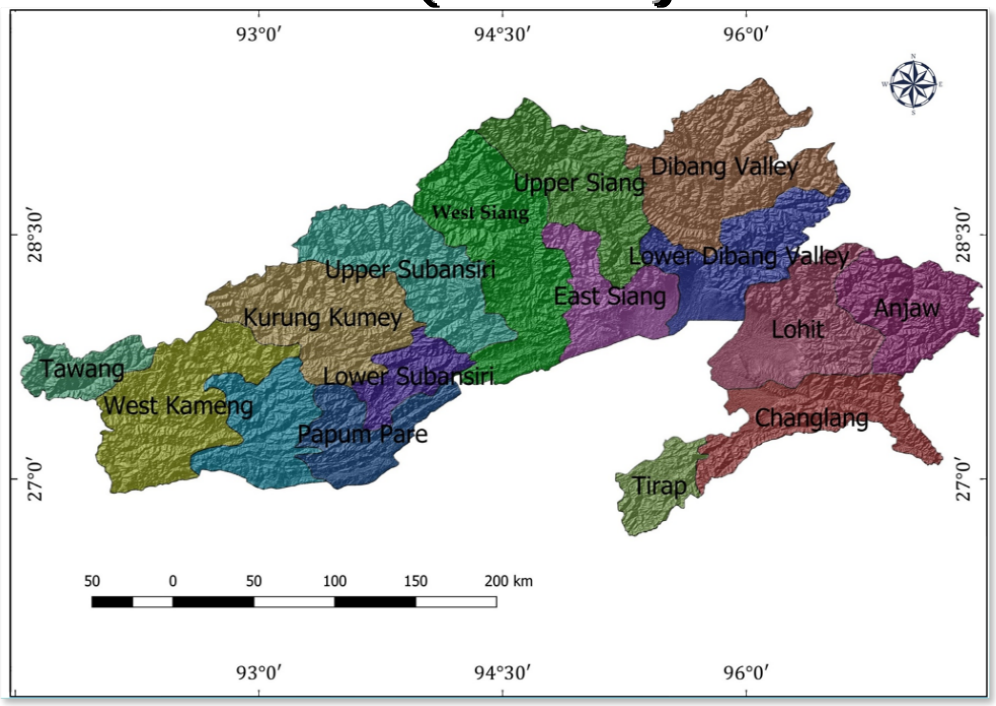
Technical Series: A **No. 01../2021-22**

DYNAMIC GROUND WATER RESOURCES OF ARUNACHAL PRADESH (2020-21)



CENTRAL GROUND WATER BOARD

NORTH EASTERN REGION

GUWAHATI

SEPTEMBER, 2021

केंद्रीय भूमिजल बोर्ड

पूर्वोत्तर क्षेत्र

गुवाहाटी

सितम्बर २०२१

DYNAMIC GROUND WATER RESOURCES OF ARUNACHAL PRADESH (2020-2021)

Prepared by

WATER RESOURCES DEPARTMENT
GOVERNMENT OF ARUNACHAL PRADESH
ITANAGAR

&

CENTRAL GROUND WATER BOARD
NORTH EASTERN REGION, GUWAHATI
GUWAHATI

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, the demand of drinking as well as domestic water is increasing by leaps and bounds. Simultaneously the growing need for agricultural products is necessitating the need for ground 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 assessment of 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 2020. The annual extractable groundwater resources is 2.91 BCM, of which annual allocation for domestic needs up to 2025 is 0.009 BCM and 2.90 BCM is available for irrigation and other uses. Present stage of ground water extraction in the state is only 0.36%.

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, Guwahati and 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.

(B.RAY)
REGIONAL DIRECTOR (i/c),

CONTENTS

PLATES

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 Dr. D. J. Khound, Scientist-B, Shri R. Kalita, Scientist-D and Shri Ebadur Rahman, Scientist-B 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-97methodology 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. In 2017 GW resources of Arunachal Pradesh had been estimated based on revised ground water resource estimation methodology of 2015 (GEC' 2015). As per 2017 estimate, the total Replenishable Ground Water Resource of the state is worked out as **3.025BCM.**

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 vide letter no. SWRD-(G.W)-13/2010 dated 12/11/2020 with the following members **(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

c. Brief outlines of the proceedings of the resources estimation including outcome of various meetings

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 Quarternary 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 Quarternary and Upper Teriary 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.
Semiconsolidated	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 2.3.**

Table 2.3: Chemical analysis results of ground water, Arunachal Pradesh

Range of Chemical Constituents															
pH	EC μS/cm at 25°C	Fe	K	TH as $CaCO_3$	Ca	Mg	CO_3	Na	HCO_3	Cl	NO_3	TDS	SiO_2	PO_4	F
6.89-7.7	158-278	0.8 - 7.4	1.8-2	66-135	15-26	6.8-17	Nil	8-19	79-134	3.6-11	0-0.9	100-220	38-49	Nil	0-1.0

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 ESTIATION 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 for all hydro-hydro-meteorologics
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:

Inflow – Outflow = 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-GRES system has multi-level user to input data, trigger computations and approval to accept data and estimation of resource. In IN-GRES, 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-GRES. 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-GRES

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-GRES 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. Till 2019 there are 25 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 2020.

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 are available in departmental web sites. As per this report only in East Siang district ground water irrigation is available. 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 is considered. Surface water irrigation data as mentioned district irrigation plan 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 m bgl and 3.5 m bgl 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 (Fig.)

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 GWR 2020 for Arunachal Pradesh, recharge calculated through the two methods are compared. After comparison rainfall recharge estimated by water level fluctuation is adopted for Tirap, East Siang and Lohit Districts.

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 (**Plate-**).

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 2019-20. Assessment of ground water resource of the state has been estimated for the year 2020

The resource has been computed district-wise (Table 5). 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. 1). Total annual ground water recharge of the state is 319108ham. Rainfall recharge is 311893 ham recharge from other sources is 7215ham. The outflow components, i.e., evaporation and transpiration together amounts 4588ham. Total natural discharge is 27482.27ham. So annual extractable ground water resources of the state have been assessed to be 291626 ham.

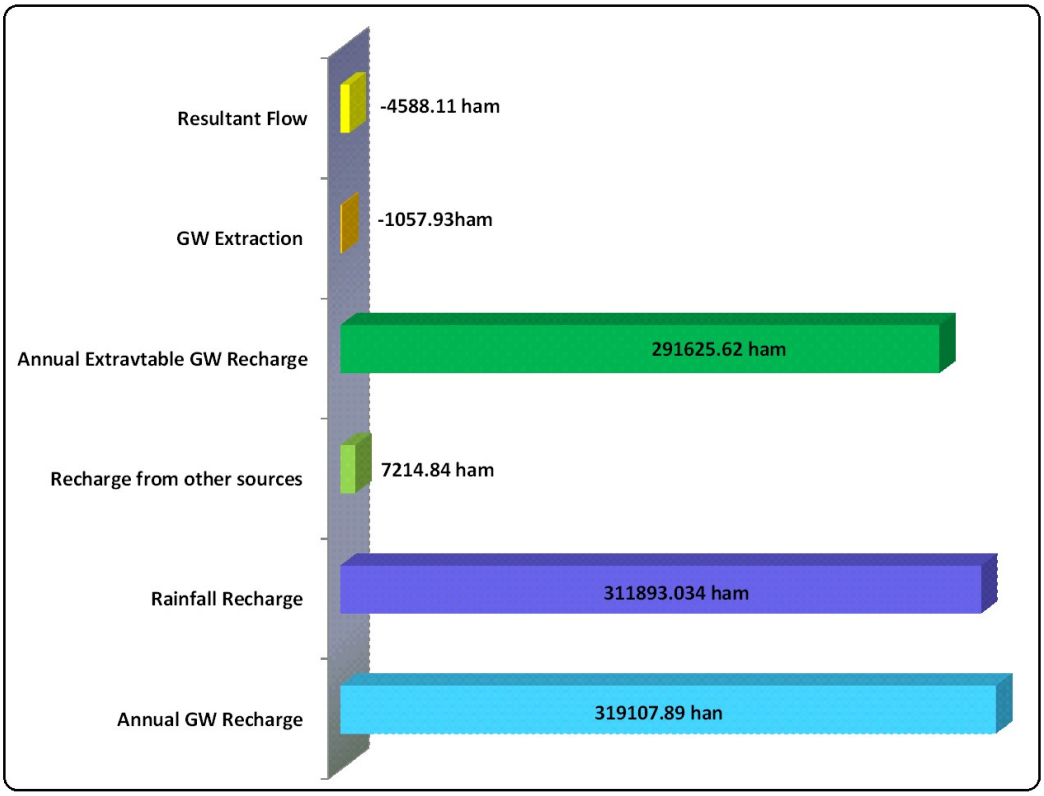


Fig. 5.1: Inflow and outflow componenets of GW resources of Arunachal Pradesh

The existing ground water extraction for all uses is 1058ham. Of which extraction for domestic use is maximum. Extraction for irrigation is 253ham and industrial extraction is 22ham. Allocation of ground water for domestic use is worked out to be 893.48ham. The net ground water availabilities for future use is 290457ham. 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 (2017)	Year of Estimation (2020)	Comparison between dynamic GW resources estimated in 2017 & 2020
1	2	3	4	5(4 – 3)
1.	Total Annual Ground Water Recharge (Ham)	302499.86	319107.89	16608.03
	Total Natural Discharges (Ham)	35829.83	22894.16	-12935.67
2.	Annual Extractable Ground Water Resource (HAM)	266670.03	291625.6	24955.57
	Existing Gross Extraction (HAM)	747.50	1,057.93	310.57
	Irrigation uses (HAM)	0	253.09	253.09
	Domestic uses (HAM)	728	782.911	54.911
3.	Industrial uses (HAM)	16.5	21.93	5.4273
4.	Stage of GW Extraction (%)	0.28	0.36277	0.08277
5.	Provision for domestic (HAM)	1893.51	893.48	-1000.03
6	Provision for future use (HAM)	264760.02	290457	25696.98

From the comparison table it is observed that estimated total replenisable ground water resource as on March 2020 is more than 2017 estimate by **24955.57ham** (or nearly 9%). Other components of GWRE are marginally changed 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	Tirap	12500	5429.47	268.2	1784.75	10.31	7492.73	374.63	0	0	7118.10
2	Changlang	53000	16679.05	1092.6	7569.09	0.86	25341.6	2534.16	908.66	509	21389.78
3	Lohit	200000	51716.05	667.5	41949.60	0	94333.15	4716.66	218.55	2073.61	87324.33
4	Lower Dibang Valley	120000	42860.40	995.7	33884.40	0	77740.5	7774.05	0		69966.45
5	East Siang	110100	59109.22	1742.17	17483.44	171.97	78506.8	3925.34	195.54	394.62	73991.30
6	West Siang	10459	4445.29	0	916.73	0	5362.02	536.202	0		4825.82
7	East Kameng	31250	8567.56	480	3180.99	0	12228.55	1222.86	0		11005.69
8	West Kameng	6175	2342.95	61.2	397.31	0	2801.46	280.146	0		2521.31
9	Lower Subansiri	10135	2843.16	111	1442.42	0	4396.58	439.658	115.37	50.29	3791.26
10	Upper Subansiri	700	141.52	101.4	73.65	5.08	321.65	32.165	0		289.49
11	Papum Pare	17819	6610.99	1505.05	2465.01	1.8	10582.85	1058.285	31.21	91.26	9402.10
	Total	**572138**	**200745.6**	**7024.82**	**111147.39**	**190.02**	**319107.89**	**22894.16**	**1469.33**	**3118.78**	**291625.62**

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	Tirap	66.63	0	0	66.63	71.23	7046.87	0.94	Safe	Fresh	**Valid**
2	Changlang	185.31	0	0	185.31	205.88	21183.89	0.87	Safe	Fresh	**Valid**
3	Lohit	231.12	0	0.24	231.36	254.34	87069.75	0.26	Safe	Fresh	No sufficient WL data for validation
4	Lower Dibang Valley	32.87	0	0	32.87	34.28	69932.17	0.05	Safe		No sufficient WL data for validation
5	East Siang	68.24	253.09	1.0368	322.37	73.76	73663.41	0.44	Safe		**Valid**
6	West Siang	21.99	0	1.44	23.43	23.04	4801.34	0.49	Safe	Fresh	No GWMS in the district
7	East Kameng	28.35	0	0	28.35	35.68	10970.01	0.26	Safe	Fresh	No GWMS in the district
8	West Kameng	11.4	0	0.72	12.12	12.25	2508.34	0.48	Safe	Fresh	No GWMS in the district
9	Lower Subansiri	20.59	0	0	20.59	28.05	3763.22	0.54	Safe		**Valid**
10	Upper Subansiri	19.11	0	0	19.11	26.37	263.13	6.6	Safe	Fresh	No GWMS in the district
11	Papum Pare	97.3	0	18.49	115.79	128.6	9,255.01	1.23	Safe	Fresh	**Valid**
	Total	**782.91**	**253.09**	**21.9273**	**1057.93**	**893.48**	**290457.1**	**0.36**	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	NA	NA	NA
2	Changlang	NA	7702.24	NA	7702.24
3	Lohit	NA	NA	NA	NA
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	6306.48	NA	6306.48
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	2164.05	NA	2164.05
13	Upper Subansiri	NA	NA	NA	NA
14	Papum Pare	NA	943.19	NA	943.19
15	Tawang	NA	NA	NA	NA
16	Kurung Kumey	NA	NA	NA	NA
Total		**NA**	**17115.96**		**17115.96**

Annexure A 1: Constitution of State Level Committee for ground water resources estimation

No SWRD (GW) -13/2010
GOVERNMENT OF ARUNACHAL PRADESH
WATER RESOURCES DEPARTMENT
CIVIL SECRETARIAT::ITANAGAR
BLOCK NO. 3, 3rd FIOOR ROOM NO.1

ORDER

Dated Itanagar, the 12th Nov'2020

In partial of modification of earlier order of even No. dated 25th Aug,2010 & 7th Oct, 2020 the Governor of Arunachal Pradesh is pleased to re- constitute State Level Committee (SLC) for Assessment of Dynamic Ground Water Resources (AoDGWR) in Arunachal Pradesh comprising of following members:-

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

Sd/-
Naresh Kumar, IAS
Chief Secretary
Govt. of Arunachal Pradesh
Itanagar.

No SWRD (GW)-13/2010/1129 – 41 Dated Itanagar, the 26 Nov'2020

Copy to :-

1. The Secretary to His Excellency the Governor of Arunachal Pradesh, Itanagar.
2. The PPS to HCM Arunachal Pradesh Itanagr.
3. The PS to DCM Arunachal Pradesh, Itanagar.
4. The PS to all HM Arunachal Pradesh, Itanagar.
5. The PS to Chief Secretary, Govt. Arunachal Pradesh Itanagar.
6. The Secretary (WRD/Plg). Govt. of A.P.Itanagar.
7. The Chief Engineers, WRD, (EZ/WZ/P&D),Itanagar for information & necessary action.
8. The Chief Engineer (P&D), PHED & W.S DepartmentA.P.Itnagar/ Naharlagun for information.
9. The Director Agriculture, A.P. Naharlagun,for information and necessary action.
10. The SE (Coordination), WRD Itanagar, for information and necessary action.
11. The General Manager, NABARD Bank, A.P. Regional Officer, Bank Tinali, T.T. Marg, Itanagar-791111 for information & necessary action.
12. The Regional Director, Central Ground Water Board (CGWG), North East Regional, Guwahati, for information & necessary action.
13 All SE, WRD Circle..... for information & necessary action.
14 All EE, WRD Division.....for information & necessary action.
15. The order Book.
16. Office Copy.

(Geyum Padu)
Secretary (WRD)
Govt. of Arunachal Pradesh
Itanagar.

Annexure A 2: Minutes of State Level Committee for ground water resources estimation

MINUTES OF THE FIRST MEETING OF THE STATE LEVEL COMMITTEE HELD ON 26TH MARCH, 2021 through Google Meet FOR ASSESSMENT OF THE DYNAMIC GROUND WATER RESOURCES (2020) FOR THE STATE OF ARUNACHAL PRADESH

The meeting of the State Level Committee (SLC) for Assessment of Dynamic Ground Water Resources of Arunachal Pradesh was held on 26.03.2021 through Google Meet under the Chairmanship of Er. L. Angu, Chief Engineer (P&D), Water Resources Department, Govt. of Arunachal Pradesh.

The list of Members attended the meetings are:

1. Er. M. Ngomdir, C.E, (EZ), WRD, Govt. of Arunachal Pradesh.
2. Er. G. Borang, C.E, (WZ), WRD, Govt. of Arunachal Pradesh.
3. Er. T Ketan, CE(P& D),, PHED, Govt. of Arunachal
4. Sri Nitum Riba, DDA, Dept. of Agriculture, Govt. of Arunachal Pradesh
5. Shri B Ray, Regional Director (i/c) & Member Secretary, CGWB, NER, Guwahati
6. Shri R.K. Kalita, Scientist-D, CGWB, NER, Guwahati
7. Dr. S S Singh, Scientist C, CGWB, NER, Guwahati.
8. Dr. D. J. Khound, Scientist-B, CGWB, NER, Guwahati.
9. Shri Ebadur Rahman, Scientist-B, CGWB, SUO, Naharlagun

The Chairman, SLC, Govt.of Arunachal Pradesh welcomed the committee members. Shri B Ray, Regional Director (i/c) & Member Secretary CGWB, NER, Guwahati give a brief on dynamic ground water resource estimation for Arunachal Pradesh as on March 2020.

Dr. D. J. Khound, Scientist-B, CGWB, NER, Guwahati presented the dynamic groundwater resources of Arunachal Pradesh (as on March 2020) which is jointly estimated by CGWB, NER and Govt. of Arunachal Pradesh. The presentation was delivered with an introduction on various features of the INGRES software which has been designed by IIT Hyderabad for ground water resource estimation. During presentation the categorisation of assessment units as per GEC' 2015 was discussed. The data sheets uploading procedure, triggering computations and viewing results of computations in INGRES are enumerated in the presentation. The summarised result of dynamic groundwater resource of Arunachal Pradesh was also presented. The annual extractable resource of Arunachal Pradesh as on March 2020 is 2.92BCM, groundwater extraction is 1057.93 ham and stage of extraction is 0.36%. Lastly, a comparison sheet showing difference between dynamic ground water resources for 2017 and 2020 was presented before the committee members. Comparison of groundwater resources of Arunachal Pradesh in 2017 and 2020 shows that almost all the components of ground resources of Arunachal Pradesh in 2020 are marginally increased due to refinement of data. He also mentioned that the manual calculation has also been done and it matches with the result of INGRES.

After thorough deliberation by various members of the committee, the Dynamic Groundwater Resource Estimation of Arunachal Pradesh using INGRES was finally approved by the committee.

26-03-2021.

(Er. L. Angu)
Chief Engineer (P&D)
Water Resources Department, Govt. of Arunachal Pradesh
&
Chairman of the SLC

Annexure 1B: "Basic Data" input sheet for ARUNACHAL PRADESH for year 2019-2020

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 2B: "Basic Data" input sheet for ARUNACHAL PRADESH for year 2019-2020

S.N	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	TIRAP	TIRAP	Alluvium	Valley Fills	AL06	100	16	22
2	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Alluvium	Valley Fills	AL06	100	16	22
3	WEST SIANG	WEST SIANG	Alluvium	Valley Fills	AL06	100	16	22
4	UPPER SUBANSIRI	UPPER SUBANSIRI	Alluvium	Valley Fills	AL06	100	16	22
5	LOWER SUBANSIRI	LOWER SUBANSIRI	Alluvium	Valley Fills	AL06	100	16	22
6	EAST SIANG	EAST SIANG	Alluvium	Valley Fills	AL06	100	16	22
7	CHANGLANG	CHANGLANG	Alluvium	Valley Fills	AL06	100	16	22
8	LOHIT	LOHIT	Alluvium	Valley Fills	AL06	100	16	22
9	PAPUM PARE	PAPUM PARE	Alluvium	Valley Fills	AL06	100	16	22
10	WEST KAMENG	WEST KAMENG	Alluvium	Valley Fills	AL06	100	16	22
11	EAST KAMENG	EAST KAMENG	Alluvium	Valley Fills	AL06	100	16	22

Annexure 2C: "Domestic (Consumptive Use)" input sheet for ARUNACHAL PRADESH, for year 2019-2020

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

Annexure 2D: "Industrial (Unit Draft)" input sheet for ARUNACHAL PRADESH for year 2019-2020

S.N	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	TIRAP	TIRAP	Non Command	Industry 1	Structure 1	0	0	0	0
2	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	Industry 1	Structure 1	0	0	0	0
3	WEST SIANG	WEST SIANG	Non Command	Packaged Drinking Water	Dug Well	1	1	0.2	0.4
4	WEST SIANG	WEST SIANG	Non Command	Packaged Drinking Water	Tube Well	1	1	0.3	0.54
5	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	Industry 1	Structure 1	0	0	0	0
6	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	Industry 1	Structure 1	0	0	0	0
7	EAST SIANG	EAST SIANG	Non Command	Packaged Drinking Water	Tube Well	1	1	0.36	0.6768
8	CHANGLANG	CHANGLANG	Non Command	Industry 1	Structure 1	0	0	0	0
9	LOHIT	LOHIT	Non Command	Packaged Drinking Water	Tube Well	1	1	0.08	0.16
10	PAPUM PARE	PAPUM PARE	Non Command	Packaged Drinking Water	Dug Well	2	2	0.1915	0.38225
11	PAPUM PARE	PAPUM PARE	Non Command	Packaged Drinking Water	Tube Well	4	4	0.32025	0.6405
12	PAPUM PARE	PAPUM PARE	Non Command	Breweries	Tube Well	4	4	1.125	2.25
13	WEST KAMENG	WEST KAMENG	Non Command	Industry 1	Structure 1	1	1	0.288	0.432
14	EAST KAMENG	EAST KAMENG	Non Command	Industry 1	Structure 1	0	0	0	0

Annexure 2E: "Irrigation (Unit Draft)" input sheet for ARUNACHAL PRADESH for year 2019-2020

S.No	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	TIRAP	TIRAP	Non Command	Structure 1	0	0	0	0
2	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	Structure 1	0	0	0	0
3	WEST SIANG	WEST SIANG	Non Command	Structure 1	0	0	0	0
4	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	Structure 1	0	0	0	0
5	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	Structure 1	0	0	0	0
6	EAST SIANG	EAST SIANG	Non Command	Tube well	19	19	6.63	5.32
7	EAST SIANG	EAST SIANG	Non Command	Dug well	93	93	0.16	0.12
8	CHANGLANG	CHANGLANG	Non Command	Structure 1	0	0	0	0
9	LOHIT	LOHIT	Non Command	Structure 1	0	0	0	0
10	PAPUM PARE	PAPUM PARE	Non Command	Structure 1	0	0	0	0
11	WEST KAMENG	WEST KAMENG	Non Command	Structure 1	0	0	0	0
12	EAST KAMENG	EAST KAMENG	Non Command	Structure 1	0	0	0	0

Annexure 3: "Ground Water Well - Assessment Unit Level" input sheet for ARUNACHAL PRADESH for year 2019-2020

S.No	District	Assessment Unit	Assessment Sub-Unit (Command, Non Command, Poor Quality)	* Year	Level (m)	
1	CHANGLANG	CHANGLANG	Non Command	2015	3.8	3.17
2	CHANGLANG	CHANGLANG	Non Command	2016	3.23	4.33
3	CHANGLANG	CHANGLANG	Non Command	2017	2.97	2.71
4	CHANGLANG	CHANGLANG	Non Command	2018	3.24	4.11
5	CHANGLANG	CHANGLANG	Non Command	2019	0.0	3.3
6	EAST SIANG	EAST SIANG	Non Command	2015	7.42	3.47
7	EAST SIANG	EAST SIANG	Non Command	2016	6.78	3.23
8	EAST SIANG	EAST SIANG	Non Command	2017	10.63	3.99
9	EAST SIANG	EAST SIANG	Non Command	2018	7.03	4.44
10	EAST SIANG	EAST SIANG	Non Command	2019	4.44	3.39
11	LOHIT	LOHIT	Non Command	2015	5.06	2.29
12	LOHIT	LOHIT	Non Command	2016	2.79	3.0
13	LOHIT	LOHIT	Non Command	2017	4.52	3.27
14	LOHIT	LOHIT	Non Command	2018	4.54	2.99
15	LOHIT	LOHIT	Non Command	2019	3.35	2.38
16	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2015	4.91	2.42
17	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2016	4.91	2.08
18	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2017	4.61	1.29
19	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2018	4.95	1.74
20	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2019	4.24	1.28
21	PAPUM PARE	PAPUM PARE	Non Command	2015	3.12	3.31
22	PAPUM PARE	PAPUM PARE	Non Command	2016	3.14	2.47
23	PAPUM PARE	PAPUM PARE	Non Command	2017	4.75	2.95
24	PAPUM PARE	PAPUM PARE	Non Command	2018	3.24	3.15
25	PAPUM PARE	PAPUM PARE	Non Command	2019	3.75	2.42
26	TIRAP	TIRAP	Non Command	2015	7.2	4.32
27	TIRAP	TIRAP	Non Command	2016	6.25	4.53
28	TIRAP	TIRAP	Non Command	2017	5.87	3.75
29	TIRAP	TIRAP	Non Command	2018	4.58	2.63
30	TIRAP	TIRAP	Non Command	2019	5.82	5.11

Annexure 4A: "Recharge from Other Sources - Crop Water Requirement", SURFACE WATER IRRIGATION input sheet for ARUNACHAL PRADESH for year 2019-2020

S.N	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	TIRAP	TIRAP	No	600	0	894	0	0.5	0.5	No	Vegetable	0	180	0	191	0.3	0.3
2	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	No	600	0	3319	0	0.5	0.5	No							
3	WEST SIANG	WEST SIANG	No			0	0	0.5	0.5	No							
4	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	LOWER SUBANSIRI	LOWER SUBANSIRI	No	600	600	370	0	0.5	0.5	No							
6	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	CHANGLANG	CHANGLANG	No	600	0	3642	0	0.5	0.5	No	Vegetable	0	180	0	16	0.3	0.3
8	LOHIT	LOHIT	No	600	0	2225	0	0.5	0.5	No							
9	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	WEST KAMENG	WEST KAMENG	No	600	0	204	0	0.5	0.5	No	Vegetable	0	180	492	0	0.3	0.3
11	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 2019-2020

S.N	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	TIRAP	TIRAP	No					No							
2	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	No					No							
3	WEST SIANG	WEST SIANG	No					No							
4	UPPER SUBANSIRI	UPPER SUBANSIRI	No					No							
5	LOWER SUBANSIRI	LOWER SUBANSIRI	No					No							
6	EAST SIANG	EAST SIANG	No	75.03	0	0.45	0.45	No	Vegetable	0	75.4	0.25	0.25	0.45	0.25
7	CHANGLANG	CHANGLANG	No					No							
8	LOHIT	LOHIT	No					No							
9	PAPUM PARE	PAPUM PARE	No					No							
10	WEST KAMENG	WEST KAMENG	No					No							
11	EAST KAMENG	EAST KAMENG	No					No							

Annexure 5:"Rainfall Data at Assessment unit level" input sheet for ARUNACHAL PRADESH for year 2019-2020

S.No	District	Assessment Unit	Assessment Sub-Unit (Command, Non Command, Poor Quality)	*Year	Monsoon		Non-Monsoon	
					*Actual (mm)	*Normal (mm)	*Actual (mm)	*Normal (mm)
1	TIRAP	TIRAP	Non Command	2016-2017	1501.2	2510.4	761.6	949.0
2	TIRAP	TIRAP	Non Command	2018-2019	1632.2	2510.4	931.0	949.0
3	TIRAP	TIRAP	Non Command	2015-2016	1390.4	2510.4	1028.2	949.0
4	TIRAP	TIRAP	Non Command	2014-2015	1344.4	2510.4	404.6	949.0
5	TIRAP	TIRAP	Non Command	2017-2018	1562.1	2510.4	481.6	949.0
6	TIRAP	TIRAP	Non Command	2019-2020	1391.4	2510.4	337.8	949.0
7	TIRAP	TIRAP	Non Command	2013-2014	1856.6	2510.4	282.1	949.0
8	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	2016-2017	3673.5	1923.5	1963.4	1583.5
9	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	2018-2019	4110.8	1923.5	1511.2	1583.5
10	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	2015-2016	4193.9	1923.5	2434.5	1583.5
11	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	2014-2015	2825.3	1923.5	1254.7	1583.5
12	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	2017-2018	3632.4	1923.5	967.2	1583.5
13	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	2019-2020	2951.7	1923.5	1115.4	1583.5
14	LOWER DIBANG VALLEY	LOWER DIBANG VALLEY	Non Command	2013-2014	1843.9	1923.5	1236.5	1583.5
15	WEST SIANG	WEST SIANG	Non Command	2016-2017	1476.5	2223.2	716.3	689.7
16	WEST SIANG	WEST SIANG	Non Command	2018-2019	1532.5	2223.2	700.0	689.7
17	WEST SIANG	WEST SIANG	Non Command	2015-2016	1321.0	2223.2	505.6	689.7
18	WEST SIANG	WEST SIANG	Non Command	2014-2015	1589.6	2223.2	553.5	689.7
19	WEST SIANG	WEST SIANG	Non Command	2017-2018	2029.2	2223.2	673.7	689.7
20	WEST SIANG	WEST SIANG	Non Command	2019-2020	2156.2	2223.2	666.0	689.7
21	WEST SIANG	WEST SIANG	Non Command	2013-2014	1334.5	2223.2	524.4	689.7
22	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	2016-2017	1696.8	1093.6	473.0	652.9
23	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	2018-2019	704.4	1093.6	639.2	652.9

24	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	2015-2016	1018.3	1093.6	565.2	652.9
25	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	2014-2015	957.8	1093.6	470.9	652.9
26	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	2017-2018	1375.2	1093.6	518.5	652.9
27	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	2019-2020	1122.6	1093.6	556.8	652.9
28	UPPER SUBANSIRI	UPPER SUBANSIRI	Non Command	2013-2014	689.7	1093.6	545.0	652.9
29	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2016-2017	2236.03	1276.3	816.89	860.6
30	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2018-2019	2128.36	1276.3	745.88	860.6
31	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2015-2016	2326.6	1276.3	990.03	860.6
32	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2014-2015	2115.37	1276.3	695.27	860.6
32	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2017-2018	2567.16	1276.3	654.1	860.6
33	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2013-2014	1879.45	1276.3	713.89	860.6
34	LOWER SUBANSIRI	LOWER SUBANSIRI	Non Command	2019-2020	2264.07	1276.3	594.8	860.6
35	EAST SIANG	EAST SIANG	Non Command	2016-2017	3069.2	3397.0	969.0	1021.8
36	EAST SIANG	EAST SIANG	Non Command	2018-2019	2265.8	3397.0	1035.2	1021.8
37	EAST SIANG	EAST SIANG	Non Command	2015-2016	3562.9	3397.0	1067.3	1021.8
38	EAST SIANG	EAST SIANG	Non Command	2014-2015	3223.9	3397.0	1000.6	1021.8
39	EAST SIANG	EAST SIANG	Non Command	2017-2018	3434.2	3397.0	1151.4	1021.8
40	EAST SIANG	EAST SIANG	Non Command	2013-2014	2771.0	3397.0	976.0	1021.8
41	EAST SIANG	EAST SIANG	Non Command	2019-2020	2872.2	3397.0	1019.0	1021.8
42	CHANGLANG	CHANGLANG	Non Command	2016-2017	1238.1	1690.4	682.4	909.1
43	CHANGLANG	CHANGLANG	Non Command	2018-2019	811.0	1690.4	978.5	909.1
44	CHANGLANG	CHANGLANG	Non Command	2015-2016	1327.3	1690.4	1139.2	909.1
45	CHANGLANG	CHANGLANG	Non Command	2014-2015	1331.7	1690.4	519.7	909.1
46	CHANGLANG	CHANGLANG	Non Command	2017-2018	1122.3	1690.4	698.9	909.1
47	CHANGLANG	CHANGLANG	Non Command	2013-2014	1283.6	1690.4	381.2	909.1
48	CHANGLANG	CHANGLANG	Non Command	2019-2020	1384.2	1690.4	498.5	909.1
49	LOHIT	LOHIT	Non Command	2016-2017	1518.1	1750.1	1082.2	1253.4
50	LOHIT	LOHIT	Non Command	2018-2019	1285.3	1750.1	941.6	1253.4
51	LOHIT	LOHIT	Non Command	2015-2016	1802.9	1750.1	1444.0	1253.4
52	LOHIT	LOHIT	Non Command	2014-2015	1541.8	1750.1	804.2	1253.4
53	LOHIT	LOHIT	Non Command	2017-2018	1908.0	1750.1	748.9	1253.4
54	LOHIT	LOHIT	Non Command	2013-2014	1499.5	1750.1	883.4	1253.4

55	LOHIT	LOHIT	Non Command	2019-2020	1787.4	1750.1	471.7	1253.4
56	PAPUM PARE	PAPUM PARE	Non Command	2016-2017	2554.5	2408.0	859.2	928.8
57	PAPUM PARE	PAPUM PARE	Non Command	2018-2019	2068.1	2408.0	887.6	928.8
58	PAPUM PARE	PAPUM PARE	Non Command	2015-2016	2546.8	2408.0	1011.5	928.8
59	PAPUM PARE	PAPUM PARE	Non Command	2014-2015	2929.9	2408.0	924.0	928.8
60	PAPUM PARE	PAPUM PARE	Non Command	2017-2018	2776.7	2408.0	688.2	928.8
61	PAPUM PARE	PAPUM PARE	Non Command	2013-2014	1812.5	2408.0	920.1	928.8
62	PAPUM PARE	PAPUM PARE	Non Command	2019-2020	2233.8	2408.0	711.4	928.8
63	WEST KAMENG	WEST KAMENG	Non Command	2016-2017	968.3	1976.8	243.0	544.6
64	WEST KAMENG	WEST KAMENG	Non Command	2018-2019	1441.3	1976.8	377.7	544.6
65	WEST KAMENG	WEST KAMENG	Non Command	2015-2016	1306.8	1976.8	505.6	544.6
66	WEST KAMENG	WEST KAMENG	Non Command	2014-2015	1806.7	1976.8	363.5	544.6
67	WEST KAMENG	WEST KAMENG	Non Command	2017-2018	1141.2	1976.8	372.8	544.6
68	WEST KAMENG	WEST KAMENG	Non Command	2013-2014	1405.1	1976.8	203.4	544.6
69	WEST KAMENG	WEST KAMENG	Non Command	2019-2020	1233.7	1976.8	476.7	544.6
70	EAST KAMENG	EAST KAMENG	Non Command	2016-2017	567.7	1459.8	542.7	676.3
71	EAST KAMENG	EAST KAMENG	Non Command	2018-2019	644.5	1459.8	197.2	676.3
72	EAST KAMENG	EAST KAMENG	Non Command	2015-2016	409.4	1459.8	214.9	676.3
73	EAST KAMENG	EAST KAMENG	Non Command	2014-2015	498.6	1459.8	107.9	676.3
74	EAST KAMENG	EAST KAMENG	Non Command	2017-2018	755.5	1459.8	91.7	676.3
75	EAST KAMENG	EAST KAMENG	Non Command	2013-2014	987.9	1459.8	152.2	676.3
76	EAST KAMENG	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 2019-2020

S. N	District	Assessment Unit	Assessment Sub-Unit (Command, Non Command, Poor Quality)	Zone Number	Zone Description	Evaporation rate in	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	TIRAP	TIRAP	non_command		0.0-0.5			0	0	0.25	0.25	0	0
2	TIRAP	TIRAP	non_command		0.5-1.0			0	0	0.75	0.75	0	0
3	TIRAP	TIRAP	non_command		1.0-1.5			0	0	1.25	1.25	0	0
4	TIRAP	TIRAP	non_command		1.5-2.0			0	0	1.75	1.75	0	0
5	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		0.0-0.5			0	0	0.25	0.25	0	0
6	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		0.5-1.0			0	0	0.75	0.75	0	0
7	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		1.0-1.5			0	0	1.25	1.25	0	0
8	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		1.5-2.0			0	0	1.75	1.75	0	0
9	EAST SIANG	EAST SIANG	non_command		0.0-0.5			0	0	0.25	0.25	0	0
10	EAST SIANG	EAST SIANG	non_command	2.0	0.5-1.0	1	1	0	225.1	0.75	0.75	153	212
11	EAST SIANG	EAST SIANG	non_command		1.0-1.5			0	0	1.25	1.25	0	0
12	EAST SIANG	EAST SIANG	non_command		1.5-2.0			0	0	1.75	1.75	0	0
13	CHANGLANG	CHANGLANG	non_command		0.0-0.5			0	0	0.25	0.25	0	0
14	CHANGLANG	CHANGLANG	non_command		0.5-1.0			0	0	0.75	0.75	0	0
15	CHANGLANG	CHANGLANG	non_command		1.0-1.5			0	0	1.25	1.25	0	0
16	CHANGLANG	CHANGLANG	non_command		1.5-2.0			0	0	1.75	1.75	0	0
17	LOHIT	LOHIT	non_command	1.0	0.0-0.5	1	1	0	4413	0.25	0.25	153	212
18	LOHIT	LOHIT	non_command	2.0	0.5-1.0	1	1	0	1663	0.75	0.75	153	212
19	LOHIT	LOHIT	non_command		1.0-1.5			0	0	1.25	1.25	0	0
20	LOHIT	LOHIT	non_command		1.5-2.0			0	0	1.75	1.75	0	0
21	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	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	PAPUM PARE	PAPUM PARE	non_command		1.0-1.5			0	0	1.25	1.25	0	0
24	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 2019-2020

S.N	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	TIRAP	TIRAP	non_command	1.0	0.0-0.5	1	2.5	1	0	0	0.25	0.25	122	243
2	TIRAP	TIRAP	non_command	2.0	0.5-1.0	1	2.5	1	0	0	0.75	0.75	122	243
3	TIRAP	TIRAP	non_command	3.0	1.0-1.5	1	2.5	1	0	0	1.25	1.25	122	243
4	TIRAP	TIRAP	non_command	4.0	1.5-2.0	1	2.5	1	0	0	1.75	1.75	122	243
5	TIRAP	TIRAP	non_command	5.0	2.0-2.5	1	2.5	1	0	0	2.25	2.25	122	243
6	TIRAP	TIRAP	non_command	6.0	2.5-3.0	1	2.5	1	0	0	2.75	2.75	122	243
7	TIRAP	TIRAP	non_command	7.0	3.0-3.5	1	2.5	1	0	0	3.25	3.25	122	243
8	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		0.0-0.5						0.25	0.25		
9	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		0.5-1.0						0.75	0.75		
10	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	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		1.5-2.0						1.75	1.75		
12	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		2.0-2.5						2.25	2.25		
13	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		2.5-3.0						2.75	2.75		
14	LOWER SUBANSIRI	LOWER SUBANSIRI	non_command		3.0-3.5						3.25	3.25		
15	EAST SIANG	EAST SIANG	non_command		0.0-0.5						0.25	0.25		
16	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	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	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	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	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	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	CHANGLANG	CHANGLANG	non_command		0.0-0.5						0.25	0.25		
23	CHANGLANG	CHANGLANG	non_command		0.5-1.0						0.75	0.75		
24	CHANGLANG	CHANGLANG	non_command	3.0	1.0-1.5	1	2.5	1	7025	0	1.25	1.25	153	212
25	CHANGLANG	CHANGLANG	non_command	4.0	1.5-2.0	1	2.5	1	1098	0	1.75	1.75	153	212
26	CHANGLANG	CHANGLANG	non_command	5.0	2.0-2.5	1	2.5	1	1152	3803	2.25	2.25	153	212
27	CHANGLANG	CHANGLANG	non_command	6.0	2.5-3.0	1	2.5	1	2158	4866	2.75	2.75	153	212
28	CHANGLANG	CHANGLANG	non_command		3.0-3.5						3.25	3.25		
29	LOHIT	LOHIT	non_command	1.0	0.0-0.5	1	2.5	1	0	4413	0.25	0.25	153	212
30	LOHIT	LOHIT	non_command	2.0	0.5-1.0	1	2.5	1	0	1663	0.75	0.75	153	212
31	LOHIT	LOHIT	non_command	3.0	1.0-1.5	1	2.5	1	2222	1013	1.25	1.25	153	212
32	LOHIT	LOHIT	non_command	4.0	1.5-2.0	1	2.5	1	0	0	1.75	1.75	153	212
32	LOHIT	LOHIT	non_command	5.0	2.0-2.5	1	2.5	1	0	0	2.25	2.25	153	212
33	LOHIT	LOHIT	non_command	6.0	2.5-3.0	1	2.5	1	0	0	2.75	2.75	153	212
34	LOHIT	LOHIT	non_command	7.0	3.0-3.5	1	2.5	1	0	0	3.25	3.25	153	212
35	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	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	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	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	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	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	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

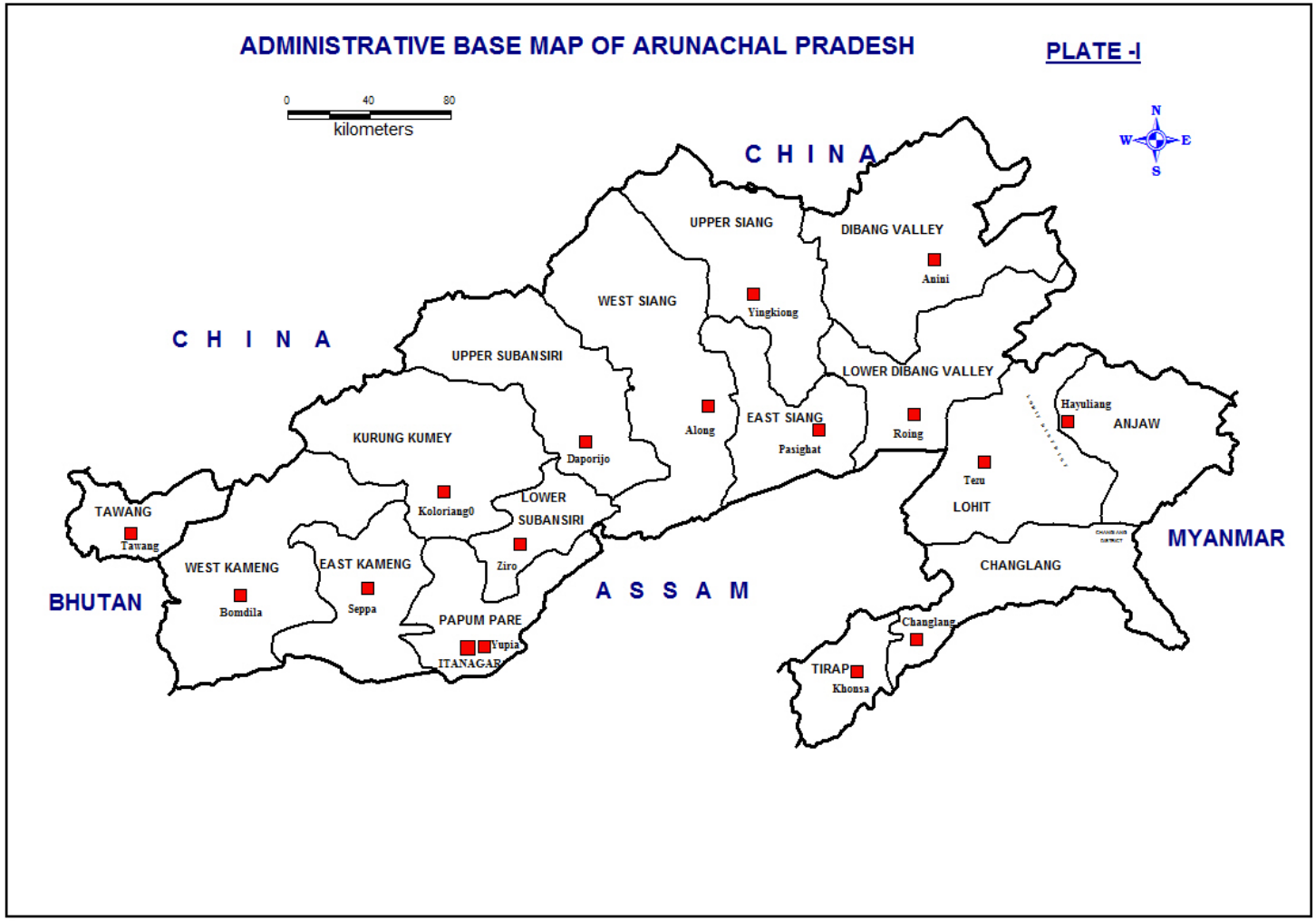


Plate 1: Administrative base map of Arunachal Pradesh

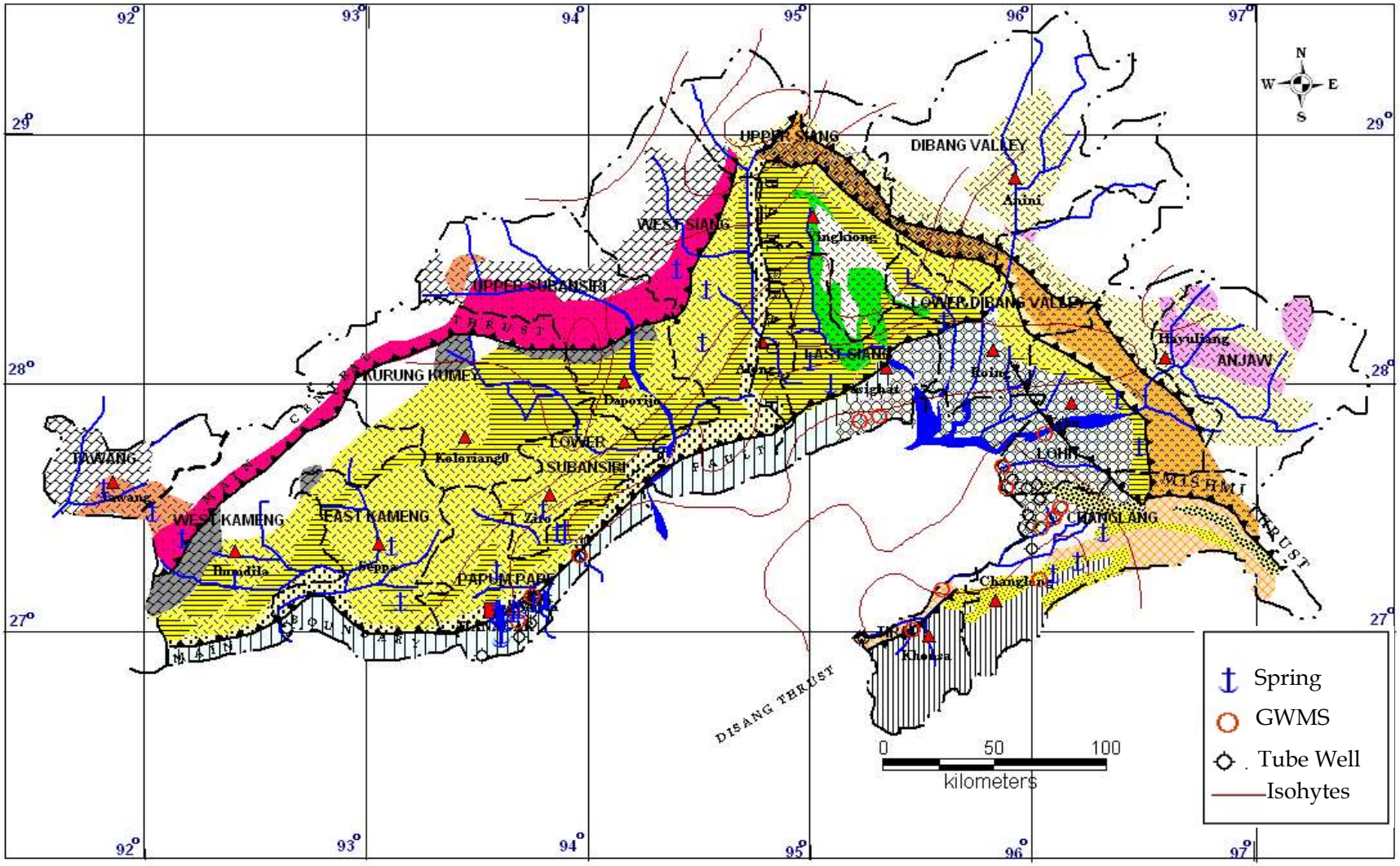


PLATE II: Hydrogeological Map of Arunachal Pradesh

Map Symbol	Description		Groundwater Potentiality
	Thrust		
	Newer Alluvium	Unconsolidated Formation	Moderate yield, 30-50m³/hr. Drawdown within 10 to 15m.
	Older Alluvium		
	Namsang & Dihing Formations	Semi-consolidated Formation	Low yield, up to 20m³/hr. Draw down within 25m.
	Siwalik Group		
	Surma & Naharkatia Groups		
	Barail Group	Consolidated Formation	Low yield, 5 to 15m³/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			
	Tertiary Tourmaline Granite		Yield up to 5m³/hr in metasediments and igneous rocks
	Lohit Granitoid		
	Abor Volcanic		
	Palaeoproterozoic		

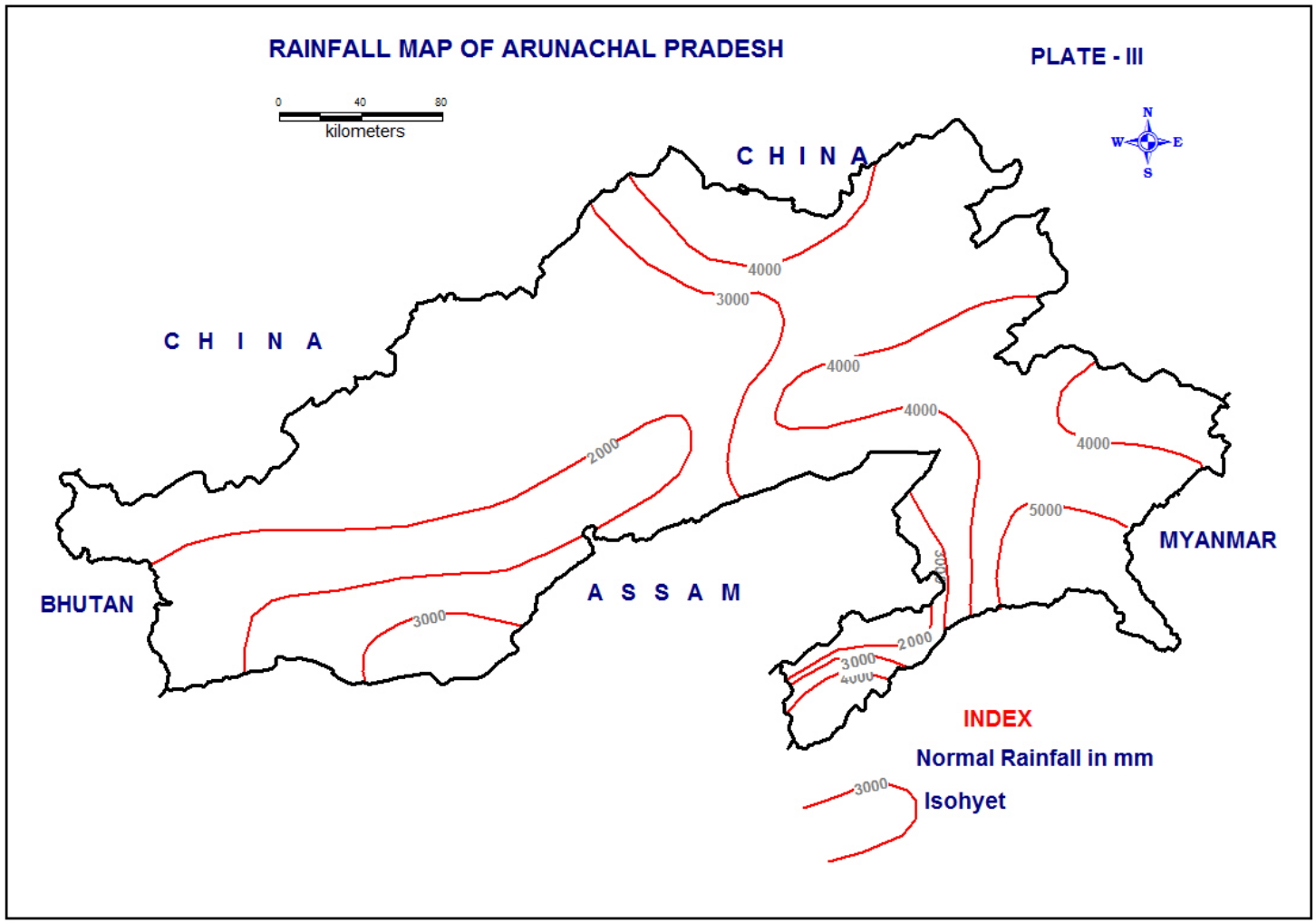


Plate III: Isohyte map of ArunachalPradesh

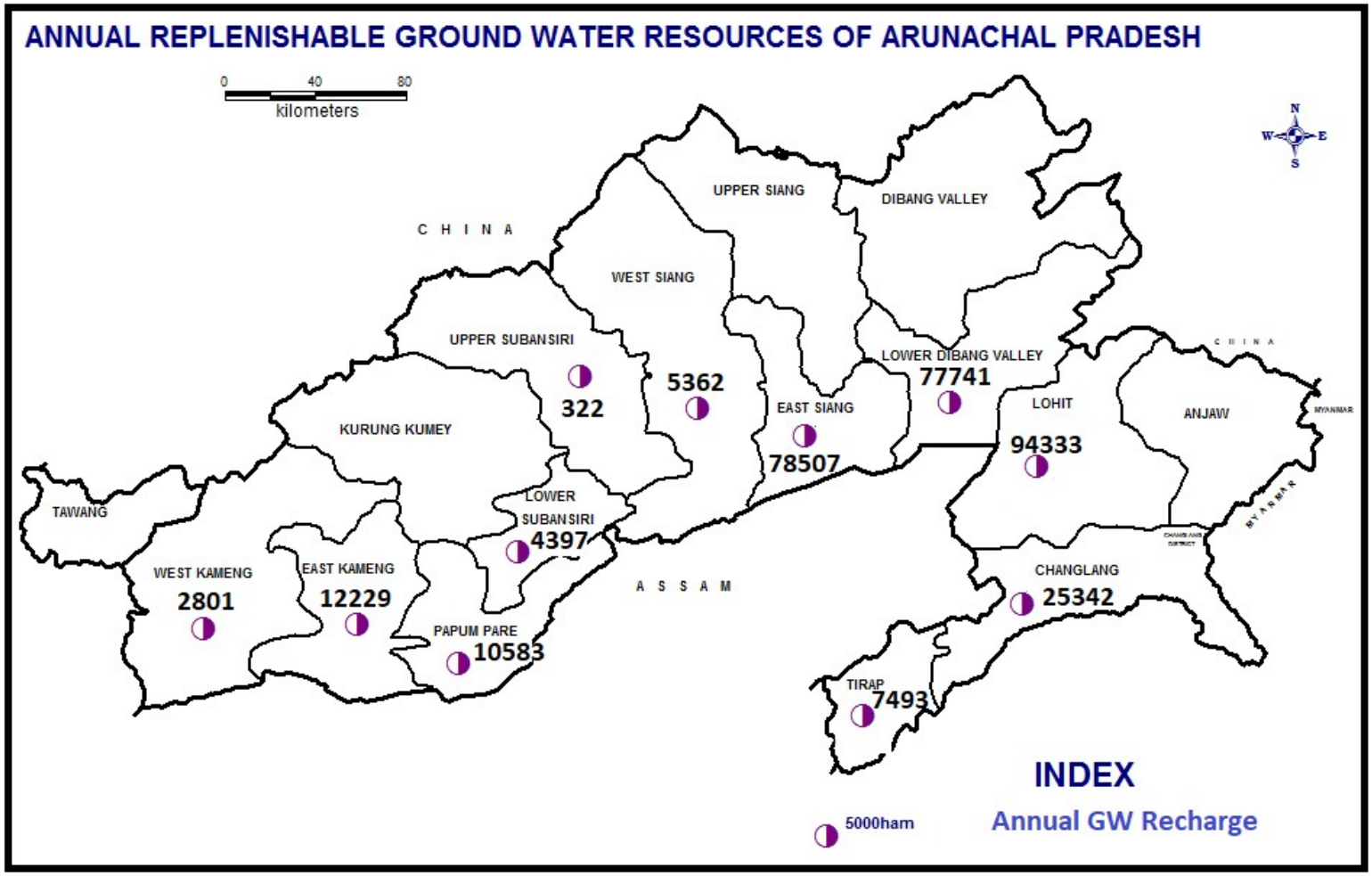


Plate IV: Annual replenishable groundwater resources of Arunachal Pradesh

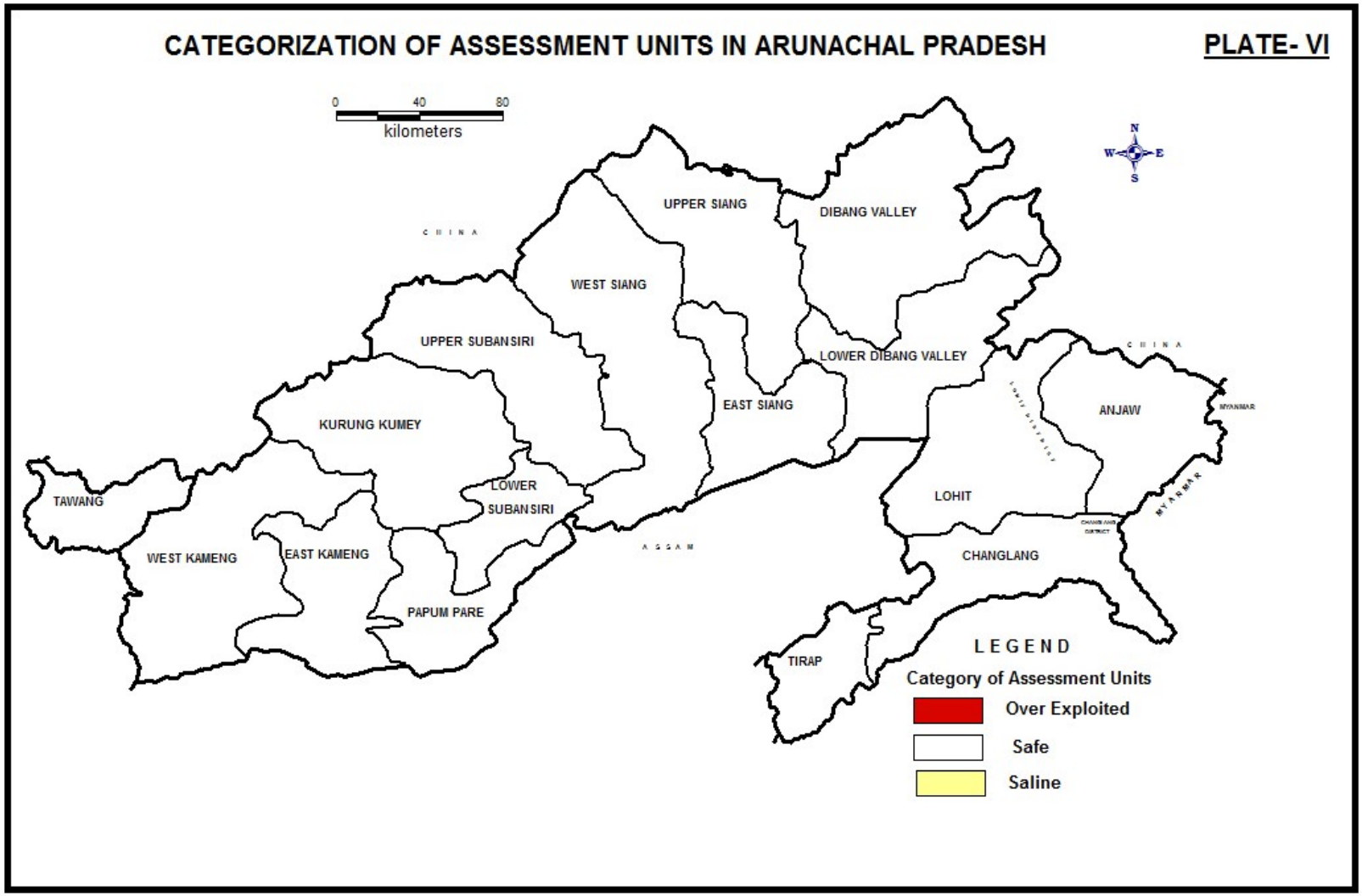


Plate V: Categorization of assessment units in Arunachal Pradesh