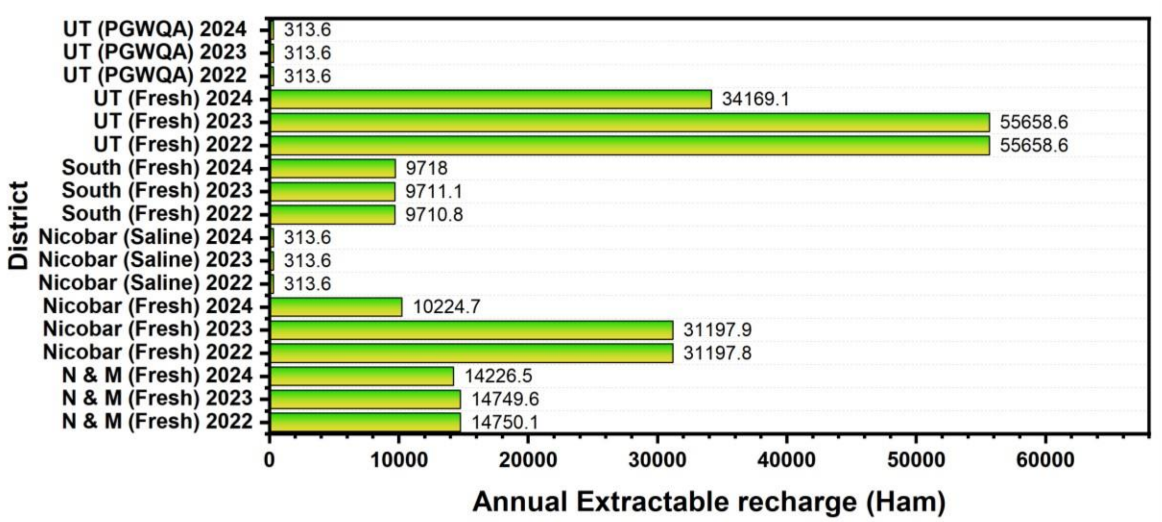
Components	2004	2011	2013	2017	2020	2022	2023	2024
Annual Replenishable Ground Water Recharge(HaM)	32673	33561	41449	33158	31551	61817	61843	37966
Annual Extractable Ground Water Recharge(HaM)	32599	31023	37304	32132	28492	55659	55659	34169
Gross Ground Water Draft(HaM)	1197.4	1965.6	573.53	908.18	739.49	754.81	764.27	706.42
Stage of Ground Water Development(%)	3.72	4.54	1.54	2.83	2.60	1.36	1.37	2.08
Categorization	Safe	Safe	Safe	Safe	Safe	Safe	Safe	Safe

Table–5.5: Comparison among GWRE'2024, GWRE'2023 and GWRE'2022 in Andaman & Nicobar Island

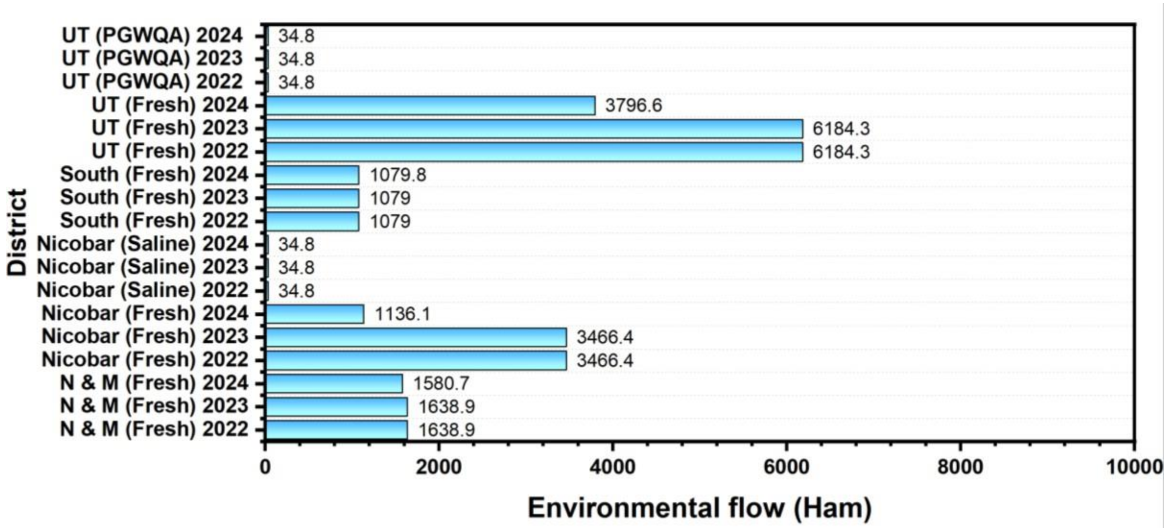
S. No.	District	Year	Annual Replenishable Recharge (Ham)			Environment al flow (Ham)	Annual Extractable recharge (Ham)	Ground Water Extraction (Ham)				Stage of GW Extraction (%)	Category
			Rainfall	Other Sources	Total			Domestic	Industrial	Irrigation	Total		
1	N & M Andaman (Fresh)	**2022**	16376	12.6	16389	1638.9	14750.1	251.3	83	0.8	335.2	2.3	Safe
		2023	16376	12.1	16388.4	1638.9	14749.6	254.9	83.2	0.8	339	2.3	Safe
		2024	15655	151.9	15807.2	1580.7	14226.5	258.5	13.2	0.8	272.4	1.7	Safe
2 A	Nicobar (Fresh)	**2022**	34663	1	34664.2	3466.4	31197.8	84.7	0.9	0.3	85.8	0.3	Safe
		2023	34663	1.2	34664.4	3466.4	31197.9	85.9	1	0.3	87	0.3	Safe
		2024	11344	16.1	11360.8	1136.1	10224.7	90.2	0.9	0.3	91.3	0.9	Safe
2 B	Nicobar (Saline)	**2022**	348	0	348.4	34.8	313.6	3	0	0	3	1	Saline
		2023	348	0	348.4	34.8	313.6	3.1	0	0	3.1	1	Saline
		2024	348	0	348.4	34.8	313.6	3.1	0	0	3.1	0	Saline
3	South Andaman (Fresh)	**2022**	10777	12.5	10789.8	1079	9710.8	309.6	13.5	10.7	333.8	3.4	Safe
		2023	10777	12.9	10790.1	1079	9711.1	314	13.6	10.7	338.3	3.5	Safe
		2024	10777	20.5	10797.7	1079.8	9718	318.4	13.6	10.6	342.7	3.5	Safe
4 A	State Total (Fresh)	**2022**	61816	26.1	61842.9	6184.3	55658.6	645.6	97.5	11.7	754.8	1.4	Safe
		2023	61816	26.1	61842.9	6184.3	55658.6	654.8	97.8	11.7	764.3	1.4	Safe
		2024	37777	188.5	37965.7	3796.6	34169.1	667.1	27.7	11.7	706.4	1.8	Safe
4 B	State Total (Pgwqa)	**2022**	348	0	348.4	34.8	313.6	3	0	0	3	1	Saline
		2023	348	0	348.4	34.8	313.6	3.1	0	0	3.1	1	Saline
		2024	348	0	348.4	34.8	313.6	3.1	0	0	3.1	1	Saline



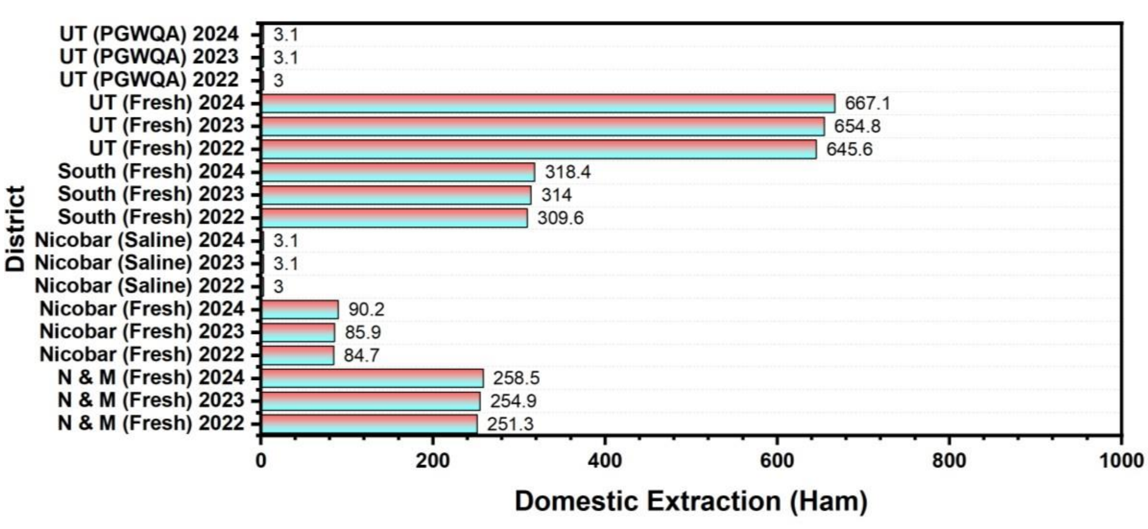
Figure–5.7: Annual Replenishable recharge during 2024, 2023 and 2022 in UT



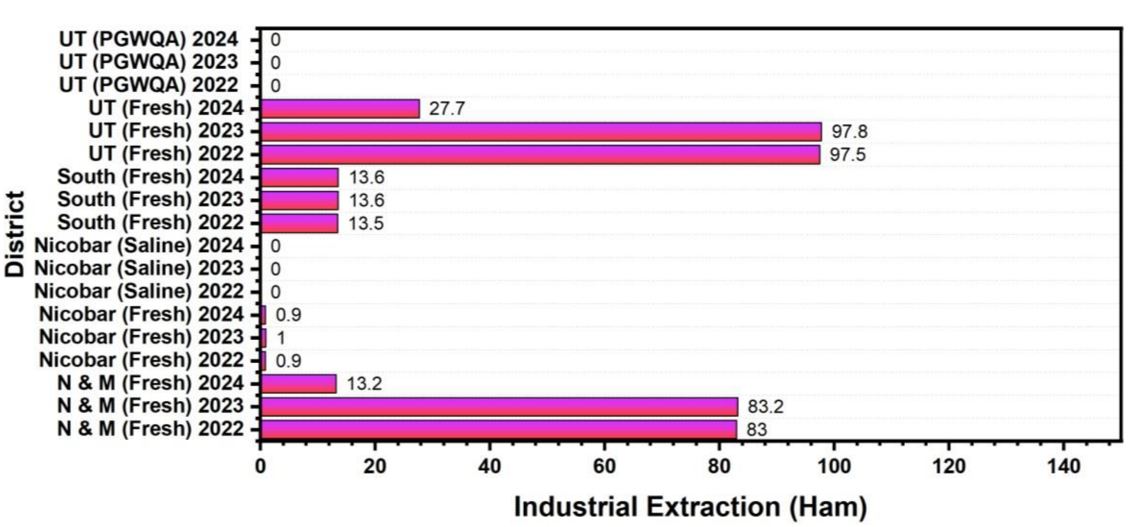
Figure–5.8: Annual Extractable recharge during 2024, 2023 and 2022 in UT



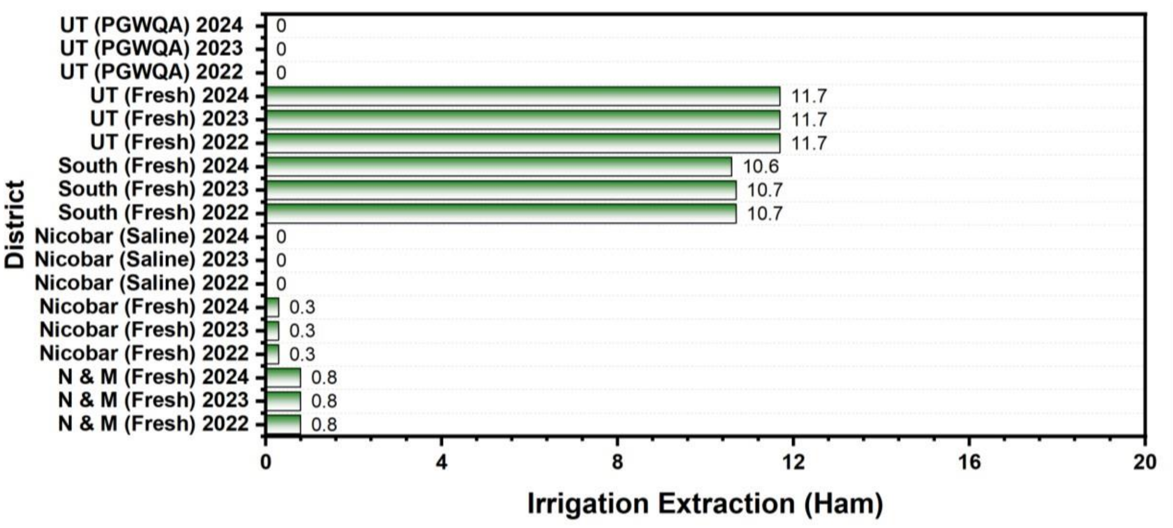
Figure–5.9: Environmental flow during 2024, 2023 and 2022 in UT



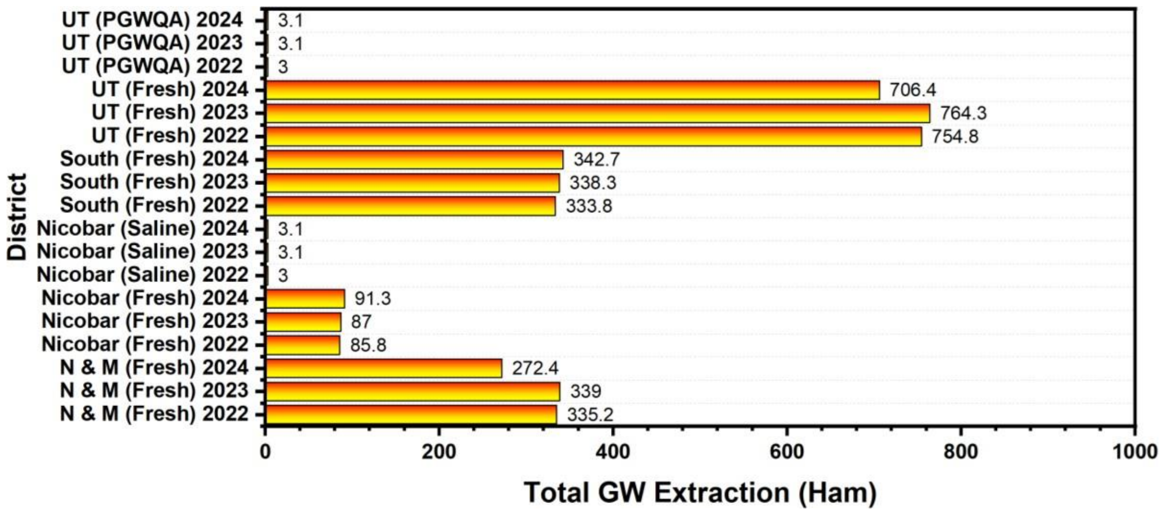
Figure–5.10: Annual Domestic GW Extraction during 2024, 2023 and 2022 in UT



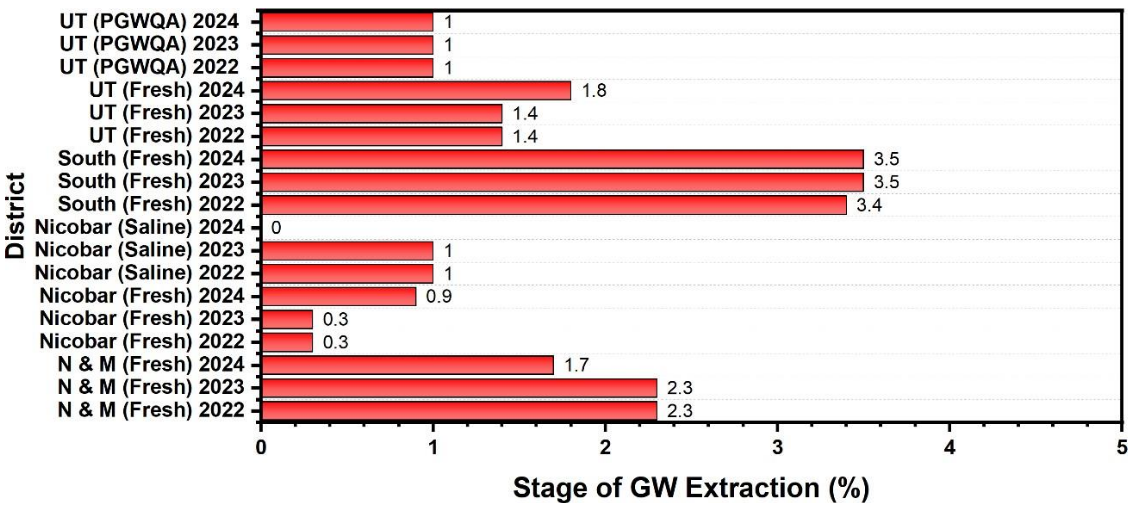
Figure–5.11: Annual Industrial GW Extraction during 2024, 2023 and 2022 in UT



Figure–5.11: Annual Irrigation GW Extraction during 2024, 2023 and 2022 in UT



Figure–5.12: Annual Total GW Extraction during 2024, 2023 and 2022 in UT



Figure–5.13: Stage of GW Extraction during 2024, 2023 and 2022 in UT

5.4 Ground water recharge in the poor quality zone

The topography of Chowra Island is such that whatever may be the rainfall gets recharged does not reside into the aquifer and it immediately gets discharged into the sea.

5.4.1 Additional annual potential recharges

In all the assessment units, computation of rainfall recharge during monsoon and non monsoon has been computed using only Rainfall Infiltration Method (RIF). So, Percent Deviation (PD) factor as per the guidelines by GEC'97 methodology does not arise here.

The SLC formation order, as well as the Minutes of the SLC Meeting of 07.10.2024, containing the approval of the GWRE 2024 in respect of the UT of A & N Islands is attached as annexure.

General description of the ground water assessment unit, recharge from rainfall, recharge from other sources, natural discharge and annual extractable ground water resource, ground water extraction, annual ground water allocation for domestic Use as on 2025, net ground water availability for future use, stage of ground water extraction and categorization assessed in dynamic ground water resources of the Andaman and Nicobar islands as computed through INGRES is provided in the subsequent Annexures(1 – 5) and attribute table.

CHAPTER 6

CONCLUSIONS

6.1 Recommendations

Andaman & Nicobar Islands comprise an arc-shaped chain of islands in the Bay of Bengal and are characterized by rugged topography, steep slope, low infiltration capacity and close proximity of hills to the sea. Marine sedimentary group of rocks comprising shale, sandstone, grit and conglomerate; extrusive and intrusive igneous rocks (volcanics and ultramafics) and limestone occupy the entire geographical area. Amongst these, the Sedimentary Group is most pervasive and occupy nearly 70% of the entire area of the islands while the igneous group covers nearly 15% while the rest of 15% goes to the coralline and limestone formations. All these rock formations have been subjected to many tectonic activities, evident from the occurrence of shallow and deep focus earthquakes in the islands. Marine sedimentary rocks are developed only through dug wells having meagre yield of 0.1 to 0.5 lps. The igneous Ophiolite suite of rocks in the area although restricted in occurrence, are observed to yield moderate to high both in shallow and deeper locales and they are developed by dug wells and bore well with yield ranging from 1 to 10 lps. Area covered by Coralline Limestone contains appreciable quantity of groundwater with yield ranging from 5 to25 lps.

- ❖ Island Hydrogeological set up demands judicious and measured (regulated) use of fresh water lenses seasonally (though falls under Safe category).
- ❖ State may review their free/subsidized electricity policy to farmers (if applicable), bring suitable water pricing policy and may work further towards crop rotation/diversification/other initiatives to reduce overdependence on groundwater.
- ❖ Regulation & control of Ground water Extraction: Ministry of Jal Shakti has issued the guidelines for control and regulations of ground water extraction vide notification dated 24.09.2020. Concerned departments may ensure implementations of the guidelines.

Computed Result of Assessment Unit
(Island wise)

Annexure I

DYNAMIC GROUND WATER RESOURCES OF INDIA, 2024															
INDIA															
S.NO	States / Union Territories	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		Total Annual Ground Water Recharge			Irrigation	Industrial	Domestic	Total			
		Recharge from rainfall	Recharge from other Sources	Recharge from Rainfall	Recharge from other Sources										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	ANDAMAN AND NICOBAR ISLANDS	0.2	0	0.17	0	0.38	0.04	0.34	0	0	0.01	0.01	0.01	0.33	2.08
	Total (bcm)	0.2	0	0.17	0	0.38	0.04	0.34	0	0	0.01	0.01	0.01	0.33	2.08

Annexure II

DYNAMIC GROUND WATER RESOURCES OF INDIA, 2024															
ANDAMAN AND NICOBAR ISLANDS															
S.NO	Name of District	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		Total Annual Ground Water Recharge			Irrigation	Industrial	Domestic	Total			
		Recharge from rainfall	Recharge from other Sources	Recharge from Rainfall	Recharge from other Sources										
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1	**N & M ANDAMAN**	9538.7	73.1	6116.5	78.7	15807.2	1580.7	14226.4	0.8	13.1	258.4	272.3	269.1	13943.4	1.9
2	**NICOBAR**	4732.1	7.4	6264.0	8.6	11012.3	1101.2	9911.1	0.2	0.9	87.0	88.2	90.6	9819.3	0.8
3	**SOUTH ANDAMAN**	5974.5	13.7	4802.74	6.7	10797.7	1079.7	9717.9	10.6	13.6	318.4	342.6	331.6	9362.1	3.5
	Total (Ham)	20245.4	94.3	17183.3	94.1	37617.3	3761.7	33855.5	11.7	27.6	664.0	703.3	691.4	33124.8	2.0
	Total (Bcm)	0.2	0	0.17	0	0.3	0.04	0.3	0	0	0.01	0.01	0.01	0.3	2.0

Annexure III (A)

CATEGORIZATION OF BLOCKS/ MANDALS/ TALUKAS IN INDIA (2024)													
ANDAMAN AND NICOBAR ISLANDS													
S.No	States / Union Territories	Total No. of Assessed Units	Safe		Semi-Critical		Critical		Over-Exploited		Saline		
			Nos.	%	Nos.	%	Nos.	%	Nos.	%	Nos.	%	
1	ANDAMAN AND NICOBAR ISLANDS	36	35	97.22	-	-	-	-	-	-	1	2.78	
	Total	36	35	97.22	-	-	-	-	-	-	1	2.78	
	Grand Total	36	35	97.22	-	-	-	-	-	-	1	2.78	

Annexure III (B)

DYNAMIC GROUND WATER RESOURCES OF INDIA, 2024													
ANDAMAN AND NICOBAR ISLANDS													
S.No	Name of District	Total No. of Assessed Units	Safe		Semi-Critical		Critical		Over-Exploited		Saline		
			No	%	No.	%	No.	%	No.	%	No.	%
1	N & M ANDAMAN	13	13	100.0	-	-	-	-	-	-	-	-
2	NICOBAR	13	12	92.31	-	-	-	-	-	-	1	7.69
3	SOUTH ANDAMAN	10	10	100.0	-	-	-	-	-	-	-	-
	Total	36	35	97.22	-	-	-	-	-	-	1	2.78

Annexure III (C)

ANNUAL EXTRACTABLE RESOURCE OF ASSESSMENT UNITS UNDER DIFFERENT CATEGORIES, 2024												
ANDAMAN AND NICOBAR ISLANDS												
S.No	State/Union Territories	Total Annual Extractable Resource of Assessed Units (in mcm)	Safe		Semi-Critical		Critical		Over-Exploited		Saline	
			Total Annual Extractable Resource (in mcm)	%	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	**ANDAMAN AND NICOBAR ISLANDS**	338.56	338.56	100	-	-	-	-	-	-	-	-
	Total	338.56	338.56	100	-	-	-	-	-	-	-	-
	Grand Total	338.56	338.56	100	-	-	-	-	-	-	-	-

Annexure III (D)

DYNAMIC GROUND WATER RESOURCES OF INDIA, 2024												
ANDAMAN AND NICOBAR ISLANDS												
S.No	Name of District	Total Annual Extractable Resource of Assessed Units (in mcm)	Safe		Semi-Critical		Critical		Over-Exploited		Saline	
			Total Annual Extractable Resource (in mcm)	%	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	**N & M ANDAMAN**	142.26	142.26	100	-	-	-	-	-	-	-	-
2	**NICOBAR**	99.11	99.11	100	-	-	-	-	-	-	-	-
3	**SOUTH ANDAMAN**	97.18	97.18	100	-	-	-	-	-	-	-	-
	Total	338.56	338.56	100	-	-	-	-	-	-		
	Grand Total	338.56	338.56	100	-	-	-	-	-	-		

Annexure III (E)

AREA OF ASSESSMENT UNITS UNDER DIFFERENT CATEGORIES IN INDIA (2024)														
ANDAMAN AND NICOBAR ISLANDS														
S.No	States / Union Territories	Total Geographical Area of Assessed Units (in sq km)	Recharge Worthy Area (in sq km)	Safe		Semi-Critical		Critical		Over-Exploited		Saline		
				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	ANDAMAN AND NICOBAR ISLANDS	7851.57	1276.39	1276.39	100	-	-	-	-	-	-	-	-
	Total	7851.57	1276.39	1276.39	100	-	-	-	-	-	-	-	-
	Grand Total	7851.57	1276.39	1276.39	100	-	-	-	-	-	-	-	-

Annexure III (F)

DYNAMIC GROUND WATER RESOURCES OF INDIA, 2024													
ANDAMAN AND NICOBAR ISLANDS													
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	**N & M ANDAMAN**	580.4	580.4	100.0	-	-	-	-	-	-	-	-
2	**NICOBAR**	380.75	380.75	100.0	-	-	-	-	-	-	-	-
3	**SOUTH ANDAMAN**	315.24	315.24	100.0	-	-	-	-	-	-	-	-
	Total	1276.39	1276.39	100.0	-	-	-	-	-	-	-	-

Annexure IV (A)

CATEGORISATION OF ASSESSMENT UNIT, 2024							
ANDAMAN AND NICOBAR ISLANDS							
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
9	0	0	0

Annexure IV (B)

QUALITY PROBLEMS IN ASSESSMENT UNITS, 2023							
ANDAMAN & NICOBAR ISLANDS							
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
1	**NICOBAR**					1	Chowra Island (C)

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
36	0	0	1

Annexure V (A)

State-Wise Summary Of Assessment Units Improved Or Deteriorated From 2023 To 2024 Assessment				
ANDAMAN AND NICOBAR ISLANDS				
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	**ANDAMAN AND NICOBAR ISLANDS**	0	0	9

Annexure V (B)

COMPARISON OF CATEGORIZATION OF ASSESSMENT UNITS (2022, 2023 & 2024)													
ANDAMAN AND NICOBAR ISLANDS													
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	Name of District	Name of Assessment Unit	Stage of Ground Water Extraction (%) 2024	Categorization in 2024	Remark
1	N & M Andaman	Narcondam Island	0.034019	safe	N & M Andaman	Narcondam Island	0.034019	safe	N & M Andaman	Narcondam Island	0.0352	safe	No change
2	N & M Andaman	Middle Andaman	3.944314	safe	N & M Andaman	Middle Andaman	3.994366	safe	N & M Andaman	Middle Andaman	3.2790	safe	No change
3	N & M Andaman	Porlob Island	0	safe	N & M Andaman	Porlob Island	0	safe	N & M Andaman	Porlob Island	0	safe	No change
4	N & M Andaman	Strait Island	0.137489	safe	N & M Andaman	Strait Island	0.137489	safe	N & M Andaman	Strait Island	0.1423	safe	No change
5	N & M Andaman	Long Island	0.827531	safe	N & M Andaman	Long Island	0.834636	safe	N & M Andaman	Long Island	0.8849	safe	No change
6	N & M Andaman	Smith Island	0.492781	safe	N & M Andaman	Smith Island	0.499673	safe	N & M Andaman	Smith Island	0.5243	safe	No change
7	N & M Andaman	Aves Island	0	safe	N & M Andaman	Aves Island	0	safe	N & M Andaman	Aves Island	0	safe	No change
8	N & M Andaman	Baratang Island	0.810521	safe	N & M Andaman	Baratang Island	0.815994	safe	N & M Andaman	Baratang Island	0.8533	safe	No change
9	N & M Andaman	East Island	0.048164	safe	N & M Andaman	East Island	0.048164	safe	N & M Andaman	East Island	0.0498	safe	No change
10	N & M Andaman	Interview Island	0.003948	safe	N & M Andaman	Interview Island	0.003948	safe	N & M Andaman	Interview Island	0.0046	safe	No change
11	N & M Andaman	North Andaman	2.365818	safe	N & M Andaman	North Andaman	2.394836	safe	N & M Andaman	North Andaman	1.9510	safe	No change
12	N & M Andaman	North Passage Island	0.002442	safe	N & M Andaman	North Passage Island	0.002441	safe	N & M Andaman	North Passage Island	0.0025	safe	No change
13	N & M Andaman	Stewart Island	0	safe	N & M Andaman	Stewart Island	0	safe	N & M Andaman	Stewart Island	0	safe	No change
14	South Andaman	Neil Island	1.6186	safe	South Andaman	Neil Island	1.641801	safe	South Andaman	Neil Island	1.6641	safe	No change
15	South Andaman	Port Blair	8.360663	safe	South Andaman	South Andaman	8.497292	safe	South Andaman	South Andaman	8.5882	safe	No change
16	South Andaman	Little Andaman	2.320337	safe	South Andaman	Little Andaman	2.354226	safe	South Andaman	Little Andaman	2.3870	safe	No change
17	South Andaman	Viper Island	0	safe	South Andaman	Viper Island	0	safe	South Andaman	Viper Island	0	safe	No change
18	South Andaman	Peel Island	0	safe	South Andaman	Peel Island	0	safe	South Andaman	Peel Island	0	safe	No change
19	South Andaman	North Sentinnel Isla	0.012187	safe	South Andaman	North Sentinnel Isla	0.011932	safe	South Andaman	North Sentinnel Isla	0.0119	safe	No change
20	South Andaman	Flatbay Island	0.011159	safe	South Andaman	Flatbay Island	0.011164	safe	South Andaman	Flatbay Island	0.0111	safe	No change
21	South Andaman	Havelock Island	1.091371	safe	South Andaman	Havelock Island	1.106896	safe	South Andaman	Havelock Island	1.1226	safe	No change

22	South Andaman	John Lawrence Island	0	safe	South Andaman	John Lawrence Island	0	safe	South Andaman	John Lawrence Island	0	safe	No change
23	South Andaman	Rutland Island	0.041913	safe	South Andaman	Rutland Island	0.042804	safe	South Andaman	Rutland Island	0.0433	safe	No change
24	Nicobar	Chowra Island	0	salinity	Nicobar	Chowra Island		salinity	Nicobar	Chowra Island	0	salinity	No change
25	Nicobar	Bampooka Island	0	safe	Nicobar	Bampooka Island	0	safe	Nicobar	Bampooka Island	0	safe	No change
26	Nicobar	Pulo Milo Island	0.173732	safe	Nicobar	Pulo Milo Island	0.173732	safe	Nicobar	Pulo Milo Island	0.1737	safe	No change
27	Nicobar	Kondul Island	0	safe	Nicobar	Kondul Island	0	safe	Nicobar	Kondul Island	0	safe	No change
28	Nicobar	Trinket Island	0	safe	Nicobar	Trinket Island	0	safe	Nicobar	Trinket Island	0	safe	No change
29	Nicobar	Car Nicobar Island	2.020573	safe	Nicobar	Car Nicobar Island	2.049476	safe	Nicobar	Car Nicobar Island	2.0781	safe	No change
30	Nicobar	Great Nicobar Island	0.081052	safe	Nicobar	Great Nicobar Island	0.082184	safe	Nicobar	Great Nicobar Island	0.7793	safe	No change
31	Nicobar	Kamorta Island	0.588756	safe	Nicobar	Kamorta Island	0.596676	safe	Nicobar	Kamorta Island	0.6052	safe	No change
32	Nicobar	Katchal Island	0.291985	safe	Nicobar	Katchal Island	0.295681	safe	Nicobar	Katchal Island	0.2993	safe	No change
33	Nicobar	Little Nicobar Islan	0.091936	safe	Nicobar	Little Nicobar Islan	0.093213	safe	Nicobar	Little Nicobar Islan	0.0932	safe	No change
34	Nicobar	Nancowrie Island	0.85788	safe	Nicobar	Nancowrie Island	0.871284	safe	Nicobar	Nancowrie Island	0.8808	safe	No change
35	Nicobar	Teressa Island	1.94617	safe	Nicobar	Teressa Island	1.972789	safe	Nicobar	Teressa Island	1.99929	safe	No change
36	Nicobar	Tillangchang Island	0.042317	safe	Nicobar	Tillangchang Island	0.042317	safe	Nicobar	Tillangchang Island	0.0423	safe	No change

Annexure VI

Assessment Unit Wise Report																		
ANDAMAN AND NICOBAR ISLANDS																		
District	Block	Rainfall (mm)	GW recharge (Ham)			Annual Ground water Recharge (ham)	Environmental Flows (ham)	Annual Extractable Ground water Resource (ham)	Extraction				Stage of Ground Water Extraction (%)	Categorization of Assessment Unit	Allocation of Ground Water Resource for Domestic Utilisation for projected year 2025 (ham)	Net Annual Ground Water Availability for Future Use (ham)	Total Ground Water Availability in Unconfined Aquifier (ham)	
			Rainfall Recharge	Tanks and Ponds	Total				Domestic	Industrial	Irrigation	Total					Fresh	Saline
N & M ANDAMAN	Diglipur	2913.3	6556.92	96.48	6653.4	6653.4	665.34	5988.06	105.6	3.38	0.054	109.13	1.640	safe	110.06	5874.56	5988.06	
	Mayabunder	2913.3	944.49	0.84	945.33	945.33	94.53	850.8	0.044	0	0	0.03	0.003	safe	0.06	850.75	850.8	
	Rangat	2913.3	8153.91	54.58	8208.49	8208.49	820.86	7387.63	152.7	9.74	0.75	163.2	1.988	safe	159.07	7218.09	7387.63	
NICOBAR	Car Nicobar	2805.2	2356.7	0.1	2356.8	2356.8	235.68	2121.12	43.67	0.195	0.1984	44.0	1.870	safe	45.48	2075.24	58129.12	
	Great Nicobar	2805.2	3834.87	15.76	3850.63	3850.63	385.07	3465.5	20.48	0.14	0.0294	20.6	0.536	safe	21.33	3444.07	3465.56	
	Narcowry	2805.2	5153.07	0.28	5153.35	5153.35	515.34	4638.01	26.03	0.588	0.0252	26.6	0.516	safe	23.87	4299.99	4324.45	
SOUTH ANDAMAN	Little Andaman	3015.7	2166.78	0	2166.78	2166.78	216.67	1950.11	46.08	0.24	0.232	46.5	2.148	safe	47.98	1901.66	1950.11	
	Port Blair	3015.7	8503.72	20.46	8524.18	8524.18	852.42	7671.76	272.3	13.375	10.415	296.13	3.474	safe	283.63	7364.36	8596.76	
	Ferrarganj	3015.7	106.76	0	106.76	106.76	10.67	96.09	0.012	0	0	0.01	0.009	safe	0.01	96.08	216.09	

Fwd: Meeting Link_1st State Level Committee (SLC) Meeting on Ground Water Resource Assessment - 2024 of Andaman & Nicobar Islands - reg.

AG ANADI GAYEN <rder-cgwb@nic.in>
Tue, 16 Jul 2024 1:53:00 PM +0530 •

To "Ms Purva Garg, IAS," <secy.215@and.nic.in>, "Shri Thapali Kanooth Prijith Rekh" <ceapwd@and.nic.in>, "Shri Thapali Kanooth Prijith Rekh" <ceapwd.and@nic.in>, "Shri Biju Varghese" <eeplg1.and@nic.in>, "arunkumar.adn" <arunkumar.adn@gmail.com>, "dstandamans" <dstandamans@gmail.com>, "Director Agriculture" <diragri@and.nic.in>, "dirind.and" <dirind@and.nic.in>, "portblair" <portblair@nabard.org>

Cc "INDRANIL ROY" <indranilroy-cgwb@gov.in>, "SHAISTA KHAN" <shaistakhan-cgwb@gov.in>, "neelspinor" <neelspinor@gmail.com>, "Sandip Bhowal" <sandipbhowal-cgwb@nic.in>

From: "SHAISTA KHAN" <shaistakhan-cgwb@gov.in>
To: "Ms Purva Garg, IAS," <secy.215@and.nic.in>, "Shri Thapali Kanooth Prijith Rekh" <ceapwd@and.nic.in>, "Shri Thapali Kanooth Prijith Rekh" <ceapwd.and@nic.in>, "Shri Biju Varghese" <eeplg1.and@nic.in>, "arunkumar adn" <arunkumar.adn@gmail.com>, dstandamans@gmail.com, "Director Agriculture" <diragri@and.nic.in>, "dirind.and" <dirind@and.nic.in>, portblair@nabard.org
Cc: "ANADI GAYEN" <rder-cgwb@nic.in>, "INDRANIL ROY" <indranilroy-cgwb@gov.in>, "Dr Nilamoni" <drnilamonib.cgwb@gov.in>, "Sandip Bhowal" <sandipbhowal-cgwb@nic.in>
Sent: Tuesday, July 16, 2024 9:38:27 AM
Subject: Meeting Link_1st State Level Committee (SLC) Meeting on Ground Water Resource Assessment - 2024 of Andaman & Nicobar Islands - reg.

Sir/Madam,
With reference to the trailing mail please find herewith the link for 1st State Level Committee (SLC) Meeting on Ground Water Resource Assessment - 2024 of Andaman & Nicobar Islands which is scheduled to be held on **16.07.2024 (Tuesday) through virtual mode.**

1st SLC meeting GWRA 2024 Andaman & Nicobar Island
Tuesday, July 16 · **2:30 – 5:30pm**
Time zone: Asia/Kolkata
Google Meet joining info
Video call link: https://meet.google.com/xwn-sudr-gyv

Regards
Dr Shaista Khan
Scientist-C
for Regional Director

From: "ANADI GAYEN" <rder-cgwb@nic.in>
To: "Ms Purva Garg, IAS," <secy.215@and.nic.in>
Cc: "Shri Thapali Kanooth Prijith Rekh" <ceapwd@and.nic.in>, "Shri Thapali Kanooth Prijith Rekh" <ceapwd.and@nic.in>, "Shri Biju Varghese" <eeplg1.and@nic.in>, "arunkumar adn" <arunkumar.adn@gmail.com>, dstandamans@gmail.com, "Director Agriculture" <diragri@and.nic.in>, "dirind.and" <dirind@and.nic.in>, portblair@nabard.org, "INDRANIL ROY" <indranilroy-cgwb@gov.in>, "SHAISTA KHAN" <shaistakhan-cgwb@gov.in>, "Dr Nilamoni" <drnilamonib.cgwb@gov.in>, "Sandip Bhowal" <sandipbhowal-cgwb@nic.in>
Sent: Monday, July 15, 2024 2:13:30 PM
Subject: 1st State Level Committee (SLC) Meeting on Ground Water Resource Assessment - 2024 of Andaman & Nicobar Islands - reg.

Madam,

Kindly find attached herewith Meeting Notice regarding 1st State Level Committee (SLC) Meeting on Ground Water Resource Assessment - 2024 of Andaman & Nicobar Islands.

The Meeting is scheduled to be held on 16.07.2024 (Tuesday) at 3:00 pm in virtual mode. It is earnestly requested to make it convenient to attend the meeting.

This is for your kind information.

सादर / Regards,

तकनीकी अनुभाग / Technical Section
कृते ीय िनदेशक / For Regional Director
क5ीय भूिम जल बोड /Central Ground Water Board
पूवा , कोलकाता/Eastern Region, Kolkata

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के ीय भूिमजल बोड / CENTRAL GROUND WATER BOARD
पूवा , 'भुजिलका' / Eastern Region, 'BHUJALIKA'
ॉक: सीपी-6, से4र: 5, िबधाननगर, कोलकाता - 700 091 / Block: CP-6, Sector: V, Bidhannagar, Kolkata - 700 091
जल संसाधन, नदी िवकास और गंगा संर ण िवभाग / Department of Water Resources, River Development & Ganga Rejuvenation
जल शि4 मं ालय / Ministry of Jal Shakti
भारत सरकार / Government of India
दूरभाष / Phone : +91 (0) 33 2367 3081
फै / Fax : +91 (0) 33 2367 3030
ईमेल / Email : rder-cgwb@nic.in
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Always Wear Mask - Maintain Social Distance - Wash / Sanitize Your Hands Frequently
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के ीय भूिमजल बोड / CENTRAL GROUND WATER BOARD
पूवा , 'भुजिलका' / Eastern Region, 'BHUJALIKA'
ॉक: सीपी-6, से4र: 5, िबधाननगर, कोलकाता - 700 091 / Block: CP-6, Sector: V, Bidhannagar, Kolkata - 700 091
जल संसाधन, नदी िवकास और गंगा संर ण िवभाग / Department of Water Resources, River Development & Ganga Rejuvenation
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ईमेल / Email : rder-cgwb@nic.in
==
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==

Minutes of the Second Meeting of State Level Committee for Assessment of Ground Water Resources of Andaman & Nicobar Islands (as on 31.03.2024), held on 07.10.2024 under online mode

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The 2nd meeting of State Level Committee (SLC) for assessment of Ground Water Resources of Andaman & Nicobar Islands (as on 31.03.2024) was held through virtual mode on 07.10.2024 at 18:00 Hrs on Google Meet Platform, under the Chairmanship of the Secretary, PWD, Andaman & Nicobar Administration. The lists of attendees are provided in the Annexure – 1.

The agenda of the meeting were as follows:

1. Welcome and Introduction of all the members and distinguished invitees.
2. Background of the meeting and brief introduction of Ground Water Resource Assessment-2024 (GWRA 2024) of Andaman & Nicobar Islands
3. Presentation of the results of the Ground Water Resource Assessment of Andaman & Nicobar Islands (as on 31.03.2024).
4. Approval of GWRA 2024 for Andaman & Nicobar Islands
5. Any other items with the permission of the Chair.

At the very outset, with kind permission of the Chair, Dr. Anadi Gayen, Regional Director, Central Ground Water Board (CGWB), Eastern Region (ER), Kolkata and Member Convenor, SLC, welcomed all the Members of the SLC, and other distinguished invitees of the meeting and narrated the agenda in detail and also apprised the Chair about the background of the meeting.

Dr. Indranil Roy, Scientist-'D', CGWB, ER presented the results and computational outcomes of Ground Water Resource Estimation (GWRE) of the UT of Andaman & Nicobar Islands (as on 31.03.2024). He explained about the functionality of the web-based 'INDIA- Groundwater Resource Estimation System' (INGRES) tool in estimation of GWRE process. Summary of Ground Water Resource Estimation of the UT of Andaman & Nicobar Islands is as below.

Components	Dynamic GW Resource	
	(BCM)	(ham)
Total Ground Water Recharge	0.379657	37965.72
Net Ground Water Availability	0.331248	33124.8
Gross Ground Water Draft for All Uses	0.007064	667.12
Current Annual GW Draft for Irrigation	0.000117	11.70
Current Annual GW Draft for Domestic	0.006671	667.12
Current Annual GW Draft for Industrial uses	0.000276	27.66
Stage of G.W. Development (%)	1.8 %	
Annual Allocation of GW for Domestic & Industrial Water Supply for 2025	0.006914	691.49
Net GW Availability for 'Future Use'	0.331248	33124.8

Initiating the discussion, Ms. Purva Garg, IAS, Secretary, APWD and Chairman, SLC, enquired about the current stage of Groundwater extraction in Campbell Bay area and the feasibility of abstraction structures for Industrial purposes. In reply of that Dr. Indranil Roy, Scientist- 'D' informed that in the upland areas ground water abstraction structures are feasible with careful planning but the beach area should be avoided for abstracting the ground water. He also informed that there are a total of 113 Nos. of groundwater monitoring station available in the A & N Islands Union Territory (UT) and two times in a year (pre-monsoon and post-monsoon) water level measurement is recorded by CGWB, ER, Kolkata. Discussions were also held about the shortage of drinking water in Andaman and Nicobar Island as a whole. Dr. Anadi Gayen, RD, ER, added that the careful GW abstraction in the area required in a site specific manner, with due consideration of the hydrogeological scenario.

At the end the Ground Water Resources of Andaman and Nicobar Island (as on 31.03.2024) was unanimously accepted and was accorded due approval by the members of the State Level Committee (SLC) for Andaman and Nicobar Island.

The meeting ended with the vote of thanks to the chair.

17/01/2025

Regional Director,
CGWB, Eastern Region
Member Secretary, SLC GWRA 2024, A&N Islands

ANNEXURE – I

Participant List of the Second Meeting of State Level Committee for Assessment of Ground Water Resources of Andaman & Nicobar Islands (as on 31.03.2024), held online on 07.10.2024

Sl No	Name	Designation
1.	Ms. Purva Garg, IAS	Secretary (PWD), A&N Administration & Chairman, SLC GWRA 2024, A&N Islands
2.	Er. Biju Vergese	APWD, A&N Administration
3.	Dr. Anadi Gayen	Regional Director CGWB, ER, Kolkata & Member Convenor, SLC
4.	Smt. Sandhya Yadav	Scientist- ‘D’(HG), CGWB, ER, Kolkata
5.	Dr. Indranil Roy	Scientist- ‘D’(HG), CGWB, ER, Kolkata
6.	Dr. Shaista Khan	Scientist- ‘C’(HG), CGWB, ER, Kolkata
7.	Dr. Nilamoni Barman	Scientist- ‘C’(HM), CGWB, ER, Kolkata
8.	Sri Atalanta N. Chowdhury	Scientist- ‘B’(CH), CGWB, ER, Kolkata

Fwd: Approval of MoM on annual ground water assessment

AG

ANADI GAYEN <rder-cgwb@nic.in>

Fri, 17 Jan 2025 1:56:21 PM +0530

To "INDRANIL ROY" <indranilroy-cgwb@gov.in>, "Nilamoni Barman" <drnilamonib.cgwb@gov.in>

============ Forwarded message ============
From: Arun Kumar <arunkumar.adn@gmail.com>
To: "RD ER"<rder-cgwb@nic.in>
Cc: "M SIVARAMA SUBRAMANIAN"<ceapwd@and.nic.in>
Date: Fri, 17 Jan 2025 10:26:09 +0530
Subject: Approval of MoM on annual ground water assessment
============ Forwarded message ============

Good morning sir

I am directed to inform you that the Draft MoM submitted on the Annual dynamic groundwater assessment of A&N Island 2024 has been approved by the competent authority with the request that MoM may kindly be issued and signed by the Member Secretary, SLC.

--
Regards

Arun Kumar
9474216270