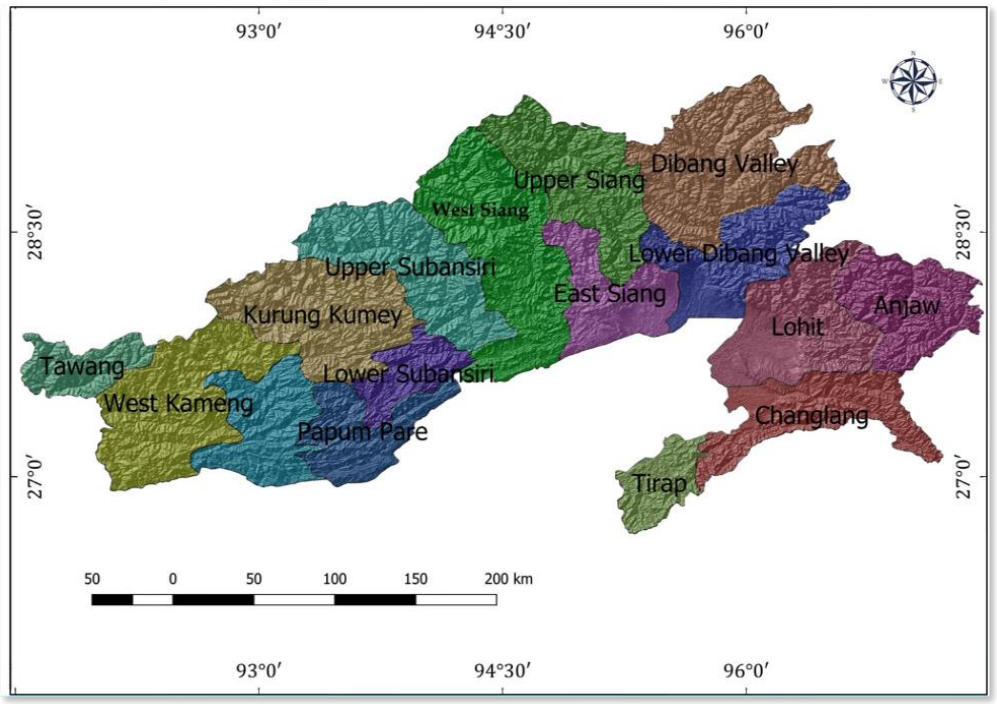
Technical Series: A **No. 01../2021-22**

DYNAMIC GROUND WATER RESOURCES OF ARUNACHAL PRADESH As on March, 2022



CENTRAL GROUND WATER BOARD

NORTH EASTERN REGION

GUWAHATI

OCTOBER, 2022

केन्द्रीय भूमि जल बोर्ड

पूर्वोत्तर क्षेत्र

गुवाहाटी अक्टूबर २०२१

DYNAMIC GROUND WATER RESOURCES OF ARUNACHAL PRADESH (2021-2022)

Prepared by

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PREFACE

Arunachal Pradesh is the biggest state in North Eastern Region bounded by longitude 91^0 30' to $97^0$30`E and latitude $26^0$30` to $29^0$39`N, with a geographical area of 83,743 Sq. Km. As per 2011 census the state population is 10,96,702. With rapid growth of population in Arunachal Pradesh in general and in the foothill areas in particular, thedemand of drinking as well as domestic water is increasing by leaps and bounds. Simultaneously the growing need for agricultural products is necessitating the need forground water exploration as also its development in the valleys.

The sustainable development of ground water resource requires precise quantitative assessment based on reasonably valid scientific principles. The assessmentof ground water resource is a complex task which involves computation and estimation of different parameters associated with the inflow and the outflow of this natural resource. In order to ascertain the ground water resource in the shallow aquifers that gets annually recharged through rainfall and other sources under various hydrogeological conditions in the country, scientific methodology following well defined norms, need to be adopted.

This report presents the Dynamic Ground Water Resources of Arunachal Pradesh estimated based on GEC'2015 in web based IN-GRES software with base year as 2022. The annual extractable groundwater resources is 4.066 BCM, of which annual allocationfor domestic needs up to 2025 is 0.009 BCM and 4.033 BCM is available for irrigation and other uses. Present stage of ground water extraction in the state is only 0.79%.

The estimation of dynamic groundwater resources for Arunachal Pradesh was jointly done by the Ground Water Wing of the Water Resources Department, Govt. of Arunachal Pradesh and Central Ground Water Board, North Eastern Region. The efforts made by the scientists of Central Ground Water Board, North Eastern Region, Guwahatiand Water Resources Department, Govt. of Arunachal Pradesh, Itanagar are commendable.

I firmly believe that the present report will go a long way to help the planners and policy makers in the ground water sector to formulate future ground water extraction and sustainable management plan for the state of Arunachal Pradesh.

(Suresh Kapil)
REGIONAL DIRECTOR

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CONTRIBUTORS

Estimation of ground water resources of Arunachal Pradesh is based on the data provided by the concerned State Departments. The computation of the resource estimation and preparation of the report are done by Shri Rajat Gupta, Assistant Hydrogeologist & Dr. D. J. Khound, Scientist-C of Central Ground Water Board, North Eastern Region.

CHAPTER 1

INTRODUCTION

1.0. Background for re-estimating the ground water resources

Arunachal Pradesh occupies the easternmost part of the country and is spread over an area of 83,743 sq. km. The state lies between Latitudes 26°30′N-29°30′N latitude and 91°30′E – 97°30′E longitude. The state is bounded on the north by China, on the east by Myanmar and on the west by Bhutan. In the south it is bounded by the state of Assam and Nagaland. The state has been divided into 16 districts, 51 Sub-divisions, 92 blocks and 190 circles.

The first assessment of ground water resources of Arunachal Pradesh was carried out in 1992 based on 'Ground Water Estimation Methodology', 1984 (GEC'84). The ground water resource of the state was reassessed for the assessment year 2004 using 'Ground Water Resource Estimation Methodology – 1997' (GEC'97). The ground water resource of the state of Arunachal Pradesh has been re-assessed based on the GEC-2015 methodology and modified database.

The earlier estimation of ground water resources potential was carried out in the year 1992 based on 'Ground Water Estimation Methodology', 1984 (GEC'84. The Total Replenishable Ground Water Resource was worked out as **1.44** billion cubic metre (BCM). Keeping 15% of this resource as provision for Domestic, Industrial & Other uses, the rest of the ground water resource is available for irrigation. Thus provision for Domestic, Industrial & Other Uses is 0.22 BCM and available Ground Water Resource for Irrigation is 1.22 BCM. The Net Draft for irrigation at year 1992 was Nil. In 2004, the ground water resource of the state had been re-estimated by Central Ground Water Board, North Eastern Region based on Ground Water Resource Estimation Methodology – 1997' (GEC'97) which is a revised methodology. The dynamic ground water resource of Arunachal Pradesh was again reassessed in 2009, 2011, 2013 and 2017,2020. In 2020 GW resources of Arunachal Pradesh had been estimated based on revised ground water resource estimation methodology of 2015 (GEC' 2015). As per 2020 estimate, the total Replenishable Ground Water Resource of the state is worked out as **4.066 BCM.**

The Current assessment has been carried out based on revised ground water resource estimation methodology of 2015 (GEC' 2015) and modified database of Arunachal Pradesh. No SWRD (G.W) -13/2010

B. Constitution of state level committee for ground water resources estimation

The State Level Committee for ground water resources estimation has been re-constituted by the Government of Arunachal Pradesh with the following members and the 1st SLC meeting on GWRA 2021-2022 for Arunachal Pradesh held on 30.03.2022**(Annexure A)**:

1. Commissioner/Secretary, WRD, Govt. of A.P. -Chairman
2. Commissioner/Secretary, (Plg.), Govt. of A.P. - Member
3. Chief Engineer, (P&D), WRD - Member
4. Chief Engineer (EZ), WRD - Member
5. Chief Engineer (WZ), WRD - Member
6. Chief Engineer, (P&D), PHE & WS Deptt. - Member
7. Director of Agriculture, Naharlagun - Member
8. Regional Director, CGWB (NER), Guwahati -Member Secretary

CHAPTER 2

HYDROGEOLOGICAL CONDITIONS OF ARUNACHAL PRADESH

2.0 DESCRIPTION OF ROCK TYPES WITH AREA COVERAGE

Hydrogeologically the state can be categorized into three units, viz-(i) Consolidated representing the crystalline formations and the (ii) Semi-consolidated and (iii) Unconsolidated units representing the Sedimentaries.

The consolidated formations (crystallines) occur along the high and moderate hill ranges of the state. These formations mostly comprise meta-sediments like gneiss and schist and fissured formations (i.e.-Phyllites, Schist, Quartzites etc.) belonging to Archean to Paleozoic age. They act basically as run-off zone. The weathered part as well as the secondary pores developed in the form of joints, fissures etc in the consolidated formations have good ground water potential.

The semi-consolidated formations comprise the Tertiary Group of rocks represented by the Disang, Barail, Tipam, Siwalik and Dihing groups of rock. They are occupying the areas in the south and southwestern part of the state and show gradual decrease in altitude and behave as run-off, infiltration as also discharge zones. They contribute recharge to ground water depending on litho-character.

Ground water in both consolidated and semi-consolidated formations is manifested as springs. Springs in all geological formations are both seasonal and perennial in nature.

The older alluvium comprising the terrace deposits of Pleistocene and also the terrace and alluvial fan deposits of Holocene age form the unconsolidated formation. They are distributed as thin layers in intermontane valleys and with considerable thickness in open and wide valleys joining Brahmaputra Alluvial plains. Deposition shows poor sorting in distribution of grains. High or low rate of infiltration is observed depending on physical geometry and matrix of formation. Terrace types of deposits are found extending in and along the foothill zone. It is commonly referred to Bhabar belt, comprising sand, gravel, pebble and boulder. The zone contains one or more aquifers, which have fair to good ground water potential. The aquifers at places tend to be artesian in nature. Unconsolidated Quaternary and Upper Tertiary formations form the main hydrological units in the state.

2.1. Rock Types

The state constitutes rocks from Archaean to Recent. Major part is covered with consolidated crystalline rocks and meta-sediments of Precambrian and Palaeozoic times, while Tertiary sediments consisting semi-consolidated argillaceous assemblage occupy periphery areas bordering Assam. Unconsolidated Quaternary sediments

comprising Alluvium prevail in the fringe valley areas and as thin carpet in isolated structural valleys. More than 90% of the area is covered by hilly terrain.

Unconsolidated Quaternary and Upper Tertiary formations form the main hydrological units for ground water recharge in the state. Other than this, Semi consolidated Lower Tertiary and Upper Paleozoic formations are important from Ground Water development point of view.

2.2 Hydrometeorological Conditions

The climate of the state is mainly influenced by orography. It is sub-tropical, wet and highly humid in nature in the foothill regions and cold in higher elevations. The temperature falls below freezing point during extremely cold period. The maximum temperature ranges from 27^{o}C and minimum winter temperature in the higher altitude goes down below freezing point. Humidity is very high. Heavy rainfall is received during summer and occasional rainfall during winter. January and February are the driest months. The rainfall received during summer is under the spell of South-West monsoon. The onset of South-West monsoon in the region occurs by the end of May or the first week of June and withdraws by late September or early October. But, very often pre-monsoon showers are experienced during March and April. Copious rainfall is received in the southern, eastern and northeastern part of the state during the summer. From March to May, the region comes under the influence of equatorial Westerlies and receives precipitation with occasional thundershowers.

The average annual rainfall in different stations of the state varies from 2000 to 5000 mm with some variation. The isohyets showing the rainfall pattern in the state on the basis of normal annual rainfall, has been depicted in Plate III.

2.3 Description of Hydrogeological Units

The unconsolidated alluvial sediments in the valley areas act as good repositories for ground water development. Valleys adjoining Assam are most promising where good thickness of granular aquifer zones is distributed. However, physical parameters of heterogeneous aquifer sediments with variable matrix play an important role in determining permeability, transmissibility and specific capacity of aquifer zones. Intervening clay layers found with arenaceous sediments indicate leaky aquifer system. Auto-flow conditions seen at places are promoted due to high hydraulic head. In the intermontane valleys thickness of alluvium and weathered residium are important factors. Potential aquifer zones are likely to prevail

Semi-consolidated Tertiary formations are likely to give moderate or poor yield and expected to be controlled by aquifer geometry and structural features.

In consolidated formations ground water potentiality appears to be very much limited. However, highly weathered and fissured formation in pockets may offer some scope for development

Ground water exploration studies were carried out by Central Ground Water Board (CGWB) in the state revealed that water bearing formations are observed in Unconsolidated Alluvium of Quaternary Age, Primary/Secondary porosity of semi-consolidated sandstone of Tertiary Age, Secondary porosity of granite, schist, gneiss, phyllite of Archean to Pre Cambrian Age. Discharge of the deep tubewells varies from 1.4 m^3/hr to 54 m^3/hr while transmissivity ranges from 1.14 to 661 m^2/day. Storativity ranges from 0.35 x 10^{-3} to 6.65 x10^{-3}.

Table 2.1 : Ground Water Potential in different Hydrogeological formations of Arunachal Pradesh

Formation	Lithology	Groundwater potential
Unconsolidated	sand, clay, silt, gravel, pebble, cobble and boulder	Moderate yield, 30-50m^3/hr. Drawdown within 10 to 15m.
Semi-consolidated	Shale, siltstone, sandstone, interbedded with coal seams and limestone	Low yield, up to 20m^3/hr. Drawdown within 25m.
Consolidated		
Fissured Formation	Phyllites, schist, slates, quartzites	Low yield, 5 to 15m^3/hr.
Metasediment	Gnessic complex with acid and basic intrusives	Yield up to 5m^3/hr.

2.4 Ground Water level conditions

Major part of the state, Arunachal Pradesh is hilly and monitoring stations are located along the southern boundary. The depth to water level in the pre-monsoon period is restricted to 10m. However, water levels within 5mbgl have been recorded in most of the stations. In the post monsoon period also the depth to water level has been found within 10m. There is no significant decline in water level is observed in pre and post-monsoon seasons.

2.5 Ground Water Quality

Analysis of water samples collected from the tube wells indicated that ground water in the area is suitable for both drinking and irrigation purposes. Almost all the constituents are within the permissible limit barring high iron concentration in some areas. Results of analysis of water samples are shown in **Table 2.2**

Table 2.2: Chemical analysis results of ground water, Arunachal Pradesh

Range of Chemical Constituents															
pH	EC µS/cm at 25^{0}C	Fe	K	TH as $CaCO_3$	Ca	Mg	CO_3	Na	HCO_3	Cl	NO_3	TDS	SiO_2	PO_4	F
6.89-	158-	0.8 -	1.8-2	66-	15-	6.8-	Nil	8-19	79-	3.6-	0-0.9	100-	38-	Nil	0-1.0

7.7	278	7.4		135	26	17			134	11		220	49		

Chemical analysis of Ground Water samples collected during the various studies conducted by CGWB indicate that the quality of ground water is good for domestic, industrial and agricultural use. No toxic element has been reported so far from any parts of the state.

CHAPTER 3

GROUND WATER RESOURCES ESTIMATION BY AUTOMATION

3.0. Introduction

While analyzing 2017 dynamic GW resources of India, it was felt that there is an urgent need for automation of Ground Water Resource Estimation to make the assessment frequent and effective. This will provide a common and standardized platform using GEC-2015 methodology. This includes a web-based application and its pan-India operationalization. A GEC dashboard as a final output of automation for the entire India, will be able to show all type of recharges and discharge components reflecting the overall stage of extraction at the selected Level (District, tehsil, block, Mandal ,blocks, etc). This will not only help the Decision makers to make decisions but also empower the stakeholders with knowledge to take part in the decision making process. In this context a project was assigned by the Ministry of Jal Shakti to IIT Hyderabad who in technical support of Vasar Labs IT Solution, Hyderabad prepared web based software known as "In-GRESS" (INDIA GROUNDWATER RESOURCE ESTIMATION SOFTWARE) (http://ingres.iith.ac.in).

Advantages of Automation using IN GRESS software: The process of automation has the following advantages

1. IN-GRES is the common portal to input, estimate, analyze, and access static and dynamic groundwater resources.
2. Recharge (in-fluxes) and Extraction (out-fluxes) of groundwater resources are automated.
3. Removes all the hurdles associated with manual data entry, computations, report generation, approvals, and visualization.
4. IN-GRES is a user friendly software to dynamically characterize the administrative/assessment units based on GEC-2015.

GEC 2015 Methodology: IN GRESS software is based on GEC 2015 methodology for ground water resources estimation for 3 types of Aquifers: Unconfined Aquifer, Semi-Confined Aquifer and Confined Aquifer. The resource estimation for an Unconfined Aquifer is based on the principle of water balance:

$$\text{Inflow} - \text{Outflow} = \text{Change in Storage (of an aquifer)}$$

This equation can be further elaborated as:

$$\Delta S = RRF + RSTR + RC + RSWI + RGWI + RTP + RWCS \pm VF \pm LF - GE - T - E - B$$

Where,

ΔS – Change is storage

RRF – Rainfall recharge

RSTR – Recharge from stream channels

RC – Recharge from canals

RSWI – Recharge from surface water irrigation

RGWI – Recharge from ground water irrigation

RTP – Recharge from tanks & ponds

RWCS – Recharge from water conservation structures

VF – Vertical inter aquifer flow

LF – Lateral flow along the aquifer system (throughflow)

GE – Ground Water Extraction

T – Transpiration

E – Evaporation

B – Base flow

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

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

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

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

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

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

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

ii) GIS Dashboard – GIS dashboard shows the data in Web Geo-Server format, implemented in interactive GIS platform allowing user to all GEC related information in

the map itself. GIS view represents the data on India map and color codes each District/Assessment unit based on the categorization.

The important input data files containing types of data in INGRESS and computed parameters using the input data is shown in Table 3.1 in abridge form.

Table 3.1: Comparison and recommendations of GEC 2015 with GEC 97

S. N	Input Data File in INGRESS	Type of Data	Parameters Computed
1	Basic data sheet	Recharge Worthy Area, Non-Recharge Worthy Area, Type of Soil, Specific Yield, Rainfall Infiltration Factor	
2	Aquifer Data	Aquifer information of the assessment unit i.e. Principal Aquifer, Major Aquifer and its code	
3	Rainfall Data File	1. Rainfall data assessment unit wise 2. Rain Gauge Data 3. IMD Grid Data 4. Time Series Data	Rainfall Recharge by Rainfall Infiltration Method (RIF)
5	Ground Water Well Data File	1. Assessment unit wise data 2. Well wise data 3. Time series data	Monsoon Rainfall Recharge by Water Level Fluctuation Method
5	Recharge Data File	1.Surface Water Irrigation – Canal Outlet 2. Surface Water Irrigation – Crop Water Requirement 3. Canal Seepages 4. Tanks & Ponds 5. Water Conservation Structures 6. Water Conservation Structures 7. Ground Water Irrigation	Recharge from other sources
6	Draft Data File	**Domestic** **(i)** Unit Draft **(ii)** Consumptive Use Method **Irrigation** (i) Unit Draft (ii) Power consumption **Industrial** (i) Unit Draft (ii) Power consumption	Groundwater extraction calculation for (i) Domestic (ii) Irrigation (iii) Industrial

7	Inflows and Outflows Data File	**1.** Base Flow **2.** Additional Base Flow **3.** Vertical inter Aquifer flow **4.** Lateral Aquifer flow **5.** Evapotranspiration **6.** Evaporation **7.** Transpiration **8.** Stream Channels	
8	Additional Potential Resources Data File	i) Shallow Water Areas ii) Flood Prone Areas iii) Spring Discharges	
9	Resources of Confined and Semi-Confined Aquifer Data File	Confined & semi-confined aquifer piezometer data	
10	Urban Area Resource – Pipelines and Sewages		

User Management: IN-GRESS system has multi-level user to input data, trigger computations and approval to accept data and estimation of resource. In IN-GRESS, the data validation and approval of resource computation starts from district level and ends at the Ministry level after which only the final resource is available in public domain. State, Central Ground Water Board (CGWB) and Central Level Expert Group (CLEG) act as intermediary admin in between district and Ministry. The hierarchy is as follows:

District Admin: District admin will either approve district level field user input data and computations to State Admin or rejects and reverts to field user.

State Admin: State admin initiate the process of resource estimation by uploading the assessment unit shape file in IN-GRESS. State admin also upload the Basic Data file. It either approves the data and computations to State Level Committee (SLC) for estimation of dynamic groundwater resource of the state or rejects and reverts to district admin.

SLC Admin: SLC admin after examining the resource will either approves the data and computations to CGWB admin or rejects and reverts to state admin.

CGWB Admin: CGWB admin if satisfied with the computations will approve GWRE to CLEG or if not satisfied then reverts it to SLC admin.

CLEG Admin: After CLEG's approval, the report moves to Ministry admin user for approval.

CHAPTER 4

GROUND WATER RESOURCES ESTIMATION IN ARUNACHAL PRADESH THROUGH IN-GRESS

4.0 IN-GRESS User Management: As automation of groundwater resource is introduced for the first time in Arunachal Pradesh like the rest of the country, the Central Ground Water Board, North Eastern Region has completed the task of uploading shape file of assessment unit, data entry, triggering computation and validation of computation as super admin. Uploaded basic data, aquifer data, extraction data, recharge data, etc. in IN-GRESS are shown in Annexure I to VI.

4.1 GROUND WATER ASSESSMENT UNIT

Although GEC 2015 methodology strongly advocates aquifer wise assessment of total availability of resource, at the same time it also accepts administrative units as assessment units if the aquifer geometry is not firmly established or if NAQUIM study is not completed. In Arunachal Pradesh NAQUIM study has been completed in Papum Pare, East Kameng, East Siang, Lower Dibang Valley (part) and Lohit districts during 2012-2018. Aquifer mapping of the rest of the foothill districts will be carried out in future.

The ground water resource estimation of the state is done on district-wise assessment unit due to paucity of block-wise data. In Arunachal Pradesh block wise area and other relevant data is not available. As per 2011 census there are 16 nos. of districts in the state. Since then there are numbers of districts have been created in the state by bifurcating East Siang, West Siang, Lohit, Lower Subansiri, etc. As on July 2020, there are 26 nos. of districts in the state. However, the state government has yet to finalize boundaries of the newly created districts. As such in this assessment, the older district boundaries are considered.

The ground water resource of eleven districts of the state had been re-estimated for the assessment year 2022.

4.1.1 HILLY and RECHARGE WORTHY AREA: The hilly districts namely Upper Siang, Anjaw, Dibang Valley, Kurung Kumey and Tawang are excluded from ground water resources estimation exercise as the slope of these districts are more than 20%.

Recharge worthy area, i.e., areas where slope is less than 20% are very limited and restrict in the foothill parts of the state. The recharge worthy areas are found out by subtracting the hilly area from total geographical area of the assessment unit, i.e., district.

4.1.2 POOR QUALITY AREA/ COMMANAD AND NON-COMMAND AREA

There is no quality hazard in Arunachal Pradesh as listed in GEC 2015. Therefore, there is no assessment for poor quality area.

There is no major and medium irrigation scheme in Arunachal Pradesh and as such entire state is considered as non-command area in the present assessment.

4.2 GROUND WATER EXTRACTION

Ground water extraction includes extraction for domestic, industrial and irrigation use. GEC 2015 methodology recommends following methods, i.e., unit draft method, power consumption consumptive use method and consumptive use pattern method for estimating extraction.

In the present assessment domestic extraction is calculated by consumptive use method. The data set for this estimation is Population census of 2011. As there is no input of groundwater dependency data from state government, it is calculated from village amenities part of census 2011. Dependency for each assessment unit is the ratio of number of household extracting groundwater from various sources (covered well, uncovered well, hand pump, tube well and spring) to the total number of households.

Water Resources Department, Govt. of Arunachal Pradesh has published district irrigation plan and provided data of Ground water irrigation through PMKSY. Groundwater extraction for irrigation is estimated by unit draft method.

Industrial extraction is estimated only for food and beverage industry. Central Ground Water Authority database is used for estimating the unit draft.

4.3 RECHARGE FROM OTHER SOURCES

In the present assessment only the recharge from surface water irrigation and Ground Water irrigation is considered. Surface water & Ground water irrigation data as mentioned district irrigation plan and provided by WRD, Govt. of Arunachal Pradesh is utilized in the current resource estimation.

The area irrigated by surface irrigation scheme during Kharif and Rabi seasons is considered for recharge during monsoon and non-monsoon season. Recharge from irrigation through return flow is calculated for minor irrigation only. Crop wise area brought under irrigation for monsoon and non-monsoon seasons are not available. Therefore, crop under monsoon irrigation by surface sources is considered as paddy being major crop while during non-monsoon season crops other than paddy is considered. As design discharge of surface irrigation schemes are available in MIS census, quantum of water applied is calculated by multiplying irrigated area of kharif/rabi season with crop water requirement of the respective season.

4.4 INFLOW AND OUTFLOW COMPONENTS

The inflow components are lateral flow along the aquifer system, vertical flow from hydraulically connected aquifers. Base flow, stream recharge, evaporation and transpiration are the outflow components. In the present assessment the lateral and vertical flow components could not be determined due to lack of aquifer parameters.

Base flow and stream recharge are also difficult to determine due to lack of stream gauge discharge data. Only two outflow components are determined in the present assessment, i.e. evaporation and transpiration.

Since field study results of evaporation are not available, it is considered as per guidelines of GEC 2015 that aquifer losses water through evaporation if the depth of water is within 1.0mbgl while aquifer losses water through transpiration if the depth of water is within 3.5mbgl. Evaporation and transpiration losses from aquifer are considered as zero when depth to water level is more than 1 mbgl and 3.5 mbgl respectively. Rate of evaporation is considered as 1mm/day as per guidelines. Evaporation and transpiration areas are determined from monsoon and non-monsoon depth-to-water level contour.

4.5 RAINFALL RECHARGE

Rainfall recharge is estimated in the present assessment by two prescribed methods: rainfall infiltration factor and ground water level fluctuation methods. However, ground water level fluctuation method could be used only for six districts, viz., Papum Pare, Lower Subansiri, East Siang, Lohit, Changlang and Tirap. There is no water level monitoring stations in remaining five districts.

Rainfall infiltration factor is used to estimate rainfall recharge by considering recommended rainfall infiltration factor of 22%. The normal rainfall data of Indian Meteorological Dept. (IMD) is readjusted for resource calculation based on minimum and maximum threshold values.

Rainfall recharge during monsoon season computed by Rainfall Infiltration Factor (RIF) method is compared with recharge calculated by Water Level Fluctuation (WLF) method to determine "**PD**" factor. When PD factor is not within the range of -20% to 20% than rainfall recharge estimated by rainfall infiltration factor method is adopted after multiplying with weightage factor of 0.8 (if >-20%) or 1.2 (if >20%). If PD factor is within a range of - 20% and +20%, rainfall recharge calculated through water table fluctuation method is adopted.

During estimation of GWRE 2022 for Arunachal Pradesh, recharge calculated through the two methods are compared. After comparison rainfall recharge estimated by water level fluctuation is adopted for East Siang.

4.6 TOTAL ANNUAL GROUND WATER RECHARGE OR ACCUMULATION

The total annual ground water recharge is the sum-total of monsoon and non-monsoon recharge. An allowance is kept for **Environmental Flow** (un-accounted natural discharge as per GEC'97) in the non-monsoon season by deducting 5% of total annual ground water recharge, where WLF method is employed to compute rainfall recharge during monsoon season and 10% of total annual ground water recharges

where RIF method is employed before getting the **annual extractable ground water resource**.

4.7 ALLOCATION OF GROUND WATER RESOURCE FOR UTILIZATION

The net annual ground water availability is to be apportioned between domestic, industrial and irrigation uses. Among these, as per the National Water Policy, 2002, requirement for domestic water supply is to be accorded priority. The ground water requirement for domestic water supply is to be kept based on projected population to 2025. The GEC' 15 methodology provides following empirical formula for allocation of ground water for domestic requirement

$$A = 22 * N * L_g$$

Where,

A = Allocation for domestic in mm/year.

N = Projected Population density in assessment unit in thousands per square kilometer.

L_g= Fractional Load on ground water for domestic and industrial water supply

(≤ 1.0)

The net ground 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.

4.8. ADDITIONAL POTENTIAL RECHARGE

Additional potential recharge is calculated as per GEC'15 methodology for water logged and shallow water table areas. Springs are not monitored regularly and systematic spring discharge data is not available for potential resource calculation.

- ✓ **Potential Resource in Water Logged and Shallow Water Table Areas:**

For calculation of potential resource, water logged and shallow water table areas has been delineated from depth to water (DTW) level map prepared from five years average pre-monsoon depth-to-water level within 5 m bgl.

CHAPTER 5

DYNAMIC GROUND WATER RESOURCES

The ground water resource estimation of the state is done on district-wise basis. Resource has been calculated for eleven districts of the state. The data used for resource estimation has been collected in the year 2021-2022. Assessment of ground water resource of the state has been estimated for the year 2022

The resource has been computed district-wise (Table 5.2). Rainfall recharge has been estimated by employing both Water Level Fluctuation method and Rainfall Infiltration Factor methods. However, WLF could be used for those districts where ground water monitoring stations could be established. Presently only six districts, namely, Papum Pare, Changlang, Tirap, Lohit, Lower Subansiri and East Siang have GWMS. Sub-unit-wise computation could not be carried out due to paucity of data.

In the present assessment inflow and outflow components are estimated following guidelines of GEC 2015 (Fig.5.1). Total annual ground water recharge of the state is 452546.13 ham. Rainfall recharge is 301852.86 ham and recharge from other sources is 150693.29 ham. The outflow components, i.e. evaporation and transpiration together amounts 4588ham. Total natural discharge is 41342.76ham. So annual extractable ground water resources of the state have been assessed to be 406615.26 ham.

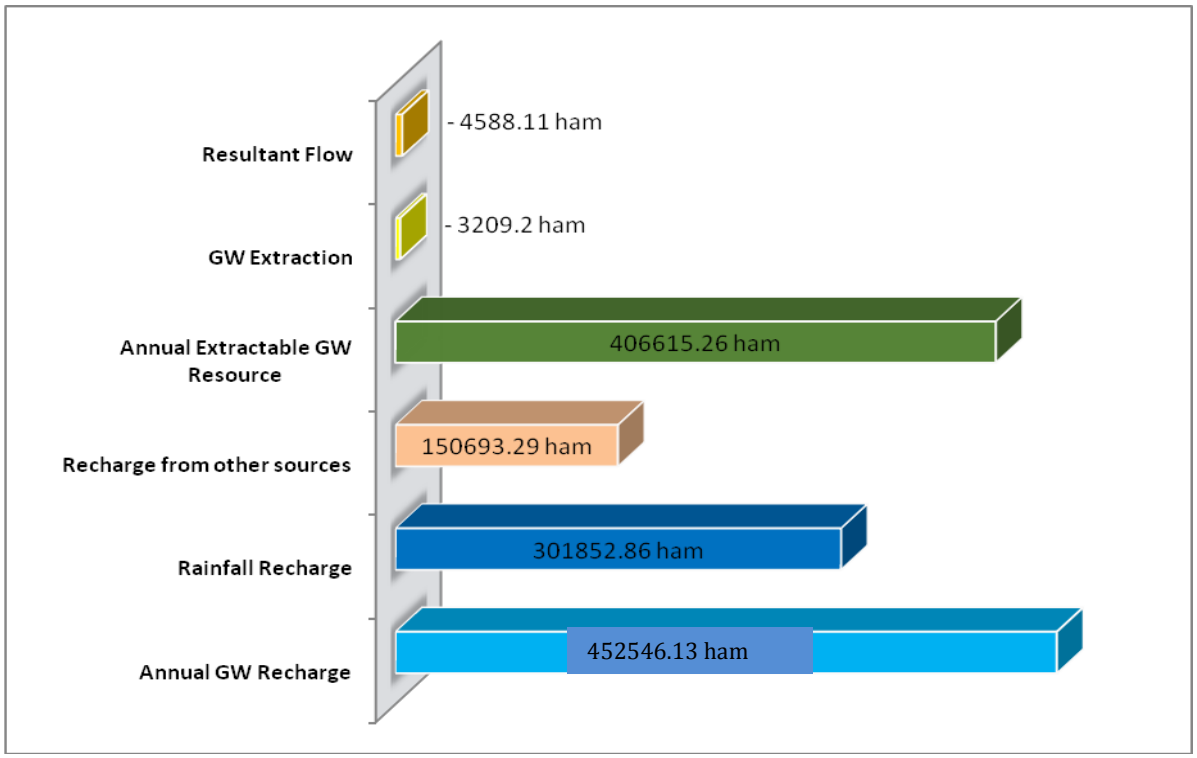


Fig. 5.1: Inflow and outflow componenets of GW resources of Arunachal Pradesh

The existing ground water extraction for all uses is 3209.20 ham. Of which extraction for irrigation use is maximum. Extraction for domestic is 809.98 ham and industrial extraction is 68.92ham. Allocation of ground water for domestic use is

worked out to be 893.48ham. The net ground water availabilities for future use is 403322.57 ham. Overall ground water extraction is less than 1%.

Table 5.1: Comparison between Ground water resources of Arunachal Pradesh (based on GEC'2015)

S. N.	ITEM	Year of Estimation (2020)	Year of Estimation (2022)	Comparison between dynamic GW resources estimated in 2017 & 2020
1	2	3	4	5(4 – 3)
1.	Total Annual Ground Water Recharge (Ham)	319107.89	452546.13	133438.24
	Total Natural Discharges (Ham)	22894.16	41342.74	18448.6
2.	Annual Extractable Ground Water Resource (HAM)	291625.6	406615.26	114989.66
	Existing Gross Extraction (HAM)	1,057.93	3209.20	215.27
	Irrigation uses (HAM)	253.09	2330.28	2077.19
	Domestic uses (HAM)	782.911	809.98	27.069
3.	Industrial uses (HAM)	21.93	68.92	46.99
4.	Stage of GW Extraction (%)	0.36	0.79	0.43
5.	Provision for domestic (HAM)	893.48	893.48	No considerable change
6	Provision for future use (HAM)	290457	403322.57	112865.57

From the comparison table it is observed that estimated total replenishable ground water resource as on March 2022 is more than 2020 estimate by **114989.66ham** (or nearly 28%). Except extraction for irrigation, other components of GWRE show minor change mainly due to refinement of data.

Table: 5.2 (A) SUMMARY REPORT IN RESPECT OF THE DYNAMIC GROUND WATER RESOURCES (contd.)

S.N.	Assessment Unit	Area suitable for G.W. recharge (in ha)	Rainfall Recharge (ham)	Annual Recharge from Other Sources (ham)	Rainfall Recharge (ham)	Annual Recharge from Other Sources (ham)	Annual G. W. Recharge (in ham)	Total Natural discharge (in ham)	Resultant Flows (Evaporation and Transpiration Loss) in ham	Resultant Flows (Evaporation-transpiration Loss) in ham	Annual extractable Ground Water Resource (ham)
			Monsoon	Monsoon	Non-Monsoon	Non-Monsoon			Monsoon	Non-Monsoon	
1	2	3	4	5	6	7	8	9	10	11	12(=8-(9+10+11)
1	CHANGLANG	53000	16679.05	33274.07	7569.09	19817.01	77339.21	7733.92	908.66	5090	68187.63
2	EAST KAMENG	31250	8567.56	3469.31	3180.99	2083.46	17301.32	1730.13	0	0	15571.19
3	EAST SIANG	110100	53855.0	6461.92	14046.82	3873.84	78237.56	3911.88	195.54	394.62	73735.52
4	LOHIT	200000	51031.20	4965.57	41934.20	2972.50	100903.46	10090.35	218.55	2073.61	88520.96
5	LOWER DIBANG VALLEY	120000	41521.92	8752.73	32545.92	5220.42	88040.99	8804.10	0	0	79236.89
6	LOWER SUBANSIRI	10135	1895.44	1213.40	1442.42	726.57	5277.83	527.78	115.37	50.29	4584.38
7	PAPUM PARE	17819	8131.71	7756.74	2332.98	4623.58	22845.00	2284.50	31.21	91.26	20438.03
8	TIRAP	12500	7142.72	264.64	1658.42	161.88	9227.65	922.77	0	0	8304.89
9	UPPER SUBANSIRI	700	141.52	9365.57	73.65	5577.67	15158.41	1515.84	0	0	13642.57
10	WEST KAMENG	6175	2342.95	10125.54	397.31	6027.37	18893.17	1889.32	0	0	17003.85
11	WEST SIANG	10459	4445.29	8745.97	916.73	5213.55	19321.54	1932.15	0	0	17389.38
	Total	**572138**	**195754.32**	**94395.44**	**106098.52**	**56297.8412**	**452546.1327**	**41342.73759**	**1469.33**	**3118.78**	**406615.28**

Table: 5.2 (A) SUMMARY REPORT IN RESPECT OF THE DYNAMIC GROUND WATER RESOURCES

S.N.	Assessment Unit	Current annual gross G.W. Extraction for domestic use (in ham)	Current annual gross G.W. Extraction for irrigation (in ham)	Current annual gross G.W. Extraction for industrial use (in ham)	Current annual gross G.W. Extraction for All uses (in ham)	Annual G.W. Allocation for Domestic water supply as on 2025 (in ham)	Net Annual G.W. availability for future use (in ham)	Stage of GW Extraction (in %)	Quantity Categorization for Future GW Development (Safe/Semi-Critical/Critical/Over Exploited)	Quality Tagging	Validation of Assessment using GW Level Trends (Valid/To be Re-assessed)
		13	14	15	16	17	18	19	20	21	22
1	CHANGLANG	191.10	257.15	0	448.26	205.88	67724.59	0.66	Safe	Fresh	**Valid**
2	EAST KAMENG	29.94	379.26	0	409.20	35.68	15156.24	2.63	Safe	Fresh	No GWMS in the district
3	EAST SIANG	69.87	579.28	1.04	650.20	73.76	73081.45	0.88	Safe	Fresh	**Valid**
4	LOHIT	237.79	361.88	48.96	648.63	254.34	87855.77	0.73	Safe		**Valid**
5	LOWER DIBANG VALLEY	33.31	225.76	0.00	259.07	34.28	78976.85	0.33	Safe		No GWMS in the district
6	LOWER SUBANSIRI	22.00	85	0.00	107.00	28.05	4471.33	2.33	Safe	Fresh	**Valid**
7	PAPUM PARE	103.51	141.54	17.15	262.20	128.6	20150.74	1.28	Safe	Fresh	**Valid**
8	TIRAP	68.03	77.4	0.00	145.43	71.23	8156.25	1.75	Safe	Fresh	**Valid**
9	UPPER SUBANSIRI	20.45	62.15	0.00	82.60	26.37	13554.05	0.61	Safe		No GWMS in the district
10	WEST KAMENG	11.65	6.24	0.00	17.89	12.25	16985.36	0.11	Safe	Fresh	No GWMS in the district
11	WEST SIANG	22.32	154.62	1.78	178.72	23.04	17209.94	1.03	Safe	Fresh	No GWMS in the district
	Total	**809.98**	**2330.28**	**68.92**	**3209.20**	**893.48**	**403322.57**	**0.79**	Safe	**Fresh**	

Table 5.3: Potential resource of water logged and shallow water table area

S.N.	District	Potential resource due to spring discharge (in ham)	Potential resource in water logged and shallow water table area (in ham)	Potential resource in flood prone area (in ham)	Total potential recharge (in ham)
1	Tirap	NA	2.05	NA	2.05
2	Changlang	NA	13761.20	NA	13761.20
3	Lohit	NA	5097.60	NA	5097.60
4	Anjaw	NA	NA	NA	NA
5	Dibang valley	NA	NA	NA	NA
6	Lower Dibang Valley	NA	NA	NA	NA
7	East Siang	NA	2494.69	NA	2494.69
8	West Siang	NA	NA	NA	NA
9	Upper Siang	NA	NA	NA	NA
10	East Kameng	NA	NA	NA	NA
11	West Kameng	NA	NA	NA	NA
12	Lower Subansiri	NA	592.27	NA	592.27
13	Upper Subansiri	NA	NA	NA	NA
14	Papum Pare	NA	1996.25	NA	1996.25
15	Tawang	NA	NA	NA	NA
16	Kurung Kumey	NA	NA	NA	NA
Total		**NA**	**23944.05**		**23944.05**

Annexure 1A: "Basic Data" input sheet for ARUNACHAL PRADESH for year 2021-2022

S.N	Location Code	District	Assessment Unit	*Total Geographical Area (ha)	*Hilly Area (ha)	*Total Recharge Worthy Area (ha)				Static/In-Storage Unconfined Ground Water Resources	
						*Command	*Non Command	*Poor Quality	Total	Bottom of the Unconfined aquifer (m)	Specific Yield in Static/In-Storage zone
1	AR160000	TIRAP	TIRAP	236200	223700	0	12500	0	12500	300	0.12
2	AR150100	TAWANG	TAWANG	217200	217200	0	0	0	0	0	0
3	AR030000	DIBANG VALLEY	DIBANG VALLEY	912900	912900	0	0	0	0	0	0
4	AR090000	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	390000	270000	0	120000	0	120000	300	0.12
5	AR200000	WEST SIANG	WEST SIANG	832500	822041	0	10459	0	10459	0	0
6	AR180000	UPPER SUBANSIRI	UPPER SUBANSIRI	703200	702500	0	700	0	700	0	0
7	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	350800	340665	0	10135	0	10135	300	0.12
8	AR050000	EAST SIANG	EAST SIANG	360300	250200	0	110100	0	110100	300	0.12
9	AR020000	CHANGLANG	CHANGLANG	466200	413200	0	53000	0	53000	300	0.12
10	AR170000	UPPER SIANG	UPPER SIANG	659000	659000	0	0	0	0	0	0
11	AR010000	ANJAW	ANJAW	619000	619000	0	0	0	0	0	0
12	AR080000	LOHIT	LOHIT	521200	321200	0	200000	0	200000	300	0.12
13	AR130000	PAPUM PARE	PAPUM PARE	346200	328381	0	17819	0	17819	50	0.12
14	AR190000	WEST KAMENG	WEST KAMENG	742200	736025	0	6175	0	6175	0	0
15	AR070000	KURUNG KUMEY	KURUNG KUMEY	604000	604000	0	0	0	0	0	0
16	AR040000	EAST KAMENG	EAST KAMENG	413400	382150	0	31250	0	31250	0	0

Annexure 1B: "Basic Data" input sheet for ARUNACHAL PRADESH for year 2021-2022

S.No	Location Code	District	Assessment Unit	Principal Aquifer	Major Aquifer	*Major Aquifer Code	Non Command		
							*Percentage of geographical area	* Recommended Specific Yield for assessment (%)	* Recommended Infiltration Factor for assessment (%)
1	AR160000	TIRAP	TIRAP	Alluvium	Valley Fills	AL06	100	16	22
2	AR090000	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Alluvium	Valley Fills	AL06	100	16	22
3	AR200000	WEST SIANG	WEST SIANG	Alluvium	Valley Fills	AL06	100	16	22
4	AR180000	UPPER SUBANSIRI	UPPER SUBANSIRI	Alluvium	Valley Fills	AL06	100	16	22
5	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	Alluvium	Valley Fills	AL06	100	16	22
6	AR050000	EAST SIANG	EAST SIANG	Alluvium	Valley Fills	AL06	100	16	22
7	AR020000	CHANGLANG	CHANGLANG	Alluvium	Valley Fills	AL06	100	16	22
8	AR080000	LOHIT	LOHIT	Alluvium	Valley Fills	AL06	100	16	22
9	AR130000	PAPUM PARE	PAPUM PARE	Alluvium	Valley Fills	AL06	100	16	22
10	AR190000	WEST KAMENG	WEST KAMENG	Alluvium	Valley Fills	AL06	100	16	22
11	AR040000	EAST KAMENG	EAST KAMENG	Alluvium	Valley Fills	AL06	100	16	22

Annexure 2A: "Domestic (Consumptive Use)" input sheet for ARUNACHAL PRADESH, for year 2021-2022

S.No	Location Code	District	Assessment Unit	Non Command									
				Population Details				* Per capita Requirement (lpcd - litres per capita per day)		* Fractional load on ground water Lg		No. of Days	
				* Reference Year	* Population as on Reference Year		* Growth Rate (%)					Monsoon	Non Monsoon
					Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	
1	AR160000	TIRAP	TIRAP	2011	111975	0	1.161	0	60	0	0.246	0	153	212
2	AR090000	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	2011	54080	0	0.72	0	60	0	0.2606	0	153	212
3	AR200000	WEST SIANG	WEST SIANG	2011	112274	0	0.804	0	60	0	0.0834	0	153	212
4	AR180000	UPPER SUBANSIRI	UPPER SUBANSIRI	2011	83448	0	5.078	0	60	0	0.0718	0	153	212
5	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	2011	83030	0	4.9	0	60	0	0.0786	0	153	212
6	AR050000	EAST SIANG	EAST SIANG	2011	99214	0	1.352	0	60	0	0.28	0	153	212
7	AR020000	CHANGLANG	CHANGLANG	2011	148226	0	1.818	0	60	0	0.4906	0	153	212
8	AR080000	LOHIT	LOHIT	2011	145726	0	1.659	0	60	0	0.6301	0	153	212
9	AR130000	PAPUM PARE	PAPUM PARE	2011	176573	0	4.473	0	60	0	0.1794	0	153	212
10	AR190000	WEST KAMENG	WEST KAMENG	2011	83947	0	1.253	0	60	0	0.0557	0	153	212
11	AR040000	EAST KAMENG	EAST KAMENG	2011	78690	0	3.762	0	60	0	0.1229	0	153	212

Annexure 2B: "Industrial (Unit Draft)" input sheet for ARUNACHAL PRADESH for year 2021-2022

S.N	Location Code	District	Assessment Unit	Assessment Sub-Unit (Command, Non Command, Poor Quality)	* Type of Industries	* Type of Structure	* No. of wells in assessment year	Actual No. of wells in use	* Estimated draft per well (ha.m)	
									Monsoon	Non-Monsoon
1	AR160000	TIRAP	TIRAP	Non Command	Industry 1	Structure 1	0	0	0	0
2	AR090000	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	Industry 1	Structure 1	0	0	0	0
3	AR200000	WEST SIANG	WEST SIANG	Non Command	Packaged Drinking Water	Dug Well	1	1	0.39	0.7854
4	AR200000	WEST SIANG	WEST SIANG	Non Command	Packaged Drinking Water	Tube Well	1	1	0.2	0.4
5	AR180000	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	Industry 1	Structure 1	0	0	0	0
6	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	Industry 1	Structure 1	0	0	0	0
7	AR050000	EAST SIANG	EAST SIANG	Non Command	Packaged Drinking Water	Tube Well	1	1	0.35	0.69
8	AR020000	CHANGLANG	CHANGLANG	Non Command	Industry 1	Structure 1	0	0	0	0
9	AR080000	LOHIT	LOHIT	Non Command	Packaged Drinking Water	Tube Well	1	1	2.72	5.44
10	AR130000	PAPUM PARE	PAPUM PARE	Non Command	Packaged Drinking Water	Dug Well	2	2	0.2135	0.425
11	AR130000	PAPUM PARE	PAPUM PARE	Non Command	Packaged Drinking Water	Tube Well	12	12	0.4409	0.881
13	AR190000	WEST KAMENG	WEST KAMENG	Non Command	Industry 1	Structure 1	0	0	0	0
14	AR040000	EAST KAMENG	EAST KAMENG	Non Command	Industry 1	Structure 1	0	0	0	0

Annexure 2C: "Irrigation (Unit Draft)" input sheet for ARUNACHAL PRADESH for year 2021-2022

S.No	Location Code	District	Assessment Unit	Assessment Sub-Unit (Command, Non Command, Poor Quality)	* Type of Structure	* No. of wells in assessment year	Actual No. of wells in use	* Estimated draft per well (ha.m)	
								Monsoon	Non-Monsoon
1	AR160000	TIRAP	TIRAP	Non Command	Tube well	16	16	1.42	1.28
2	AR160000	TIRAP	TIRAP	Non Command	Dug well	15	15	1.2	1.08
3	AR090000	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	Tube well	124	124	0.85	0.69
4	AR090000	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	Dug well	30	30	0.64	0.52
5	AR200000	WEST SIANG	WEST SIANG	Non Command	Tube well	23	23	1.74	1.44
6	AR200000	WEST SIANG	WEST SIANG	Non Command	Dug well	28	28	1.59	1.32
7	AR180000	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	Tube well	11	11	1.17	0.96
8	AR180000	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	Dug well	22	22	0.97	0.79
9	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	Tube well	25	25	1.08	0.88
10	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	Dug well	25	25	0.79	0.65
11	AR050000	EAST SIANG	EAST SIANG	Non Command	Tube well	152	152	2.09	1.71
12	AR050000	EAST SIANG	EAST SIANG	Non Command	Dug well	1	1	0.94	0.74
13	AR020000	CHANGLANG	CHANGLANG	Non Command	Tube well	105	105	1.23	1.04
14	AR020000	CHANGLANG	CHANGLANG	Non Command	Dug well	10	10	1.02	0.86
15	AR080000	LOHIT	LOHIT	Non Command	Tube well	162	162	1	0.84
16	AR080000	LOHIT	LOHIT	Non Command	Dug well	44	44	0.79	0.66
17	AR130000	PAPUM PARE	PAPUM PARE	Non Command	Tube well	51	51	1.46	1.18
18	AR130000	PAPUM PARE	PAPUM PARE	Non Command	Dug well	3	3	1.27	1.03
19	AR190000	WEST KAMENG	WEST KAMENG	Non Command	Tube well	4	4	0.85	0.71
20	AR040000	EAST KAMENG	EAST KAMENG	Non Command	Tube well	95	95	1.53	1.26
21	AR040000	EAST KAMENG	EAST KAMENG	Non Command	Dug well	47	47	1.33	1.1

Annexure 3: "Ground Water Well - Assessment Unit Level" input sheet for ARUNACHAL PRADESH for year 2021-2022

S.No	Location Code	District	Assessment Unit	Assessment Sub-Unit (Command, Non Command, Poor Quality)	* Year	Level (m)	
1	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2015	3.8	3.17
2	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2016	3.23	4.33
3	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2017	2.97	2.71
4	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2018	3.24	4.11
5	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2019	0.0	3.3
6	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2020	4.2	2.9
7	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2021	3.4	4.29
8	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2015	7.42	3.47
9	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2016	6.78	3.23
10	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2017	10.63	3.99
11	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2018	7.03	4.44
12	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2019	4.44	3.39
13	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2020	5.28	2.66
14	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2021	6.0	4.32
15	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2015	5.06	2.29
16	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2016	2.79	3.0
17	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2017	4.52	3.27
18	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2018	4.54	2.99
19	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2019	3.35	2.38
20	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2020	3.25	0.0
21	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2021	4.89	4.3
22	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2015	4.91	2.42
23	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2016	4.91	2.08
24	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2017	4.61	1.29
25	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2018	4.95	1.74
26	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2019	4.24	1.28
27	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2020	4.51	1.18
28	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2021	3.23	1.64
29	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2015	3.12	3.31

30	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2016	3.14	2.47
31	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2017	4.75	2.95
32	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2018	3.24	3.15
33	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2019	3.75	2.42
34	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2020	3.11	2.64
35	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2021	3.88	2.94
36	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2015	7.2	4.32
37	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2016	6.25	4.53
38	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2017	5.87	3.75
39	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2018	4.58	2.63
40	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2019	5.82	5.11
41	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2020	6.34	0.0
42	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2021	6.04	4.51

Annexure 4A: "Recharge from Other Sources - Crop Water Requirement", SURFACE WATER IRRIGATION input sheet for ARUNACHAL PRADESH for year 2021-2022

S.N	Location Code	District	Assessment Unit	Non-Command Area													
				Paddy						Non-Paddy							
				Continuous Water Supply (Yes/No)	* Estimated Crop Water Requirement (mm)		* Area under crop (ha)		RFF Factor		Continuous Water Supply (Yes/No)	* Crop Name	* Estimated Crop Water Requirement (mm)		* Area under crop (ha)		RFF Factor	
					Kharif	Rabi	Kharif	Rabi	Monsoon	Non - Monsoon			Kharif	Rabi	Kharif	Rabi	Monsoon	Non - Monsoon
1	AR160000	TIRAP	TIRAP	No	600	0	894	0	0.5	0.5	No	Vegetable	0	180	0	191	0.3	0.3
2	AR090000	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	No	600	0	3319	0	0.5	0.5	No							
3	AR200000	WEST SIANG	WEST SIANG	No			0	0	0.5	0.5	No							

4	AR180000	UPPER SUBANSIRI	UPPER SUBANSIRI	No	600	0	338	0	0.5	0.5	No	Vegetable	0	180	0	94.15	0.3	0.3
5	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	No	600	600	370	0	0.5	0.5	No							
6	AR050000	EAST SIANG	EAST SIANG	No	600	0	5595.97	0	0.5	0.5	No	Vegetable	0	180	0	2664.97	0.3	0.3
7	AR020000	CHANGLANG	CHANGLANG	No	600	0	3642	0	0.5	0.5	No	Vegetable	0	180	0	16	0.3	0.3
8	AR080000	LOHIT	LOHIT	No	600	0	2225	0	0.5	0.5	No							
9	AR130000	PAPUM PARE	PAPUM PARE	No	600	0	5016.83	13.64	0.5	0.5	No	Maize	0	45	0	133.12	0.3	0.3
10	AR190000	WEST KAMENG	WEST KAMENG	No	600	0	204	0	0.5	0.5	No	Vegetable	0	180	492	0	0.3	0.3
11	AR040000	EAST KAMENG	EAST KAMENG	No	600	0	1600	0	0.5	0.5	No							

Annexure 4B: "Recharge from Other Sources - Ground Irrigation" input sheet for ARUNACHAL PRADESH for year 2021-2022

S.N	Location Code	District	Assessment Unit	Non Command													
				Paddy					Non Paddy							Weighted RFF	
				Continuous Water Supply (Yes/No)	Area under Paddy (ha)		RFF Factor		Continuous Water Supply (Yes/No)	Crop name	Area under Non Paddy (ha)		RFF Factor				
					Kharif	Rabi	Monsoon	Non - Monsoon			Kharif	Rabi	Monsoon	Non - Monsoon	Monsoon	Non - Monsoon
1	AR160000	TIRAP	TIRAP	Yes	66.23	33.77	0.45	0.45	Yes		65.91	33.33	0.25	0.25	0.35	0.35
2	AR090000	LOWER DIBANG	LOWER DIBANG	Yes	74.19	25.81	0.45	0.45	Yes		77.8	22.2	0.25	0.25	0.35	0.36

		VALLEY	VALLEY													
3	AR200000	WEST SIANG	WEST SIANG	Yes	65.37	34.63	0.45	0.45	Yes	oil seeds	70.97	29.03	0.25	0.25	0.35	0.36
4	AR180000	UPPER SUBANSIRI	UPPER SUBANSIRI	Yes	63.81	36.19	0.45	0.45	Yes	vegetables	69.6	30.4	0.25	0.25	0.35	0.36
5	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	Yes	65.76	34.24	0.45	0.45	Yes		72.99	27.01	0.25	0.25	0.34	0.36
6	AR050000	EAST SIANG	EAST SIANG	Yes	76.14	23.86	0.45	0.45	Yes	vegetables	79.39	20.61	0.25	0.25	0.35	0.36
7	AR020000	CHANGLANG	CHANGLANG	Yes	75.84	24.16	0.45	0.45	Yes		72.19	27.81	0.25	0.25	0.35	0.34
8	AR080000	LOHIT	LOHIT	Yes	74.02	25.98	0.45	0.45	Yes		74.51	25.49	0.25	0.25	0.35	0.35
9	AR130000	PAPUM PARE	PAPUM PARE	Yes	70.75	29.25	0.45	0.45	Yes	vegetables	74.53	25.47	0.25	0.25	0.35	0.36
10	AR190000	WEST KAMENG	WEST KAMENG	Yes	71.53	28.47	0.45	0.45	Yes		66.67	33.33	0.25	0.25	0.35	0.34
11	AR040000	EAST KAMENG	EAST KAMENG	Yes	71.17	28.83	0.45	0.45	Yes		78.5	21.5	0.25	0.25	0.35	0.36

Annexure 5:"Rainfall Data at Assessment unit level" input sheet for ARUNACHAL PRADESH for year 2021-2022

S.No	Location Code	District	Assessment Unit	Assessment Sub-Unit (Command, Non Command, Poor Quality)	*Year	Monsoon		Non-Monsoon	
						*Actual (mm)	*Normal (mm)	*Actual (mm)	*Normal (mm)
1	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2016-2017	1501.2	2510.4	761.6	949.0
2	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2021-2022	1012.9	2510.4	530.39	949.0
3	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2018-2019	1632.2	2510.4	931.0	949.0
4	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2020-2021	1595.19	2510.4	486.63	949.0
5	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2017-2018	1562.1	2510.4	481.6	949.0
6	AR160000	ARUNACHAL PRADESH	TIRAP	Non Command	2019-2020	1391.4	2510.4	337.8	949.0
7	AR090000	ARUNACHAL PRADESH	LOWER DIBANG VALLEY	Non Command	2016-2017	3673.5	1923.5	1963.4	1583.5

8	AR090000	ARUNACHAL PRADESH	LOWER DIBANG VALLEY	Non Command	2021-2022	1309.26	1923.5	747.82	1583.5
9	AR090000	ARUNACHAL PRADESH	LOWER DIBANG VALLEY	Non Command	2018-2019	4110.8	1923.5	1511.2	1583.5
10	AR090000	ARUNACHAL PRADESH	LOWER DIBANG VALLEY	Non Command	2020-2021	2292.27	1923.5	991.7	1583.5
11	AR090000	ARUNACHAL PRADESH	LOWER DIBANG VALLEY	Non Command	2017-2018	3632.4	1923.5	967.2	1583.5
12	AR090000	ARUNACHAL PRADESH	LOWER DIBANG VALLEY	Non Command	2019-2020	2951.7	1923.5	1115.4	1583.5
13	AR200000	ARUNACHAL PRADESH	WEST SIANG	Non Command	2016-2017	1476.5	2223.2	716.3	689.7
14	AR200000	ARUNACHAL PRADESH	WEST SIANG	Non Command	2021-2022	1498.44	2223.2	915.35	689.7
15	AR200000	ARUNACHAL PRADESH	WEST SIANG	Non Command	2018-2019	1532.5	2223.2	700.0	689.7
16	AR200000	ARUNACHAL PRADESH	WEST SIANG	Non Command	2020-2021	1989.46	2223.2	846.5	689.7
17	AR200000	ARUNACHAL PRADESH	WEST SIANG	Non Command	2017-2018	2029.2	2223.2	673.7	689.7
18	AR200000	ARUNACHAL PRADESH	WEST SIANG	Non Command	2019-2020	2156.2	2223.2	666.0	689.7
19	AR180000	ARUNACHAL PRADESH	UPPER SUBANSIRI	Non Command	2016-2017	1696.8	1093.6	473.0	652.9
20	AR180000	ARUNACHAL PRADESH	UPPER SUBANSIRI	Non Command	2021-2022	1104.94	1093.6	747.12	652.9
21	AR180000	ARUNACHAL PRADESH	UPPER SUBANSIRI	Non Command	2018-2019	704.4	1093.6	639.2	652.9
22	AR180000	ARUNACHAL PRADESH	UPPER SUBANSIRI	Non Command	2020-2021	1561.56	1093.6	721.02	652.9
23	AR180000	ARUNACHAL PRADESH	UPPER SUBANSIRI	Non Command	2017-2018	1375.2	1093.6	518.5	652.9
24	AR180000	ARUNACHAL PRADESH	UPPER SUBANSIRI	Non Command	2019-2020	1122.6	1093.6	556.8	652.9
25	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2016-2017	2236.03	1276.3	816.89	860.6
26	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2021-2022	1605.54	1276.3	569.83	860.6
27	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2018-2019	2128.36	1276.3	745.88	860.6
28	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2020-2021	2090.79	1276.3	507.31	860.6
29	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2017-2018	2567.16	1276.3	654.1	860.6
30	AR110000	ARUNACHAL PRADESH	LOWER SUBANSIRI	Non Command	2019-2020	2264.07	1276.3	594.8	860.6
31	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2016-2017	3069.2	3397.0	969.0	1021.8
32	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2021-2022	1899.66	3397.0	714.69	1021.8
33	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2018-2019	2265.8	3397.0	1035.2	1021.8
34	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2020-2021	3265.66	3397.0	928.05	1021.8
35	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2017-2018	3434.2	3397.0	1151.4	1021.8
36	AR050000	ARUNACHAL PRADESH	EAST SIANG	Non Command	2019-2020	2872.2	3397.0	1019.0	1021.8
37	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2016-2017	1238.1	1690.4	682.4	909.1
38	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2021-2022	735.23	1690.4	616.38	909.1
39	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2018-2019	811.0	1690.4	978.5	909.1

40	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2020-2021	1446.76	1690.4	574.73	909.1
41	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2017-2018	1122.3	1690.4	698.9	909.1
42	AR020000	ARUNACHAL PRADESH	CHANGLANG	Non Command	2019-2020	1384.2	1690.4	498.5	909.1
43	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2016-2017	1518.1	1750.1	1082.2	1253.4
44	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2021-2022	736.21	1750.1	689.25	1253.4
45	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2018-2019	1285.3	1750.1	941.6	1253.4
46	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2020-2021	1407.09	1750.1	663.32	1253.4
47	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2017-2018	1908.0	1750.1	748.9	1253.4
48	AR080000	ARUNACHAL PRADESH	LOHIT	Non Command	2019-2020	1787.4	1750.1	471.7	1253.4
49	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2016-2017	2554.5	2408.0	859.2	928.8
50	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2021-2022	1768.36	2408.0	588.71	928.8
51	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2018-2019	2068.1	2408.0	887.6	928.8
52	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2020-2021	2238.11	2408.0	593.05	928.8
53	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2017-2018	2776.7	2408.0	688.2	928.8
54	AR130000	ARUNACHAL PRADESH	PAPUM PARE	Non Command	2019-2020	2233.8	2408.0	711.4	928.8
55	AR190000	ARUNACHAL PRADESH	WEST KAMENG	Non Command	2016-2017	968.3	1976.8	243.0	544.6
56	AR190000	ARUNACHAL PRADESH	WEST KAMENG	Non Command	2021-2022	1691.21	1976.8	436.25	544.6
57	AR190000	ARUNACHAL PRADESH	WEST KAMENG	Non Command	2018-2019	1441.3	1976.8	377.7	544.6
58	AR190000	ARUNACHAL PRADESH	WEST KAMENG	Non Command	2020-2021	1691.33	1976.8	448.83	544.6
59	AR190000	ARUNACHAL PRADESH	WEST KAMENG	Non Command	2017-2018	1141.2	1976.8	372.8	544.6
60	AR190000	ARUNACHAL PRADESH	WEST KAMENG	Non Command	2019-2020	1233.7	1976.8	476.7	544.6
61	AR040000	ARUNACHAL PRADESH	EAST KAMENG	Non Command	2016-2017	567.7	1459.8	542.7	676.3
62	AR040000	ARUNACHAL PRADESH	EAST KAMENG	Non Command	2021-2022	1788.79	1459.8	588.81	676.3
63	AR040000	ARUNACHAL PRADESH	EAST KAMENG	Non Command	2018-2019	644.5	1459.8	197.2	676.3
64	AR040000	ARUNACHAL PRADESH	EAST KAMENG	Non Command	2020-2021	2068.93	1459.8	530.19	676.3
65	AR040000	ARUNACHAL PRADESH	EAST KAMENG	Non Command	2017-2018	755.5	1459.8	91.7	676.3
66	AR040000	ARUNACHAL PRADESH	EAST KAMENG	Non Command	2019-2020	934.8	1459.8	287.4	676.3

Annexure 6A: "Fluxes : Evaporation" input sheet for ARUNACHAL PRADESH for year 2021-2022

S. N	Location Code	District	Assessment Unit	Assessment Sub-Unit (Command, Non Command, Poor Quality)	Zone Number	Zone Description	Evaporation rate in mm/day	Capillary rise	Area in hectare (ha)		Average ground water level in the zone in m		No of days Evaporation takes place	
									Monsoon	Non Monsoon	Monsoon	Non Monsoon	Monsoon	Non Monsoon
1	AR160000	TIRAP	TIRAP	non_command		0.0-0.5			0	0	0.25	0.25	0	0
2	AR160000	TIRAP	TIRAP	non_command		0.5-1.0			0	0	0.75	0.75	0	0
3	AR160000	TIRAP	TIRAP	non_command		1.0-1.5			0	0	1.25	1.25	0	0
4	AR160000	TIRAP	TIRAP	non_command		1.5-2.0			0	0	1.75	1.75	0	0
5	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		0.0-0.5			0	0	0.25	0.25	0	0
6	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		0.5-1.0			0	0	0.75	0.75	0	0
7	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		1.0-1.5			0	0	1.25	1.25	0	0
8	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		1.5-2.0			0	0	1.75	1.75	0	0
9	AR050000	EAST SIANG	EAST SIANG	non_command		0.0-0.5			0	0	0.25	0.25	0	0
10	AR050000	EAST SIANG	EAST SIANG	non_command	2.0	0.5-1.0	1	1	0	225.1	0.75	0.75	153	212
11	AR050000	EAST SIANG	EAST SIANG	non_command		1.0-1.5			0	0	1.25	1.25	0	0
12	AR050000	EAST SIANG	EAST SIANG	non_command		1.5-2.0			0	0	1.75	1.75	0	0
13	AR020000	CHANGLANG	CHANGLANG	non_command		0.0-0.5			0	0	0.25	0.25	0	0
14	AR020000	CHANGLANG	CHANGLANG	non_command		0.5-1.0			0	0	0.75	0.75	0	0
15	AR020000	CHANGLANG	CHANGLANG	non_command		1.0-1.5			0	0	1.25	1.25	0	0
16	AR020000	CHANGLANG	CHANGLANG	non_command		1.5-2.0			0	0	1.75	1.75	0	0
17	AR080000	LOHIT	LOHIT	non_command	1.0	0.0-0.5	1	1	0	4413	0.25	0.25	153	212
18	AR080000	LOHIT	LOHIT	non_command	2.0	0.5-1.0	1	1	0	1663	0.75	0.75	153	212
19	AR080000	LOHIT	LOHIT	non_command		1.0-1.5			0	0	1.25	1.25	0	0
20	AR080000	LOHIT	LOHIT	non_command		1.5-2.0			0	0	1.75	1.75	0	0
21	AR130000	PAPUM PARE	PAPUM PARE	non_command	1.0	0.0-0.5	1	1	0.4001	35.81	0.25	0.25	153	212
22	AR130000	PAPUM PARE	PAPUM PARE	non_command	2.0	0.5-1.0	1	1	80.041	79.35	0.75	0.75	153	212
23	AR130000	PAPUM PARE	PAPUM PARE	non_command		1.0-1.5			0	0	1.25	1.25	0	0
24	AR130000	PAPUM PARE	PAPUM PARE	non_command		1.5-2.0			0	0	1.75	1.75	0	0

Annexure 6B: "Fluxes : Transpiration" input sheet for ARUNACHAL PRADESH for year 2021-2022

S.N	Location Code	District	Assessment Unit	Assessment Sub-Unit (Command, Non Command, Poor Quality)	Zone Number	Zone Description	Transpiration rate in mm/day	Average Root Depth in m	Capillary rise in m	Area in hectare	Average ground water level in the zone in m			No of days Transpiration takes place	
										Monsoon	Non Monsoon	Monsoon	Non Monsoon	Monsoon	Non Monsoon
1	AR160000	TIRAP	TIRAP	non_command	1.0	0.0-0.5	1	2.5	1	0	0	0.25	0.25	122	243
2	AR160000	TIRAP	TIRAP	non_command	2.0	0.5-1.0	1	2.5	1	0	0	0.75	0.75	122	243
3	AR160000	TIRAP	TIRAP	non_command	3.0	1.0-1.5	1	2.5	1	0	0	1.25	1.25	122	243
4	AR160000	TIRAP	TIRAP	non_command	4.0	1.5-2.0	1	2.5	1	0	0	1.75	1.75	122	243
5	AR160000	TIRAP	TIRAP	non_command	5.0	2.0-2.5	1	2.5	1	0	0	2.25	2.25	122	243
6	AR160000	TIRAP	TIRAP	non_command	6.0	2.5-3.0	1	2.5	1	0	0	2.75	2.75	122	243
7	AR160000	TIRAP	TIRAP	non_command	7.0	3.0-3.5	1	2.5	1	0	0	3.25	3.25	122	243
8	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		0.0-0.5						0.25	0.25		
9	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		0.5-1.0						0.75	0.75		
10	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command	3.0	1.0-1.5	1	2.5	1	1173	368.7	1.25	1.25	153	212
11	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		1.5-2.0						1.75	1.75		
12	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		2.0-2.5						2.25	2.25		
13	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		2.5-3.0						2.75	2.75		
14	AR110000	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		3.0-3.5						3.25	3.25		
15	AR050000	EAST SIANG	EAST SIANG	non_command		0.0-0.5						0.25	0.25		
16	AR050000	EAST SIANG	EAST SIANG	non_command	2.0	0.5-1.0	1	2.5	1	0	225.1	0.75	0.75	153	212
17	AR050000	EAST SIANG	EAST SIANG	non_command	3.0	1.0-1.5	1	2.5	1	863.7	288.4	1.25	1.25	153	212
18	AR050000	EAST SIANG	EAST SIANG	non_command	4.0	1.5-2.0	1	2.5	1	1259	874.5	1.75	1.75	153	212

19	AR050000	EAST SIANG	EAST SIANG	non_command	5.0	2.0-2.5	1	2.5	1	183	1141	2.25	2.25	153	212
20	AR050000	EAST SIANG	EAST SIANG	non_command	6.0	2.5-3.0	1	2.5	1	106.9	1924	2.75	2.75	153	212
21	AR050000	EAST SIANG	EAST SIANG	non_command	7.0	3.0-3.5	1	2.5	1	68.18	2603	3.25	3.25	153	212
22	AR020000	CHANGLANG	CHANGLANG	non_command		0.0-0.5						0.25	0.25		
23	AR020000	CHANGLANG	CHANGLANG	non_command		0.5-1.0						0.75	0.75		
24	AR020000	CHANGLANG	CHANGLANG	non_command	3.0	1.0-1.5	1	2.5	1	7025	0	1.25	1.25	153	212
25	AR020000	CHANGLANG	CHANGLANG	non_command	4.0	1.5-2.0	1	2.5	1	1098	0	1.75	1.75	153	212
26	AR020000	CHANGLANG	CHANGLANG	non_command	5.0	2.0-2.5	1	2.5	1	1152	3803	2.25	2.25	153	212
27	AR020000	CHANGLANG	CHANGLANG	non_command	6.0	2.5-3.0	1	2.5	1	2158	4866	2.75	2.75	153	212
28	AR020000	CHANGLANG	CHANGLANG	non_command		3.0-3.5						3.25	3.25		
29	AR080000	LOHIT	LOHIT	non_command	1.0	0.0-0.5	1	2.5	1	0	4413	0.25	0.25	153	212
30	AR080000	LOHIT	LOHIT	non_command	2.0	0.5-1.0	1	2.5	1	0	1663	0.75	0.75	153	212
31	AR080000	LOHIT	LOHIT	non_command	3.0	1.0-1.5	1	2.5	1	2222	1013	1.25	1.25	153	212
32	AR080000	LOHIT	LOHIT	non_command	4.0	1.5-2.0	1	2.5	1	0	0	1.75	1.75	153	212
32	AR080000	LOHIT	LOHIT	non_command	5.0	2.0-2.5	1	2.5	1	0	0	2.25	2.25	153	212
33	AR080000	LOHIT	LOHIT	non_command	6.0	2.5-3.0	1	2.5	1	0	0	2.75	2.75	153	212
34	AR080000	LOHIT	LOHIT	non_command	7.0	3.0-3.5	1	2.5	1	0	0	3.25	3.25	153	212
35	AR130000	PAPUM PARE	PAPUM PARE	non_command	1.0	0.0-0.5	1	2.5	1	0.4001	35.81	0.25	0.25	153	212
36	AR130000	PAPUM PARE	PAPUM PARE	non_command	2.0	0.5-1.0	1	2.5	1	80.041	79.35	0.75	0.75	153	212
37	AR130000	PAPUM PARE	PAPUM PARE	non_command	3.0	1.0-1.5	1	2.5	1	25.05	192.13	1.25	1.25	153	212
38	AR130000	PAPUM PARE	PAPUM PARE	non_command	4.0	1.5-2.0	1	2.5	1	8.361	65.52	1.75	1.75	153	212
39	AR130000	PAPUM PARE	PAPUM PARE	non_command	5.0	2.0-2.5	1	2.5	1	273.35	115.2	2.25	2.25	153	212
40	AR130000	PAPUM PARE	PAPUM PARE	non_command	6.0	2.5-3.0	1	2.5	1	14.39	423.3	2.75	2.75	153	212
41	AR130000	PAPUM PARE	PAPUM PARE	non_command	7.0	3.0-3.5	1	2.5	1	7.216	0	3.25	3.25	153	212

Annexure A: Minutes of the 1st SLC meeting on GWRA-2022, Arunachal Pradesh

MINUTE OF THE 1ST SITTING MEETING OF STATE LEVEL COMMITTEE ON GROUND WATER RESOURCES ASSESSMENT OF ARUNACHAL PRADESH FOR THE ASSESSMENT YEAR 2021-22 AS ON MARCH 2022 ON 30TH MARCH 2022 AT 11:00 HRS IN OFFICE OF THE CHIEF ENGINEER (P&D), CHIMPU.

Dated: 30th March 2022 at 11:00 am

The first sitting of state level committee (SLC) on Ground Water Resources Assessment of Arunachal Pradesh as on March 2022 was convened on 30th March 2022 at office of the Chief Engineer (P&D), WRD through hybrid mode. The Secretary, WRD- Arunachal Pradesh, chaired the Meeting.

The Member Secretary of SLC Shri Biplab Ray Regional Director, CGWB NER welcomed Chairman and all the representative members of the committee. He highlighted that groundwater Resources of Arunachal Pradesh has been carried out jointly by Central Ground water Board, NER Guwahati and Water Resources Department (State Nodal Department)-Arunachal Pradesh in co-ordination of other departments of Arunachal Pradesh.

Shri Rajat Gupta, Asst. Hg., CGWB, SUO Naharlagun presented the findings of Ground Water Resource Assesment-2020 before the Chairman and other committee of the Member. Also informed to house that for the first time, automation of Ground Water Resources assessment has been carried out using web based IN-GRES software. He also presented assessment unit wise various data required for reassessment of Dynamic Ground water Resources of Arunachal Pradesh (as on March 2022). During the presentation timeline of various activities assigned by CGWB, CHQ, Faridabad was also discussed.

The Chairperson suggested CGWB to carry out ground water resource estimation in the water scarce area like Itanagar where the dependency on groundwater is increasing day by day.

Member Secretary requested to all line department to provide necessary data with coordination of the Nodal department for timely completion of the exercise. He also requested Secretary, WRD for constitution of District Ground Water Coordination Committee in Arunachal Pradesh. Member Secretary also requested Committee members to attend the time to time training programmes organised by IIT, Hyderabad on IN-GRESS software operation, data uploading, etc.,

After thorough discussion, all the members of SLC agreed and accepted that 11 no's assessment units used during GWRA 2020 will remain the same in the GWRA of 2022. The decision is taken because boundary demarcation for the newly created districts of Arunachal Pradesh has not yet finalised

The meeting ended with vote of thanks offered by the Member Secretary.

30/03/22
(Geyum Padu)
Secretary, WRD
& Chairman, SLC Committee
Itanagar, Arunachal Pradesh

LIST OF ATTENDEES

1. Shri GeyumPadu, Secretary (WRD), Govt. of Arunachal Pradesh, Itanagar.
2. ShriLikarAngu, CE, (P&D), WRD Arunachal Pradesh, Itanagar.
3. Shri ModekNgomdir, CE, EZ WRD, Arunachal Pradesh, Itanagar(Through VC)
4. Shri GetomBorang, CE, WZ WRD, Arunachal Pradesh, Itanagar
5. Shri TafangBagang, EE PHE & WS Department, Arunachal Pradesh, Itanagar.
6. Shri KarbomRiram, Joint Director Agriculture, Arunachal Pradesh, Naharlagun.
7. Shri Biplab Ray, Regional Director, CGWB, NER, Guwahati (Through VC)
8. Shri A. S Wangpan, EE WRD, Arunachal Pradesh, Itanagar
9. Dr. S S Singh, Sc-C, CGWB, NER, Guwahati (Through VC)
10. Dr. D. J Khound, Sc-B, CGWB, NER, Guwahati (Through VC)
11. Shri Ebadur Rahman, Sc-B, CGWB, SUO, Naharlagun
12. Miss MophiMilli, Sc-B, CGWB, NER, Guwahati (Through VC)
13. Shri Rajat Gupta, Ahg, CGWB, SUO, Naharlagun

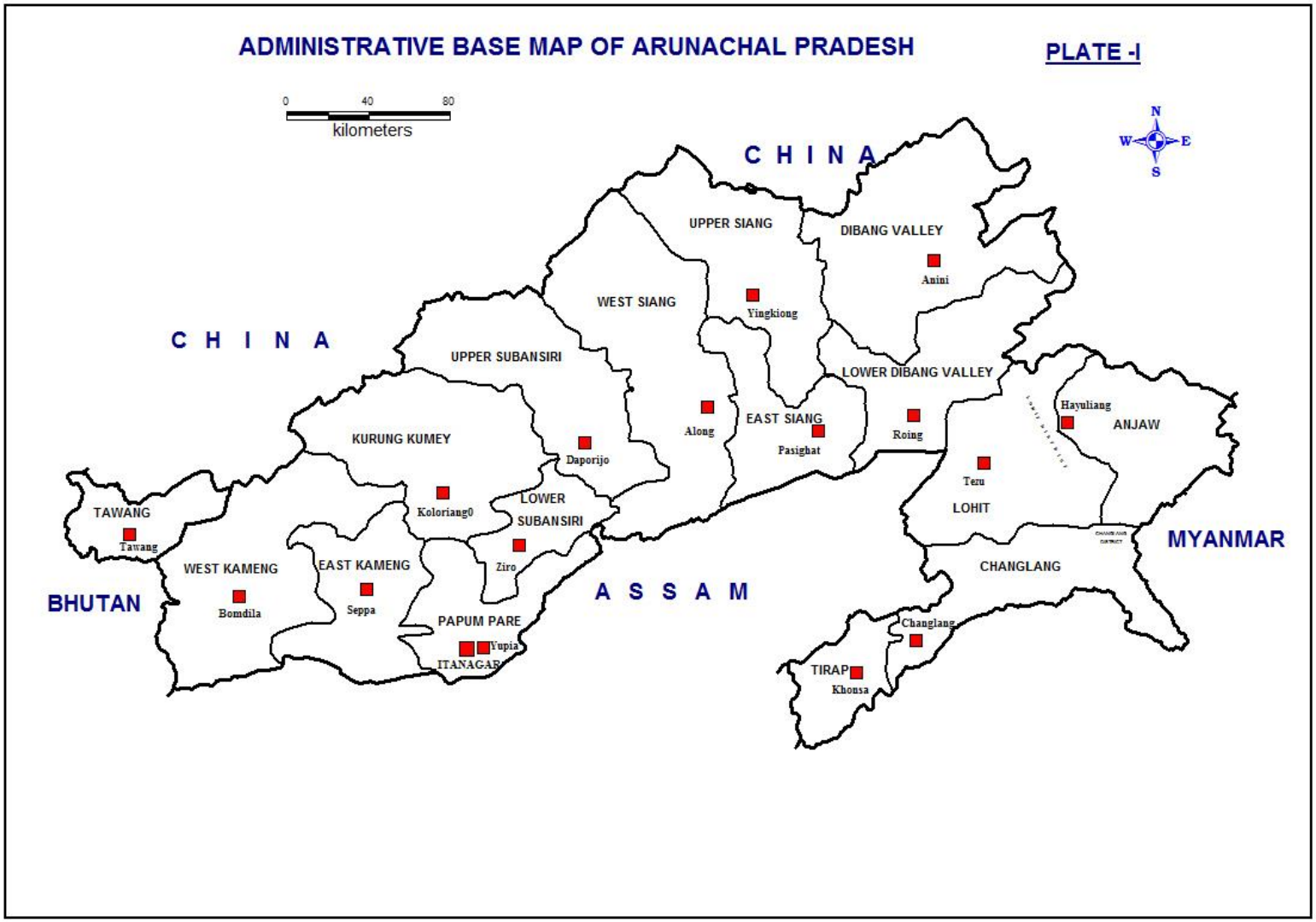
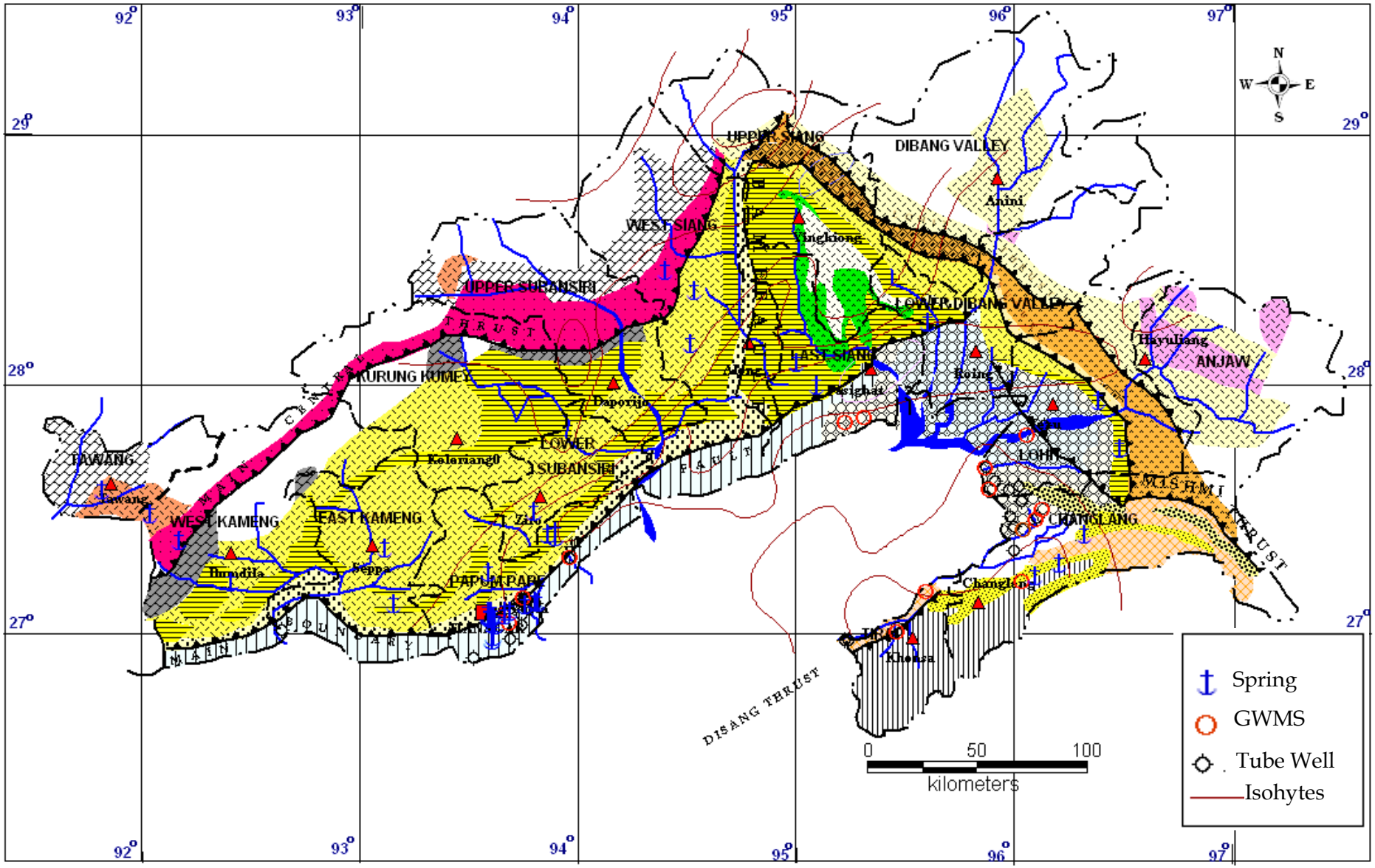
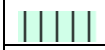
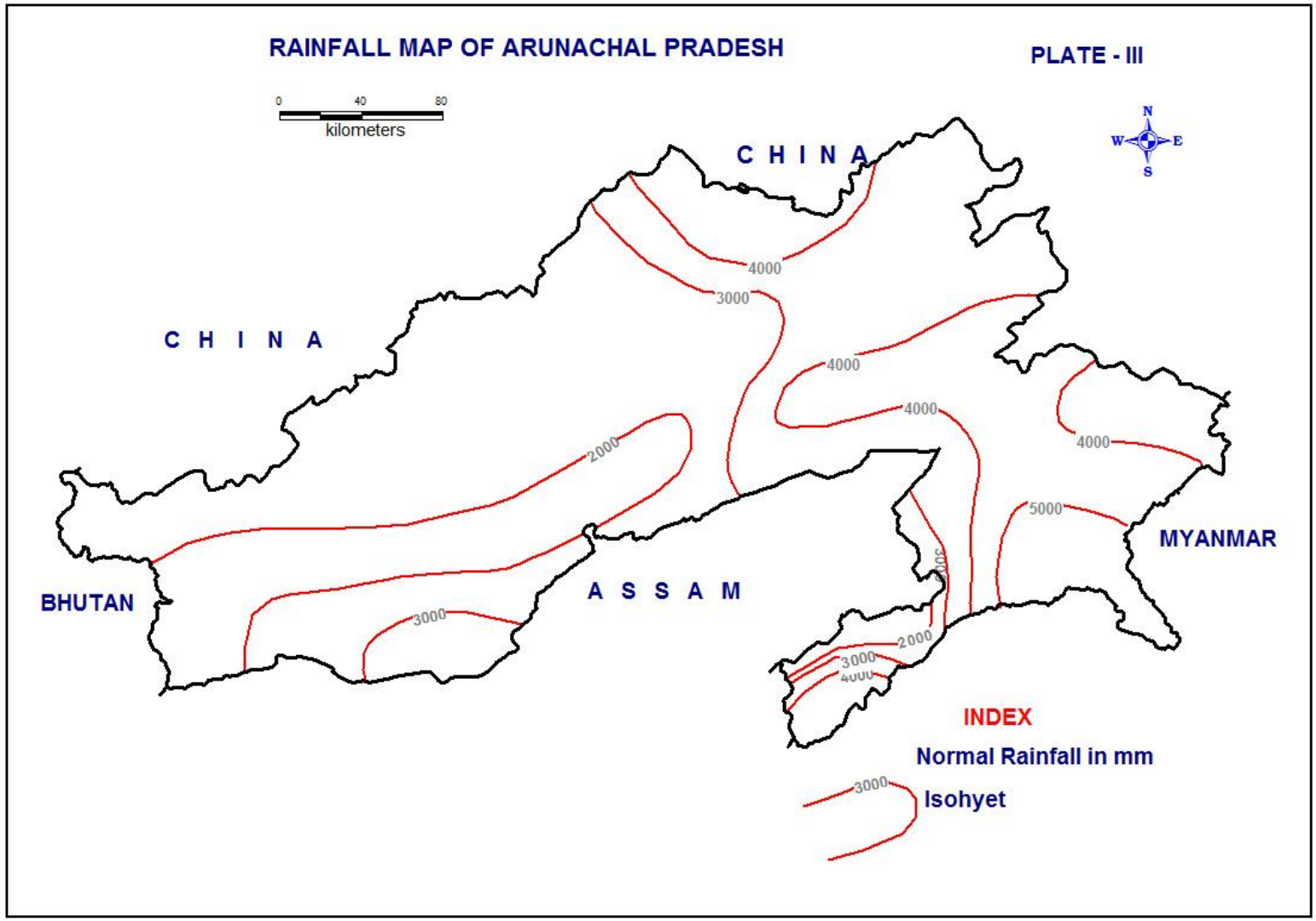
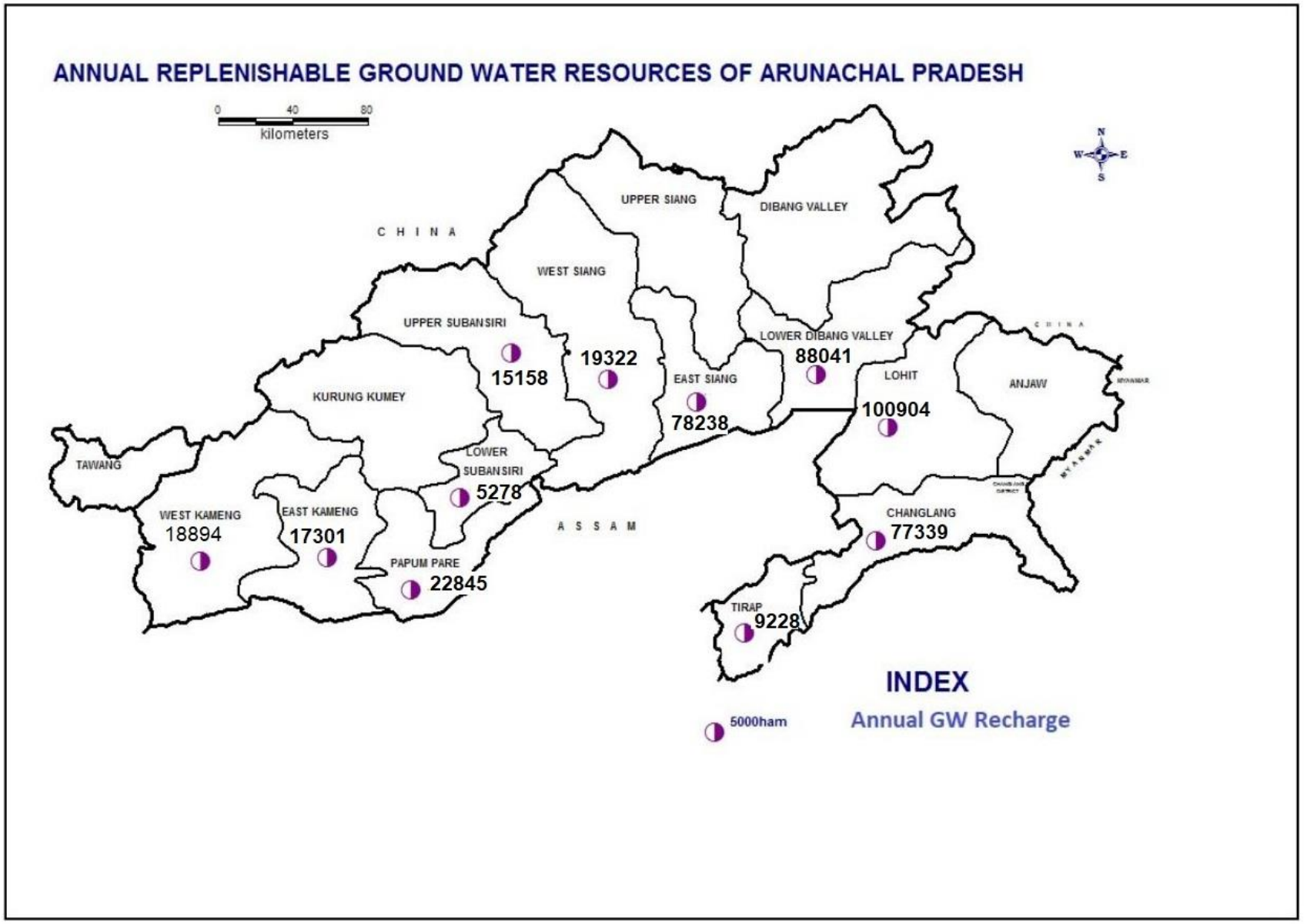

ADMINISTRATIVE BASE MAP OF ARUNACHAL PRADESH
PLATE -I
0
40
80
kilometers
N
W
E
S
CHINA
CHINA
UPPER SIANG
DIBANG VALLEY
Anini
WEST SIANG
Yingkiong
UPPER SUBANSIRI
LOWER DIBANG VALLEY
Hayuliang
ANJAW
Along
EAST SIANG
Pasighat
Roing
KURUNG KUMEY
Daporijo
Teru
LOHIT
TAWANG
Tawang
Koloriang0
LOWER
SUBANSIRI
MYANMAR
WEST KAMENG
EAST KAMENG
Ziro
CHANGLANG
BHUTAN
Bomdila
Seppa
A S S A M
PAPUM PARE
Changlang
Yupia
ITANAGAR
TIRAP
Khonsa

PLATE II: Hydrogeological Map of Arunachal Pradesh



Map Symbol	Description		Groundwater Potentiality
	Thrust		
	Newer Alluvium	Unconsolidated Formation	Moderate yield, 30-50m^3/hr. Drawdown within 10 to 15m.
	Older Alluvium		
	Namsang & Dihing Formations	Semi-consolidated Formation	Low yield, up to 20m^3/hr. Draw down within 25m.
	Siwalik Group		
	Surma & Naharkatia Groups		
	Barail Group	Consolidated Formation	Low yield, 5 to 15m^3/hr in fissured formation
	Disang Group		
	Yingkiong Group		
	Lower Gondwana Group		
	Dirang & Lumla Formations		
	Bomdila Group		
	Se La Group		
	Mishmi Formation		
	Tidding Formation		
	Yang Sangchu Formation		
IGNEOUS ROCKS			Yield up to 5m^3/hr in metasediments and igneous rocks
	Tertiary Tourmaline Granite		
	Lohit Granitoid		
	Abor Volcanic		
	Palaeoproterozoic		


RAINFALL MAP OF ARUNACHAL PRADESH
PLATE - III
0
40
80
kilometers
N
W
E
S
CHINA
CHINA
4000
3000
4000
4000
4000
2000
5000
MYANMAR
BHUTAN
ASSAM
3000
3000
2000
INDEX
Normal Rainfall in mm
3000
Isohyet


ANNUAL REPLENISHABLE GROUND WATER RESOURCES OF ARUNACHAL PRADESH
0
40
80
kilometers
N
W
E
S
C H I N A
UPPER SIANG
DIBANG VALLEY
WEST SIANG
UPPER SUBANSIRI
15158
19322
KURUNG KUMEY
EAST SIANG
78238
LOWER DIBANG VALLEY
88041
LOHIT
100904
ANJAW
TAWANG
LOWER SUBANSIRI
5278
WEST KAMENG
18894
EAST KAMENG
17301
PAPUM PARE
22845
A S S A M
CHANGLANG
77339
TIRAP
9228
INDEX
5000ham
Annual GW Recharge

CATEGORIZATION OF ASSESSMENT UNITS IN ARUNACHAL PRADESH

PLATE- VI