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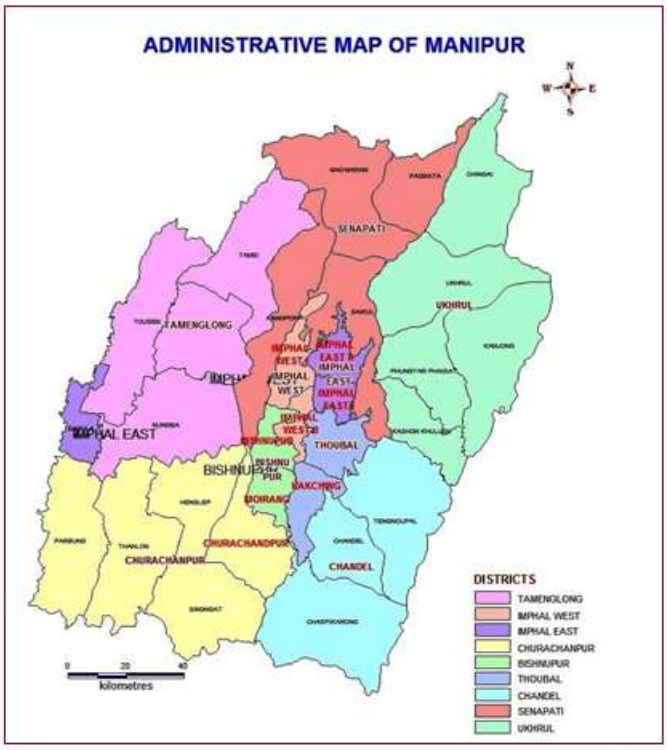
GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION
CENTRAL GROUND WATER BOARD



DYNAMIC GROUND WATER RESOURCES OF MANIPUR (As on March, 2022)

CENTRAL GROUND WATER BOARD
NORTH EASTERN REGION, GUWAHATI
November 2022

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PREFACE

The State of Manipur is characterized by hilly terrain with steep slopes. Only about one tenth part of the state has valley areas, which are found as repository of groundwater in state. The valleys covered with unconsolidated alluvial deposits and semi-consolidated Tertiary sedimentary formations are having fairly good scope for groundwater development.

For rapidly expanding urban and agricultural water requirement of the state, groundwater utilization is of fundamental importance. For proper planning and management of groundwater, reliable estimation of groundwater resource in the state is prime necessity. Keeping this objective in view, the groundwater resource potential of Manipur has been reassessed based on 'Ground Water Resource Estimation Methodology – 2015 (GEC 2015).

Ground Water Resources of Manipur has been carried out jointly by Central Ground Water Board, NER and Minor Irrigation Department, Manipur (State Nodal Department) in coordination with other members/departments of SLC.

Earlier this dynamic groundwater resource estimation work was done manually throughout the country. Later it was observed that some minor computational error might have occurred in calculating the resource, as the process of dynamic groundwater resource estimation is a complicated and lengthy. So, to overcome this human error, CGWB in collaboration with IIT Hyderabad has developed the web-based software IN-GRES (INDIA GROUNDWATER RESOURCE ESTIATION SOFTWARE).

The computation has been done based on the field data generated by Central Ground Water Board and statistical information compiled by the state government departments. The report contains blocks-wise - total ground water recharge, current annual gross ground water extraction and existing gross groundwater extraction for various uses. Stage of groundwater extraction in the State is in nascent stage. The report also throws light on the future ground water availability for various uses including irrigation and domestic sectors.

The total annual groundwater recharge in the state of Manipur is 51780.41 Ham. The annual extractable ground water resource of the state is worked out as 46602.38 Ham. The existing current annual gross ground water extraction for all uses is 3704.61 Ham of which 1677.00Ham is the current annual gross ground water extraction for irrigation use, 2003.61Ham is the current gross ground water extraction for domestic use and 24 ham is the current gross ground water extraction for industrial uses. Annual ground water allocation for domestic use as on 2025 is 2022.18 Ham and Net ground water availability for future use is 42879.20The over-all stage of groundwater extraction of Manipur is 7.95 %. As such all the assessment units falls under Safe category.

The report will be very helpful for the user agencies.

(Suresh Ch. Kapil)
Regional Director

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CONTRIBUTORS

The computation of Dynamic Ground Water Resources of Manipur for the Assessment Year 2021-22 as on March, 2022 (as per GEC 2015) has been done based on the field data generated by Central Ground Water Board and statistical information compiled by the state government departments like, Directorate of Economics and Statistics, Minor Irrigation Department, Public Health and Engineering Department, Water Resources Department, Indian Meteorological Department, Govt. of India etc. The re-assessment of the resources and preparation of the report were carried out by Dr. Sorokhaibam Somarendro Singh, Scientist D,CGWB, NER, Sri Bibhuti Bushan Sahoo, Scientist-B, CGWB and team of Chief Engineer, MID, Manipurunder the supervision of Sri Suresh Chandra Kapil, Regional Director, Central Ground Water Board, North Eastern Region, Ministry of Jal Shakti, RD & GR, Govt. of India (Guwahati).

DYNAMIC GROUNDWATER RESOURCES OF MANIPUR FOR THE ASSESSMENT YEAR 2021-22 AS ON MARCH 2022

CHAPTER 1

1.0 INTRODUCTION

Groundwater is an important resource for meeting the water requirements for irrigation, domestic and industrial uses. The groundwater is available in the zone of water level fluctuation which is active recharge zone and replenished annually, i.e., dynamic as well as in the deeper zone below the water level fluctuation i.e., in in-storage condition. The dynamic groundwater resources, which are being used regularly, are reflected in the fluctuation of water levels. Apart from this, there are huge groundwater reservoirs in the deeper zones below the active recharge zone and in the confined aquifers in the areas covered by alluvial sediments of river basins, coastal and deltaic tracts constituting the unconsolidated formations and productive fracture zones in hard rock areas. The in-storage groundwater resource can be considered for development only during the period of extreme drought condition, and that too probably only to meet drinking water supply.

The previous assessment of groundwater resources of Manipur was carried out as on March 2020. The groundwater resource of the state of Manipur as on March 2022 has been re-assessed based on the new methodology, i.e., 'Ground Water Estimation Methodology', 2015 (GEC 2015) and modified database. Dynamic Ground Water Resource of Manipur was automated through IN-GRES software (India Groundwater Resources Estimation System), a software/web-based application developed by CGWB in collaboration with Vassar Lab, IIT-Hyderabad.

The Total Annual Extractable Ground Water Resources as per the earlier estimations of groundwater resources potential of the state worked out as on March 2022 was46602.38-hectare metre (ham). Provision for DomesticUses was2022.18 ham and Available Groundwater Resource for future use was 42879.20 ham. The Net Draft for irrigation was Negligible for the entire state of Manipur.

1.1 Constitution of State Level Committee of Manipur

The State Level Committee on Ground Water Resources Estimation for the re-estimation of ground water resources of Manipur as on March 2022has been reconstituted by the office order of Govt. of Manipur dated 25th January 2022 (Annexure I).

1.2 Proceedings of Resources estimation

Reconciliation meeting on the Ground Water Resources of Manipur as on March, 2022 with the State Level Committee (Manipur) was convened on 09.09.2022under the Chairmanship of Secretary, Minor Irrigation to the Govt. of Manipur at Imphal.Copy of theMinutes of the meeting of the State Level committee (SLC) on Ground Water Resource Assessment of Manipur as on March 2022 is enclosed as Annexure II

CHAPTER 2.0

HYDROGEOLOGICAL SET UP

The State of Manipur is occupied by mostly North South parallel hill ranges made up of consolidated and semi-consolidated rocks ranging in age from pre-Mesozoic to Miocene. The consolidated formations confined to the eastern part of the state along the Myanmar border. The semi-consolidated formations, which cover almost the entire state, comprise shale, siltstone, sandstone and conglomerate. These formations belong to Disang, Barail, Surma and Tipam group of rocks. Unconsolidated Alluvium of Quaternary age occurs in the valleys and topographical lows in the central Imphal valley and western part of the state. The present resource estimation has been carried out in the districts of central Manipur (i.e., Imphal valley) where Unconsolidated Alluvium is major formation.

2.1 Description of aquifer dispositions, its lateral and vertical variations

Basically, the area considered for the estimation of Groundwater Resources is made up of Alluvium of fluvio-lacustrine origin. The principal constituents are clay, silt and sand whereas sand, gravel, pebbles and boulders are found in the foothill regions. The hillocks inside are basically composed of Disang shales but some have sandstone capping. Alluvium covers the widest aerial extent in the area. They are mainly dark grey to black carbonaceous clay, silt and sand of which clay forms the main sediments while silt and sand are subordinate. Major parts of the area belong to Alluvium which is further divided into Older and Younger Alluviums due to change in lithology.

2.2 Variation of Groundwater conditions with aquifer characteristics, depth, groundwater quality

Based on lithology and hydrogeological set up, the area is broadly divided into two types of aquifers; i.e. Weathered Rock Aquifer and Alluvium Aquifer. Two types of Aquifers are:

i. Weathered rock Aquifer

Moderately thick weathered shales are responsible for this type of aquifer. The water yielding properties are variable depending upon nature of the weathered material and surface cover.

ii. Alluvium Aquifer

The various geomorphic landforms constitute this type of aquifers. The nature of aquifer material is from Unconsolidated to Semi consolidated (sand, gravel, pebbles, gravel mixed with sand). Large alluvial plain form the potential source of groundwater.

The area covered by the valley that can be investigated for groundwater potential forming roughly 10 % of the total geographical state area. The valleys have superficial alluviums which are underlined by Tertiary rocks of Barial Series in Imphal valley. Granular zones are encountered up to a depth of about 145 m in Imphal valley. Tube wells have been installed at various places of the valley area with the yields ranging from 0.6 to 4 cum/hr. Considering the clayey nature of formation in the top aquifer, development of this resource is considered nascent on a large scale either in irrigation or water supply.

Semi consolidated Formations: Tertiary formations consisting of shale, sandstone, siltstone and mudstone of Disang and Barail Groups constitute the Semi-consolidated formations in Imphal valley. They occur in the flanking denudational, denude-structural and structure-denudational hills and also occur in the piedmont and part of the valley beneath the alluvial deposit. Highly splintery, fragile, jointed shales are predominant. The thickness of weathered rock in this formation varies from place to place. At places fairly good amount of water is yielded in parts of this formation as per CGWB and PHED, Manipur. The recorded average discharge in these places is around 272 lpm.

Unconsolidated Formations: In Imphal valley, unconsolidated formation consists of sand, silt, clay, gravel pebbles etc. with lake deposits. This unit covers the major portions of the Imphal valley. The thickness of unconsolidated alluvial deposits varies from place to place with maximum thickness of more than 145m at Mayang Imphal. The peripheral zone of the valley consists predominantly of sand, gravel whereas the rest is covered dominantly with thick layer of clay. The thickness of clay layer varies from place to place. It goes on increasing from periphery towards the centre of the valley. The thickness of clay layer at places, in the study area goes up to 61 m, and maximum thickness of clay occurs in the south-central parts lying just north of Loktak Lake.

The average thickness of alluvial deposits varies generally from 30 m to 110 m as per the findings of CGWB and PHED, Manipur. Below the depth of 110 m semi-consolidated sedimentary rocks are found.

The unconsolidated formation formed at the foothill, i.e., western peripheral zone of the valley, forming higher piedmont, consists of colluvial materials. These colluvial materials taper away within a short distance.

2.3 Aquifer geometry

Average aquifer thickness ranges from 10 to 21m. Piezometric head vary from 2.50 to 4.30 m, bgl. The transmissivity and hydraulic conductivity ranges between 4.30 and 89 m^2/day and 0.67 to 16 m/day. The discharge of tube wells ranges about 10-30 m^3 /hr at 10-15 m drawdown. In fact, there is great variation in both vertical and lateral lithology, even over small distances. Sand and gravel layers have indefinite and largely undefined boundaries.

2.4 Occurrence, movement and distribution of groundwater

Groundwater is found to occur under water table conditions in the shallow dug well horizons with depth to water table varying from 1.64 to 12 mbgl. Deeper depth to water level is observed in the northern foothill parts of the area. The groundwater movement is essentially towards the central lower part from the peripheral higher elevation of the valley and finally results to the north to south hydraulic gradient during pre-monsoon and north to south west south (SWS) region during post-monsoon period in the valley area. The hydraulic gradient in the southwestern fringe area is 12 m/km while it is 3.6 m/km in the eastern fringe. The hydraulic gradient in the southern part is 4.4 m/km (along Iril River).

2.5 Ground Water Level Conditions

Investigations carried out by CGWB show that groundwater in the near surface aquifer occurs under water table conditions. CGWB has so far established 25 observation net work stations in the state which are being monitored four times a year prior to 1991, since then regular monitoring programme could not continue due to disturbance. The water level in general lies between 1.64 and 4.25 mbgl. In the foot hill areas water level generally rest up to 12 m bgl.

2.6 Ground Water Quality

Groundwater in the state of Manipur is in general found to be suitable for domestic and agricultural purposes. However, recent studies have indicated localized higher concentration of iron (Fe) in some pockets of Manipur.

CHAPTER 3.0

HYDROMETEOROLOGICAL CONDITIONS

Manipur have sub-tropical to temperate climate depending upon the elevation. The temperature varies from 0° C to 39° C. The state experiences the phenomenon influence of the South West Tropical monsoon. About60to65% oftheannualprecipitationisreceivedduringsouth-west monsoonfromJunetoSeptember. The maximum rainfall of monsoon period occurs between June and September. The beginning of winter is marked by a steep fall in temperature during December. January is the coldest month. In February the temperature starts rising gradually. The winter winds are generally weak and variable. The average annual temperature ranges from 18°C-20°C to 23°C-25°C respectively in the higher and lower elevation. The monsoon lasts for five months from May to September with June, July and August being the wettest months. The following agro-climatic zones are the main characteristic zones in the area:

(i) Thecoldseason(December, January,February)
(ii) Thehot dryseason(March,April)
(iii) Therainyseason(May, June, July, August,September)
(iv) TheRetreating monsoonseason (October,November)

The Average annual rainfall in the resources worthy/assessment area is 1351.91 mm as per the records of IMD stations (2017-2022), of which 936.8084 mm is monsoon rainfall and 415.1012 mm is non-monsoon rainfall.

Table 1. Rainfall data (average in mm of 2017- 2022) for the resource assessment area (Source: IMD)

Sl.No.	District	Monsoon	Non-Monsoon	Total
1	Bishnupur	807.068	386.988	1194.056
2	Churachandpur	807.068	386.988	1194.056
3	Imphal East	818.634	371.688	1190.322
4	Imphal West	1450.998	547.194	1998.192
5	Thoubal	800.274	382.648	1182.922
	Total Average	**936.8084**	**415.1012**	**1351.91**

CHAPTER 4

GROUND WATER RESOURCES ESTIMATION METHODOLOGY, 2015 (GEC 2015)

The present methodology used for resources assessment is known as Ground Water Resource Estimation Methodology – 2015. GEC2015 recommends carrying out aquifer wise assessment. Aquifers are normally of larger sizes and hence it is recommended to assess the resources in smaller units called assessment units and present the results aquifer wise. A ground water assessment unit is a geographic land area for which ground water assessment is to be carried out with the objective of estimating the following components:

a) Current gross ground water extraction.
b) Recharge from 'Other Sources' (These are the sources other than rainfall)
c) Resultant Inflow into the system.
d) Recharge from rainfall.
e) Annual Extractable Ground Water Resource.
f) Current stage of ground water extraction.
g) Ground Water Table trend.
h) Categorisation for future ground water development.
i) Ground Water Allocation for future domestic water supply.
j) Net annual ground water availability for future use.
k) Additional Potential Resources
l) In-storage resources
m) Dynamic and In-storage resources of Confined and semi-Confined Aquifers

In GEC 2015, two approaches are recommended – water level fluctuation method and norms of rainfall infiltration method. The water level fluctuation method is based on the concept of storage change due to difference between various input and output components. Input refers to recharge from rainfall and other sources and subsurface inflow into the unit of assessment. Output refers to groundwater extraction, groundwater evapotranspiration, base flow to streams and subsurface outflow from the unit. Since the data on subsurface inflow/ outflow are not readily available, it is advantageous to adopt the unit for groundwater assessment as basin/ subbasin/ watershed, as the inflow / outflow across these boundaries may be taken as negligible.

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

4.1 Groundwater Recharge

Monsoon season

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

$$R = h \times Sy \times A + GGW_E$$

Where,

h = rise in water level in the monsoon season,

A = area for computation of recharge,

Sy = specific yield, GGW_E = gross groundwater extraction

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

$$R\ (Normal) = R_{rf}(normal) + R_c + R_{sw} + R_t + R_{gw} + R_{wc}$$

Where,

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

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

Non-Monsoon season

During Non-monsoon season, rainfall recharge is computed by using Rainfall Infiltration Factor (RIF) method. Recharge from other sources is then added to get total non-monsoon recharge. In case of areas receiving less than 10% of the annual rainfall during non-monsoon season, the rainfall recharge is ignored.

Total annual ground water recharge

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

Annual Extractable Ground Water Resources = (Total Annual Ground Water Recharge - Environmental Flow)

[If Environmental Flow is not estimated 5% to 10% of Total Annual Ground Water Recharge will be Environmental Flow]

Norms for estimation of recharge

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

4.2 Groundwater Extraction

The gross ground water extraction components for the estimation of most probable ground water extraction in a year which are required to be known in respect of command area, non-command area and poor ground water quality area of each ground water assessment unit are listed below:

a) Gross ground water extraction for 'Irrigation' during monsoon and non-monsoon seasons. They are used for computing recharge from irrigation water applied by ground water irrigation

b) Annual gross ground water extraction for 'Irrigation' and 'Industrial' use. It is used for computing net annual ground water availability for 'Future Use'

c) Annual gross ground water extraction for 'All Uses'. It is used for computing the current stage of ground water extraction.

d)Gross ground water extraction for 'All Uses' during monsoon season

e) It is used for computing rainfall recharge during monsoon season by the water table fluctuation method.

The gross yearly ground water extraction is to be calculated for Irrigation, Domestic and Industrial uses. The gross groundwater extraction would include the groundwater extraction from all existing groundwater structures during monsoon as well as during non-monsoon period. While the number of groundwater structures should preferably be based on latest well census, the average unit extraction from different types of structures should be based on specific studies or ad-hoc norms given in GEC 2015 report.

4.3 Stage of Ground Water Extraction & Categorization of Units

The stage of Groundwater Development is defined by,

Stage of Groundwater Extraction = $\frac{\text{Existing Gross Groundwater Extraction for all uses}}{\text{Annual Extractable Groundwater Resources}} \times 100$ (in %)

Categorization of areas for groundwater development

The units of assessment are categorized for groundwater development based on two criteria – a. stage of groundwater development, and b. long-term trend of pre and post monsoon water levels. Four categories are – **Safe** areas which have groundwater potential

for development; **Semi-critical** areas where cautious groundwater development is recommended; **Critical** areas; and **Over-exploited** areas where there should be intensive monitoring and evaluation and future groundwater development be linked with water conservation measures.

The criteria for categorization of assessment units are as follows:

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

Note: 'To be re-assessed' means that data is to be checked and reviewed. If the groundwater resource assessment and the trend of long-term water levels contradict each other, this anomalous situation requires a review of the ground water resource computation, as well as the reliability of water level data.

The long-term groundwater level data should preferably be for the period of 10 years. The significant rate of water level decline may be taken between 10 to 20 cm per year depending upon the local hydrogeological conditions.

4.4 Allocation of Groundwater Resource for Utilization

The net annual groundwater availability is to be apportioned between domestic, industrial and irrigation uses. Among these, as per the National Water Policy, 2002, requirement for domestic water supply is to be accorded priority. The requirement for domestic and industrial water supply is to be kept based on population as projected to the year 2025. The water available for irrigation use is obtained by deducting the allocation for domestic and industrial use, from the Annual Extractable Ground Water Resources.

4.5 Poor Quality Groundwater

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

4.6 Apportioning of Groundwater Assessment from Watershed to Development Unit

Where the assessment unit is a watershed, the groundwater assessment is converted in terms of an administrative unit such as block/ taluka/ mandal. Converting the volumetric resource into depth unit and then multiplying this depth with the corresponding area of the block do this.

4.7 Additional Potential Recharge

In shallow water table areas, particularly in discharge areas, rejected recharge would be considerable and water level fluctuation are subdued resulting in under-estimation of recharge component. In the area where the groundwater level is less than 5.0 m below ground level or in waterlogged areas, groundwater resources have to be estimated up to 5.0 m bgl only based on the following equation –

Potential groundwater recharge = (5-D) x A x Sp. Yield
Where,
D = depth to water table below ground surface in pre-monsoon season in shallow aquifers;
A = area of shallow water table zone.

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

CHAPTER 5

GROUND WATER RESOURCES ESTIMATION

5.1 Dynamic Groundwater Resource

The re-assessment of resources presented in this report is for the groundwater year 2021-22 as on March 2022. In the present report, the smallest administrative unit viz. block is considered for resources re-assessment except Churachandpur district. In case of Churachandpur district, Khuga Catchment area (or Khuga valley) covering an area of 321 sq km was considered as the assessment unit.

Area with more than 20% slope has been excluded for the recharge re-assessment. The total area considered for the resources estimation is 2559 sq.km, which covered Imphal West, Imphal East, Thoubal, Bishnupur and parts of Churachandpur district. The remaining of the four hill districts (i.e., Chandel, Senapati, Ukhrul and Tamenglong) were excluded for the recharge re-assessment. Nine CD blocks were considered for resources re-assessment during 2021-22.

Since the poor-quality groundwater is only a localized phenomenon, the block-wise poor-quality area have been taken as Nil. The sub-unit demarcation into command and non-command is not carried out since the data for the same are not available.

Groundwater extraction for domestic use has been estimated based on the number of different types of groundwater abstraction structures and their unit draft per year. The State Government authorities like Minor Irrigation Department, Water Resource Department, Agriculture Department, Soil & Water Conservation, MAHUD, PHED, IPD Wing-PHED, Manipur, MASTEC, DGM etc. provided the number of groundwater structures.

Groundwater extractions during monsoon and non-monsoon periods have been estimated separately by taking four months as monsoon and eight months as non-monsoon period. The annual unit groundwater extraction has been taken as 1.0 ham for shallow tube wells, considering the average discharge of wells as 15 m^3/hour with two hours pumpage per day.

Block-wise groundwater extraction for irrigation was estimated based on the number of structures as provided by Minor Irrigation Department, Manipur. The unit annual extraction has been taken as 3 hams as given in GEC 2015 for the states of some of the North Eastern States. Groundwater in the State is mostly used for domestic and irrigational purposes. Groundwater extraction for Industrial uses is in the nascent stage or negligible.

The details of canals have been collected from Irrigation and Flood Control Department, Govt of Manipur. All the canals are unlined and the canal seepage factor has been taken as 15 ham/day/million sq.m of wetted area. For estimating the recharge from surface water irrigation, details regarding various major and medium irrigation projects are collected from Irrigation and Flood Control Department, Govt of Manipur.

The return flow factor for surface water irrigation has been taken as 0.50 for paddy and 0.30 for non-paddy, which works out to be 0.374 for the assessment unit as the weighted average of return flow factor as a whole. Return flow factor for groundwater irrigation has been taken as 0.45 for paddy and 0.25 for non-paddy which works out to be 0.292 for the assessment unit as the weighted average of groundwater return flow factor a whole.

Recharge from tanks and ponds and Recharge from water conservation structure have been taken for non-monsoon. Norms recommended by GEC-2015 for Seepage from Tanks & Ponds is 1.4 mm / day. In the absence of water level data, the recharge from rainfall has been calculated using Rainfall Infiltration Factor. Following the norms recommended by GEC'97, Rainfall Infiltration Factor has been taken as 0.12 for Tertiary Sedimentary Formations. The natural discharge during non-monsoon period is taken as 10% since only RIF method is considered.

The population has been projected to 2025 based on decadal growth rate as given in Census of India, 2011. Categorization of assessment units are done based on stage of groundwater development only, since data on long term water level trend is absent.

The total annual groundwater recharge in the state of Manipur is 51780.41 Ham. The annual extractable ground water resource of the state is worked out as 46602.38 Ham. The existing current annual gross ground water extraction for all uses is 3704.61 Ham of which 1677.00 Ham is the current annual gross ground water extraction for irrigation use, 2003.61 Ham is the current gross ground water extraction for domestic use and 24 ham is the current gross ground water extraction for industrial uses. Annual ground water allocation for domestic use as on 2025 is 2022.18 Ham and Net ground water availability for future use is 42879.20 Ham. The over-all stage of groundwater extraction of Manipur is 7.95 %. As such all the assessment units falls under Safe category.

A comparison is made between the previous estimates as on 2020 and present re-estimation based on GEC 2015 as on March, 2022 and presented in tabular statement given in table.1.

Table 1 Comparisonbetween groundwater resources of Manipur as on March, 2020and as on March, 2022

S. N.	ITEM	Year of Estimation (2020)	Year of Estimation (2022)	COMPARISON BETWEEN DYNAMIC GW RESOURCES ESTIMATED IN 2020 & 2022
1	2	3	4	5(4 – 3)
1.	Annual Extractable Ground Water Resource (HAM)	46296.45	46602.38	305.93 (Increase)
2.	Existing Gross Extraction (HAM)	2368.23	3704.61	1336.38 (Increase)
A	Irrigation uses (HAM)	345	1677.00	1332 (Increase)
B	Domestic uses (HAM)	1999.23	2003.61	4.38 (Increase)
C	Industrial uses (HAM)	24.00	24.00	0
3.	Stage of GW Extraction (%)	5.12	7.95	2.83 (Increase)
4.	Provision for domestic (HAM)	2022.18	2022.18	0
5.	Provision for future use (HAM)	43905.27	42879.20	-1026.07 (decrease)

CHAPTER 6

AUTOMATIONOF ESTIMATION OF DYNAMIC GROUNDWATER RESOURCES

The computation of the resource estimation of Meghalaya for the year 2021-22 is done through IN-GRES software (India Ground Water Resource Estimation System).IN-GRES is the common portal to input, estimate, analyse, and access static and dynamic groundwater resources. India GEC system will take Data Input through Excel as well as through Forms, compute various Ground water components (recharge, draft, flux, etc.), classify assessment unit into appropriate categories, develop visibility dashboards for each of the components. System allows user to view the data in both MIS as well as GIS view. User can also download the reports in formats like CGWB, etc.

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

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

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

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

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

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

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

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

[N.B. Manipur has now become a 16-district state, after 7 new districts were formed by dividing the 9 existing districts vide Manipur Gazette Notification No.16/20/2016-R dated 8th December 2016.The newly-created districts are Tengnoupal, bifurcated from Channel district, Kampong from Ukhrul, Pherzawl from Churachandpur, Kangpokpi from Senapati and Jiribam from Imphal East districts. No district boundary map is prepared as on April 2018. A boundary commission has been set up in order to prepare the district boundary maps very soon.

The 9 (nine) nos. of assessment units used in the GWRA 2020 will remain the same in the GWRA of 2022 of Manipur. The decision was taken in the 1st sitting of State Level Committee (SLC) on GWRA 2022 of Manipur dated 17.03.2022 due to the fact that boundary demarcation forthe newly created districts of Manipur have not yet finalised till date.]

Annexure I : STATE LEVEL COMMITTEE ON GROUND WATER RESOURCES RE-ESTIMATION FOR MANIPUR AS ON MARCH 2022

GOVERNMENT OF MANIPUR
SECRETARIAT: MINOR IRRIGATION, MANIPUR

ORDERS BY THE GOVERNOR: MANIPUR
Imphal the 25th January 2022

No. **8/29/2019-MID (HKKP-GW)Pt-A):** The Governor of Manipur is pleased to re-constitute the State Level Committee (SLC) on Ground Water Resources Re-estimation for the Dynamic Ground Water Resources Assessment of Manipur for the Assessment year 2021-22 as on March 2022 comprising of the following members:

1. Secretary, Minor Irrigation, Govt. of Manipur	- Chairman
2. Chief Engineer, Water Resources Department, Manipur	- Member
3. Chief Engineer, Public Health Engineering Deptt, Manipur	- Member
4. Director, Department of Industries & Commerce, Manipur	- Member
5. Director, Department of Agriculture, Manipur	- Member
6. Director, MAHUD, Manipur	-Member
7. Director, Directorate of Horticulture & Soil Conservation, Manipur	- Member
8. General Manager, NABARD, Manipur	- Member
9. Chief Engineer, Minor Irrigation Department, Manipur	-Member & State Nodal Officer
10. Regional Director, Central Ground Water Board, NER, Guwahati	-Member Secretary

(2) The committee will be involved the estimation of Dynamic Ground Water Resources of Manipur as on March 2022 by using INDIA-Ground Water Resource Estimation System (IN-GRES) software/web-based application developed by CGWB in collaboration with IIT-Hyderabad. IN-GRES is based on the methodology and norms recommended by Ground water Resources Estimation Committee (GEC)-2015.
(3) In pursuance of Central Ground Water Board's letter **No.992/18/CGWB/NER/GWRE/2021** dated **27.12.2021**, the Chief Engineer, Minor Irrigation Department, Manipur is hereby designated as Nodal Officer for liaisoning with concerned state agencies for data acquisition and disseminating the same to Resources Estimation Cell, CGWB and IIT, Hyderabad
(3) The Committee will submit its report within the time limit fixed by the Government.
(4) Expenditure on account of TA/DA to official Members of the Committee will be met from the source from which they draw their salaries and that of non-official members will be borne by the State Nodal Department, i.e. Minor Irrigation Department, Manipur

By orders in the name of Governor,

(Arthur C. Worchuiyo)
Secretary to the Government of Manipur
Minor Irrigation

Copy to:-

1. Secretary to Governor of Manipur
2. Secretary to Chief Minister (MI), Manipur
3. Staff Officer to Chief Secretary, Government of Manipur
4. Chief Engineer, Water Resources Department, Manipur
5. Chief Engineer, Public Health Engineering Deptt, Manipur
6. Director, Department of Industries & Commerce, Manipur
7. Director, Department of Agriculture, Manipur
8. Director, MAHUD, Manipur
9. Director, Directorate of Horticulture & Soil Conservation, Manipur
10. General Manager, NABARD, Manipur
11. Chief Engineer, Minor Irrigation Department, Manipur
12. Regional Director, Central Ground Water Board, NER, Guwahati
13. Guard File

MINUTES OF THE MEETING OF THE STATE LEVEL COMMITTEE (SLC) ON DYNAMIC GROUND WATER RESOURCE ASSESSMENT OF MANIPUR AS ON MARCH 2022

Date: 9th September 2022 **Time: 11.30 AM.**

Venue: Office Chamber of Secretary (MI), Govt. of Manipur, New Secretariat

A meeting of State Level Committee (SLC) on Dynamic Ground Water Resource Assessment of Manipur as on March 2022 was convened on 9th September 2022 at 11.30 hrs in the office chamber of Secretary (MI), Govt. of Manipur, New Secretariat, Imphal.

The meeting was chaired by **C Arthur Worchuiyo, IAS, Secretary** (MI), Govt. of Manipur & Chairman of SLC. The Chairman of the SLC welcomed all the members of SLC present in the meeting. List of members attended in the meeting is enclosed as Annexure-I.

Sri Suresh Chandra Kapil, Regional Director & Member Secretary, SLC-GWRA welcomed all the representative members of the SLC. He highlighted that Ground Water Resources of Manipur has been carried out jointly by Central Ground Water Board, NER and Minor Irrigation Department, Manipur (State Nodal Department) in coordination with other members/departments of SLC.

Member Secretary, SLC briefed about computation of dynamic ground water resources of Manipu through IN-GRES software. Groundwater Resources Estimation System (IN-GRES)" is a software/web-based application developed by CGWB in collaboration with Vassar Lab, IIT-Hyderabad.

The member Secretary informed that earlier this dynamic groundwater resource estimation work was done manually throughout the country. Later it was observed that some minor computational error might have occurred in calculating the resource, as the process of dynamic groundwater resource estimation is a complicated and lengthy. So, to overcome this human error, Ministry of Jal Shakti in collaboration with IIT Hyderabad developed the software IN-GRES (INDIA GROUNDWATER RESOURCE ESTIATION SOFTWARE). He also emphasized that socio-economic condition of the state may be enhanced through sustainable development of groundwater by the stakeholders.

With due permission of the Chair, presentation of the Dynamic Groundwater Resources of Manipur as on March 2022 was made by Ms H V Sophia Kay, CGWB and Dr. S S Singh, Scientist-D & OIC, GWRA, NER along with State Nodal Officer Sri R K Dipankar Salam, Chief Engineer MID, Manipur.

With due permission of the Chair, committee members of SLC discussed in detail on the methodology of resource estimation, various factors utilized / considered as per norm or otherwise, constrains of non-availability of various field data, source of various field data utilized for resource calculation etc. SLC has suggested for inclusion of rechargeable area in hill districts of Manipur. Groundwater extraction structures for domestic use to be shared by PHED, Manipur for updating in the resource estimation. SLC decided for initiation towards constitution of State Ground Water Authority by Minor irrigation Department, Manipur.

After thorough discussion all the members of the State Level Committee (SLC) has agreed and accepted upon the figures in the draft report of Dynamic Ground Water Resources of Manipur for the Assessment Year 2021-22 as on March 2022.

9/9/2022

Suresh Chandra Kapil
Regional Director, CGWB NER
& Member Secretary, SLC

9/9/22

C Arthur Worchuiyo, IAS
Secretary (MI), Govt. of Manipur
& Chairman, SLC

ANNEXURE I

LIST OF MEMBERS PRESENT IN THE MEETING ON DYNAMIC GROUND WATER RESOURCES ASSESSMENT OF MANIPUR FOR THE ASSESSMENT YEAR 2021-22 AS ON MARCH 2022

Date:9th September 2022 **Time: 11:30 AM.**

Venue: Office Chamber of Secretary (MI), Govt. of Manipur, New Secretariat

Sl. No.	Name & Designation	Department	Contact No.	Email Mail	Signature
1	C Arthur Worchuiyo, IAS, Secretary (MI), Govt. of Manipur & Chairman of SLC	MI, Manipur	+91-9436891081	c_arthur_w@yahoo.com	
2	Sri Suresh Chandra Kapil, Regional Director & Member Secretary, SLC-GWRA	CGWB NER Guwahati	+91-9459397465	rdner-cgwb@nic.in	
3	Dr. S. S. Singh Sc-D(HG)	CGWB NER Shp	9435546102	css153@rediffmail.com	
4	Dorendra Rajkumar S.E.	PHED	8257806849	dorendraed@gmail.com	
5	L. Ratankumar Singh Geologist	Trade, Com & Ind.	9862590526		
6	L. Raghumani Singh Geologist	Trade Com & Ind	8794143206	laishramraghumani@gmail.com	
7	Mayank Kumar Sinha (AM, NABARD)	NABARD RO, Manipur	9304847896	mayank.sinha@nabard.org	
8	S. Betamoy Sharma	MID	8132867478	betamoy.sharma@manipur.gov.in	
9	Rohit Thamthem	WRD	7085299763	rohitathamthem3@gmail.com	
10	Chitan Chongthan	WRD	7005402493	chongthan0074@gmail.com	

11	P. Ramu Sir	Horti & Soil Consv.	9861295 1025	ramusunree@g.mail.com	
12	K. Chitan Singh, EE	MID	70850584 37	chitslaishram@gmail.cam	
13	Letkhotinthang Haokip . EE	MID	7005281 714	haokgyp2@outlook.com	
14	Yasser Khan JD/DS	MAHUD	8974642496	yasser.khan@gov.in	
15	Nirmal R.K.	Agri.	9862587942		
16	R.K. Dipankar Salam C.E/MID	M.I.D	8131883961		
17					
18					
19					
20					
21					
22					
23					
24					

TABLES ON COMPUTATION OF GROUND WATER RESOURCES ESTIMATION AS ON MARCH, 2022, MANIPUR (Assessment Year 2021-22)

Annexure II A

GENERAL DESCRIPTION OF THE GROUND WATER ASSESSMENT UNIT OF MANIPUR (AS ON MARCH, 2022)

Sl. No.	District	Block (CD Block)	Total Geographical Area (ha)	Hilly Area (ha)[more than 20% slope	Poor GW Quality area(ha)	Area suitable for GW Recharge(ha)
1	Imphal West	Imphal West I CD Block	28100	0	0	28100
2		Imphal West II CD Block	23800	0	0	23800
3	**Total**		**51900**	**0**	**0**	**51900**
4	Imphal East	Imphal East I CD Block (Imphal Valley)	23290	0	0	23290
5		Imphal East II CD Block (Imphal Valley)	24410	0	0	24410
6		Imphal East II CD Block (Jiribam Part)	23200	0	0	23200
6	**Total**		**70900**	**0**	**0**	**70900**
7	Thoubal	Thoubal CD Block	32400	0	0	32400
8		Kakching CD Block	19000	0	0	19000
9	**Total**		**51400**	**0**	**0**	**51400**
10	Bishnupur	Bishnupur CD Block	28000	0	0	28000
11		Moirang CD Block	21600	0	0	21600
12	**Total**		**49600**	0	0	**49600**
13	Churachandpur	Khuga Catchment Area	457000	424900	0	32100
14	**Total**		**457000**	**424900**	**0**	**32100**
15	**Chandel**	Hilly Area	**331300**	331300	0	0
16	**Senapati**	Hilly Area	**327100**	327100	0	0
17	**Tamenglong**	Hilly Area	**439100**	439100	0	0
18	**Ukhrul**	Hilly Area	**454400**	454400	0	0
15	**Grand Total**		**2232700**	**1976800**	0	**255900**
a	Total area in hectares of the 'Ground Water Assessment Unit'					255900
b	Area in hectares of the **'Hilly Area'**					0
c	Area in hectares of the portion of the Ground Water Assessment Unit in which ground water recharge is possible					255900
d	Area in hectares of the 'Poor Ground water Quality Area'					0
e	Quality Hazard (Salinity/ Arsenic/Fluoride/Others)					0
f	Area in hectares ofthe 'Command Area'					0
g	Area in hectares of the 'Non - command Area'					255900

[Source: Statistical Handbook of Manipur 2019, Govt of Manipur& Economic Survey 2020-21, Manipur]

** In Churachandpur district details of relevant block level data of the various parameters from the State Govt. are not available*

Annexure II B: GENERAL DESCRIPTION OF THE GROUND WATER ASSESSMENT UNIT OF MANIPUR (as on March, 2022)

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
IMPHAL EAST	IMPHAL EAST II	24410	0	0	24410	0	24410	20	0.12
IMPHAL EAST	IMPHAL EAST I	23290	0	0	23290	0	23290	23	0.12
UKHRUL	UKHRUL CENTRAL	119800	119800	0	0	0	0	0	0
TAMENGLONG	TAMENGLONG	85800	85800	0	0	0	0	0	0
SENAPATI	MAO-MARAM	103700	103700	0	0	0	0	0	0
UKHRUL	UKHRUL SOUTH	55500	55500	0	0	0	0	0	0
IMPHAL WEST	IMPHAL WEST II	23800	0	0	23800	0	23800	20	0.16
UKHRUL	UKHRUL NORTH	100800	100800	0	0	0	0	0	0
CHURACHANPUR	CHURACHANDPUR	59000	26900	0	32100	0	32100	30	0.16
BISHNUPUR	MOIRANG	21600	0	0	21600	0	21600	20	0.16
CHURACHANPUR	THANLON	106300	106300	0	0	0	0	0	0
UKHRUL	PHUNGYAR PHAISAT	67900	67900	0	0	0	0	0	0
THOUBAL	KAKCHING	19000	0	0	19000	0	19000	30	0.16
SENAPATI	SADAR HILLS EAST	93300	93300	0	0	0	0	0	0
CHURACHANPUR	CHURACHANDPUR NORTH	82500	82500	0	0	0	0	0	0
TAMENGLONG	NUNGBA	107600	107600	0	0	0	0	0	0
CHURACHANPUR	TIPAIMUKH	111500	111500	0	0	0	0	0	0
UKHRUL	KAMJONG	110400	110400	0	0	0	0	0	0
CHANDEL	TENGNOUPAL	121300	121300	0	0	0	0	0	0
CHANDEL	CHAKPIKARONG	141300	141300	0	0	0	0	0	0
SENAPATI	SADAR HILLS WEST	76500	76500	0	0	0	0	0	0
IMPHAL EAST	IMPHAL EAST II	23200	0	0	23200	0	23200	20	0.12
TAMENGLONG	TAMENGLONG WEST	126300	126300	0	0	0	0	0	0
CHURACHANPUR	SINGNGAT	97700	97700	0	0	0	0	0	0
TAMENGLONG	TAMENGLONG NORTH	119400	119400	0	0	0	0	0	0
SENAPATI	PAOMATA	53600	53600	0	0	0	0	0	0
CHANDEL	CHANDEL	68700	68700	0	0	0	0	0	0
THOUBAL	THOUBAL	32400	0	0	32400	0	32400	25	0.16
BISHNUPUR	BISHNUPUR	28000	0	0	28000	0	28000	27	0.16
IMPHAL WEST	IMPHAL WEST I	28100	0	0	28100	0	28100	25	0.16

ANNEXURE III A

DATA VARIABLES (INGRES TABLE) USED IN DYNAMIC GROUND WATER RESOURCES OF MANIPUR (as on March, 2022)

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	IMPHAL EAST	IMPHAL EAST II	Non-Command	2021-2022	566.23	1398.2	593.73	318.94
2	IMPHAL EAST	IMPHAL EAST II	Non Command	2018-2019	783.4	1398.2	209.24	318.94
3	IMPHAL EAST	IMPHAL EAST II	Non Command	2020-2021	759.62	1398.2	280.2	318.94
4	IMPHAL EAST	IMPHAL EAST II	Non Command	2017-2018	1294.3	1398.2	467.6	318.94
5	IMPHAL EAST	IMPHAL EAST II	Non-Command	2019-2020	689.62	1398.2	307.67	318.94
6	IMPHAL EAST	IMPHAL EAST I	Non-Command	2021-2022	566.23	1398.2	593.73	318.94
7	IMPHAL EAST	IMPHAL EAST I	Non-Command	2018-2019	783.4	1398.2	209.24	318.94
8	IMPHAL EAST	IMPHAL EAST I	Non-Command	2020-2021	759.62	1398.2	280.2	318.94
9	IMPHAL EAST	IMPHAL EAST I	Non-Command	2017-2018	1294.3	1398.2	467.6	318.94
10	IMPHAL EAST	IMPHAL EAST I	Non-Command	2019-2020	689.62	1398.2	307.67	318.94
11	IMPHAL WEST	IMPHAL WEST II	Non-Command	2021-2022	984.86	1011.1	766.39	373.78
12	IMPHAL WEST	IMPHAL WEST II	Non-Command	2018-2019	1299.2	1011.1	288.94	373.78
13	IMPHAL WEST	IMPHAL WEST II	Non-Command	2020-2021	1054.54	1054.54	401.71	401.71
14	IMPHAL WEST	IMPHAL WEST II	Non-Command	2017-2018	2933.6	1011.1	933.5	373.78
15	IMPHAL WEST	IMPHAL WEST II	Non-Command	2019-2020	982.79	1011.1	345.43	373.78
16	CHURACHANPUR	CHURACHANDPUR	Non-Command	2021-2022	855.74	1741.2	725.03	392.26
17	CHURACHANPUR	CHURACHANDPUR	Non-Command	2018-2019	990.98	1741.2	252.56	392.26
18	CHURACHANPUR	CHURACHANDPUR	Non-Command	2020-2021	935.68	935.68	360.88	360.88
19	CHURACHANPUR	CHURACHANDPUR	Non-Command	2017-2018	1597.43	1741.2	552.79	392.26
20	CHURACHANPUR	CHURACHANDPUR	Non-Command	2019-2020	668.81	1741.2	364.05	392.26
21	BISHNUPUR	MOIRANG	Non-Command	2021-2022	568.21	1608.3	635.06	379.29
22	BISHNUPUR	MOIRANG	Non-Command	2018-2019	808.81	1608.3	194.02	379.29

23	BISHNUPUR	MOIRANG	Non-Command	2020-2021	709.72	1608.3	297.32	379.29
24	BISHNUPUR	MOIRANG	Non-Command	2017-2018	1318.34	1608.3	475.36	379.29
25	BISHNUPUR	MOIRANG	Non-Command	2019-2020	630.1	1608.3	333.18	379.29
26	THOUBAL	KAKCHING	Non-Command	2021-2022	557.78	940.3	624.72	336.48
27	THOUBAL	KAKCHING	Non-Command	2018-2019	809.3	940.3	194.16	336.48
28	THOUBAL	KAKCHING	Non-Command	2020-2021	711.6	940.3	290.09	336.48
29	THOUBAL	KAKCHING	Non-Command	2017-2018	1293.22	940.3	468.45	336.48
30	THOUBAL	KAKCHING	Non-Command	2019-2020	629.47	940.3	335.82	336.48
31	IMPHAL EAST	IMPHAL EAST II	Non-Command	2021-2022	566.23	1398.2	593.73	318.94
32	IMPHAL EAST	IMPHAL EAST II	Non-Command	2018-2019	783.4	1398.2	209.24	318.94
33	IMPHAL EAST	IMPHAL EAST II	Non-Command	2020-2021	759.62	1398.2	280.2	318.94
34	IMPHAL EAST	IMPHAL EAST II	Non-Command	2017-2018	1294.3	1398.2	467.6	318.94
35	IMPHAL EAST	IMPHAL EAST II	Non-Command	2019-2020	689.62	1398.2	307.67	318.94
36	THOUBAL	THOUBAL	Non-Command	2021-2022	557.78	940.3	624.72	336.48
37	THOUBAL	THOUBAL	Non-Command	2018-2019	809.3	940.3	194.16	336.48
38	THOUBAL	THOUBAL	Non-Command	2020-2021	711.6	940.3	290.09	336.48
39	THOUBAL	THOUBAL	Non-Command	2017-2018	1293.22	940.3	468.45	336.48
40	THOUBAL	THOUBAL	Non-Command	2019-2020	629.47	940.3	335.82	336.48
41	BISHNUPUR	BISHNUPUR	Non-Command	2021-2022	568.21	1608.3	635.06	379.29
42	BISHNUPUR	BISHNUPUR	Non-Command	2018-2019	808.81	1608.3	194.02	379.29
43	BISHNUPUR	BISHNUPUR	Non-Command	2020-2021	709.72	1608.3	297.32	379.29
44	BISHNUPUR	BISHNUPUR	Non-Command	2017-2018	1318.34	1608.3	475.36	379.29
45	BISHNUPUR	BISHNUPUR	Non-Command	2019-2020	630.1	1608.3	333.18	379.29
46	IMPHAL WEST	IMPHAL WEST I	Non-Command	2021-2022	988.86	1011.1	766.39	373.78
47	IMPHAL WEST	IMPHAL WEST I	Non-Command	2018-2019	1299.2	1011.1	288.94	373.78
48	IMPHAL WEST	IMPHAL WEST I	Non-Command	2020-2021	1054.54	1054.54	401.71	401.71
49	IMPHAL WEST	IMPHAL WEST I	Non-Command	2017-2018	2933.6	1011.1	933.5	373.78
50	IMPHAL WEST	IMPHAL WEST I	Non-Command	2019-2020	982.79	1011.1	345.43	373.78

ANNEXURE IV A

ASSESSMENT UNIT (BLOCK) WISE DYNAMIC GROUND WATER RESOURCES OF MANIPUR (as on March, 2022)

Sl. No	Assessment Unit Name	Recharge from Rainfall-Monsoon Season	Recharge from Other Sources-Monsoon Season	Recharge from Rainfall-Non-Monsoon Season	Recharge from Other Sources-Non-Monsoon Season	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)
	(1)	(2)	(3)	(4)	(5)	(6) = [2+3+4+5]	(7)	(8) = [6 - 7]	(9)	(10)	(11)	(12) = [9+10+ 11]	(13)	(14) [8-12]	(15) [14/8] * 100
1	BISHNUPUR	5403.89	0.04	1274.41	56.73	6735.07	673.507	6,061.56	222	0	136.73	358.73	137.42	5,702.20	**5.92**
2	MOIRANG	4168.71	0.02	983.12	26.88	5178.73	517.873	4,660.86	105	0	144.31	249.31	153.51	4,402.35	**5.35**
3	CHURACHANDPUR	6707.1	0	1510.99	69	8287.09	828.709	7,458.38	270	0	191.07	461.07	192.05	6,996.33	**6.18**
4	IMPHAL EAST I	3907.69	25.74	891.37	165.43	4990.23	499.023	4,491.21	444	0	362.21	806.21	364.02	3,683.19	**17.95**
5	IMPHAL EAST II	7988.2	37.78	1822.17	104.23	9952.38	995.238	8,957.14	111	18	138.04	267.04	138.73	8,689.41	**2.98**
6	IMPHAL WEST I	3409.43	0.01	1260.39	33.74	4703.57	470.357	4,233.21	126	6	320.39	452.39	322.01	3,779.12	**10.69**
7	IMPHAL WEST II	2887.7	0.01	1067.52	40.68	3995.91	399.591	3,596.32	159	0	247.8	406.8	249.05	2,227.50	**11.31**
8	KAKCHING	2143.88	0.01	767.17	41.42	2952.48	295.248	2,657.23	162	0	148.6	310.6	149.35	2,345.88	**11.69**
9	THOUBAL	3655.89	0.01	1308.23	20.85	4984.98	498.498	4,486.48	78	0	314.46	392.46	316.04	4,092.45	**8.75**
State Total (in HAM)		**40272.49**	**63.62**	**10885.37**	**558.96**	**51780.44**	**5178.044**	**46,602.40**	**1677**	**24**	**2003.61**	**3704.61**	**2022.18**	**41,918.43**	**7.95**
State Total (in BCM)		**0.402725**	**0.000636**	**0.108854**	**0.00559**	**0.517804**	**0.05178**	**0.46602396**	**0.01677**	**0.00024**	**0.020036**	**0.0370461**	**0.020222**	**0.4191843**	

ANNEXURE IV B

DISTRICT WISE DYNAMIC GROUND WATER RESOURCES OF MANIPUR,2022 (in Ham)

S. No.	Name of District	Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction				Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)
		Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge			Irrigation	Industrial	Domestic	Total			
		Recharge from rainfall	Recharge from other sources	Recharge from rainfall	Recharge from other sources										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Bishnupur	9572.6	0.06	2257.53	83.61	11913.8	1191.38	10722.42	327	0	281.04	608.04	290.93	10104.55	5.67
2	Churachandpur	6707.1	0	1510.99	69	8287.09	828.709	7,458.38	270	0	191.07	461.07	192.05	6,996.33	6.18
3	Imphal East	11895.89	63.52	2713.54	269.66	14942.61	1494.261	13,448.35	555	18	500.25	1073.25	502.75	12,372.60	7.98
4	Imphal West	6297.13	0.02	2327.91	74.42	8699.48	869.948	7829.532	285	6	568.19	859.19	571.06	6006.62	10.97
5	Thoubal	5799.77	0.02	2075.4	62.27	7937.46	793.746	7143.714	240	0	463.06	703.06	465.39	6438.33	9.84
6	**Total (Ham)**	**74745.21**	**127.22**	**19695.34**	**1055.65**	**103560.9**	**10356.09**	**93204.792**	**3114**	**48**	**3544.16**	**7409.22**	**3578.97**	**77398.53**	**7.95**

ANNEXUREV A

PARAMETERS USED IN THE ASSESSMENT OF DYNAMIC GROUND WATER RESOURCES OF MANIPUR

(As on March, 2022)

Sl. No.	Assessment Unit/Block	Sub-unit (Command/ poor quality)	Specific Yield *(in fraction)*		Rainfall Infiltration Factor *(in fraction)*		Season-wise Unit Extraction *(ha m)*						
							Structure	Irrigation		Domestic		Industrial	
			Principal &Major Aquifer	Value	Principal &Major Aquifer	Value		Monsoon	Non-monsoon	Monsoon	Non-monsoon	Monsoon	Non-monsoon
1	Imphal West-I	Non-Command	Quaternary Alluvium Unconsolidated	16	Quaternary Alluvium Unconsolidated -	0.12	STW	1.0	2.0	0.33	0.67	2.0	4.0
2	Imphal West-II			16		0.12	STW	1.0	2.0	0.33	0.67	N.A	N. A
3	Imphal East-I			16		0.12	STW	1.0	2.0	0.33	0.67	2.0	4.0
4	Imphal East-II			16		0.12	STW	1.0	2.0	0.33	0.67	N. A	N.A
5	Thoubal			16		0.12	STW	1.0	2.0	0.33	0.67	N. A	N. A
6	Kakching			16		0.12	STW	1.0	2.0	0.33	0.67	N. A	N.A
7	Bishnupur			16		0.12	STW	1.0	2.0	0.33	0.67	N. A	N. A
8	Moirang			16						0.33			
9	Churachandpur* (Khuga catchment area or Khuga Valley is taken as Assessment Unit)			16		0.12	STW	1.0	2.0	0.33	0.67	N. A	N. A

[In Churachandpur district details of relevant block level data of the various parameters from the State Govt. arenot available [Source: Statistical Handbook of Manipur 2019 and Economic Survey 2020-21, Manipur, Govt of Manipur & Minor Irrigation Department, Lamphelpat, Govt.of Manipur]*

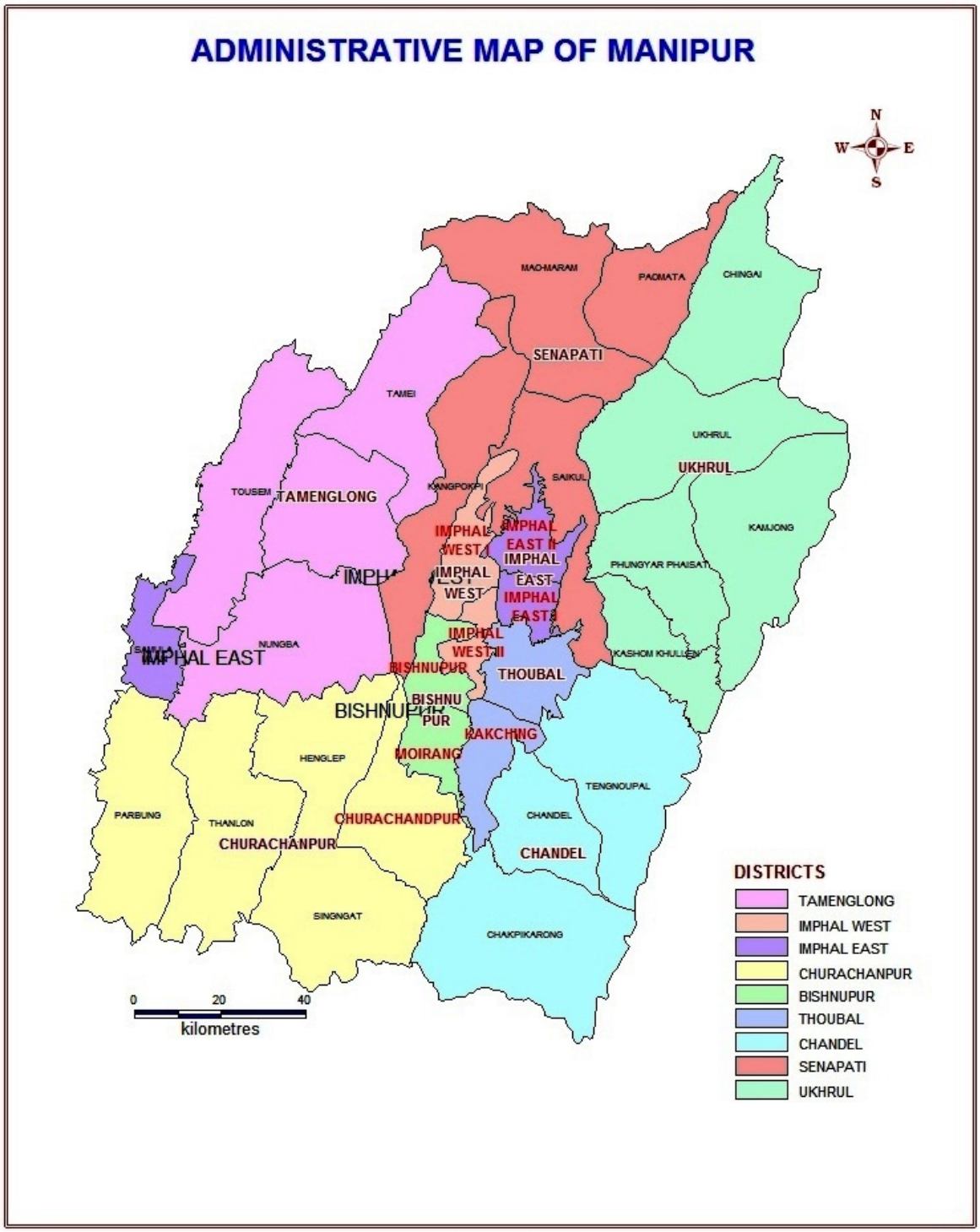

Fig.1. Map showing administrative base map of Manipur

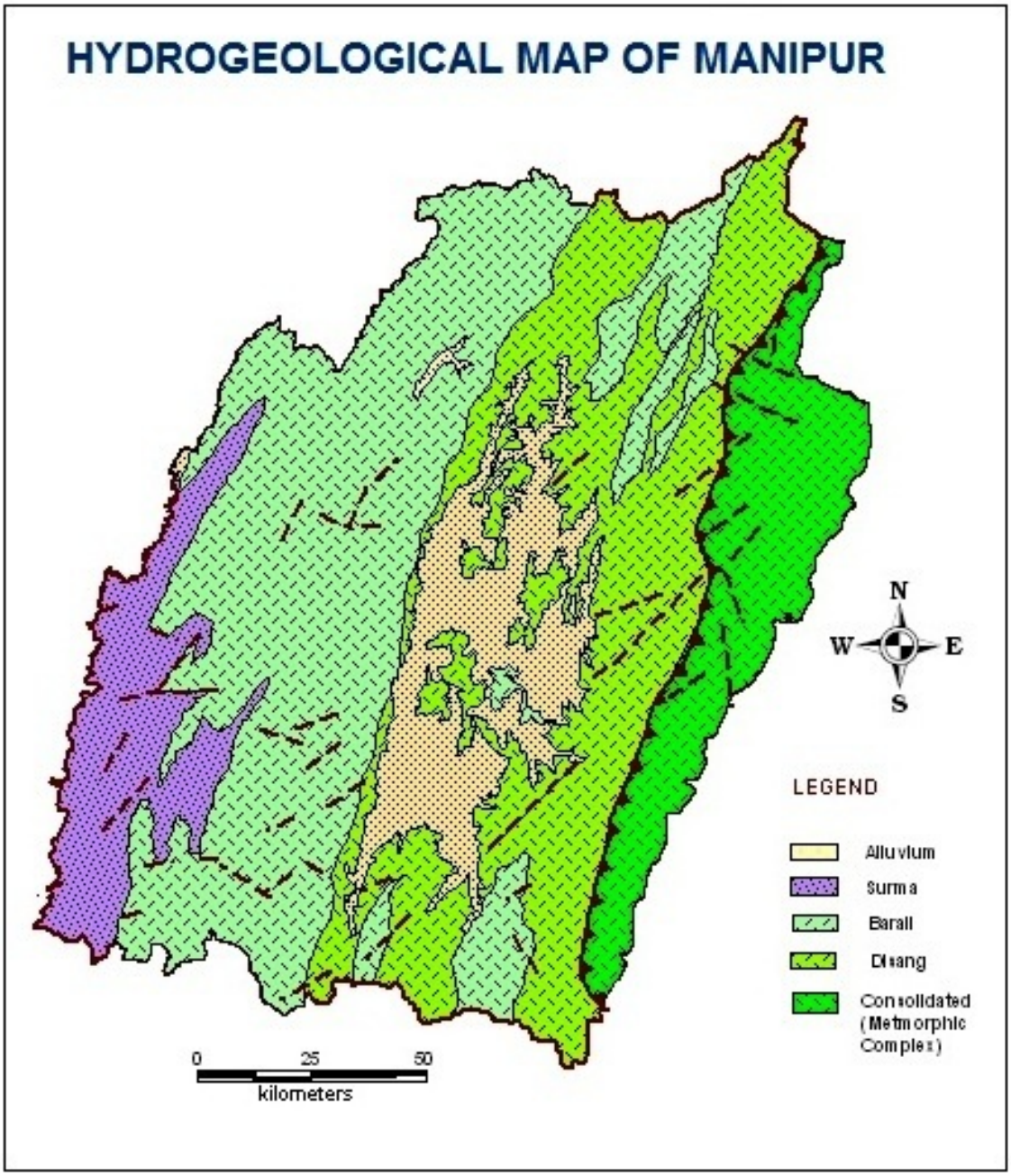

Fig.2. Map showing Hydrogeology of Manipur

PLATE-III

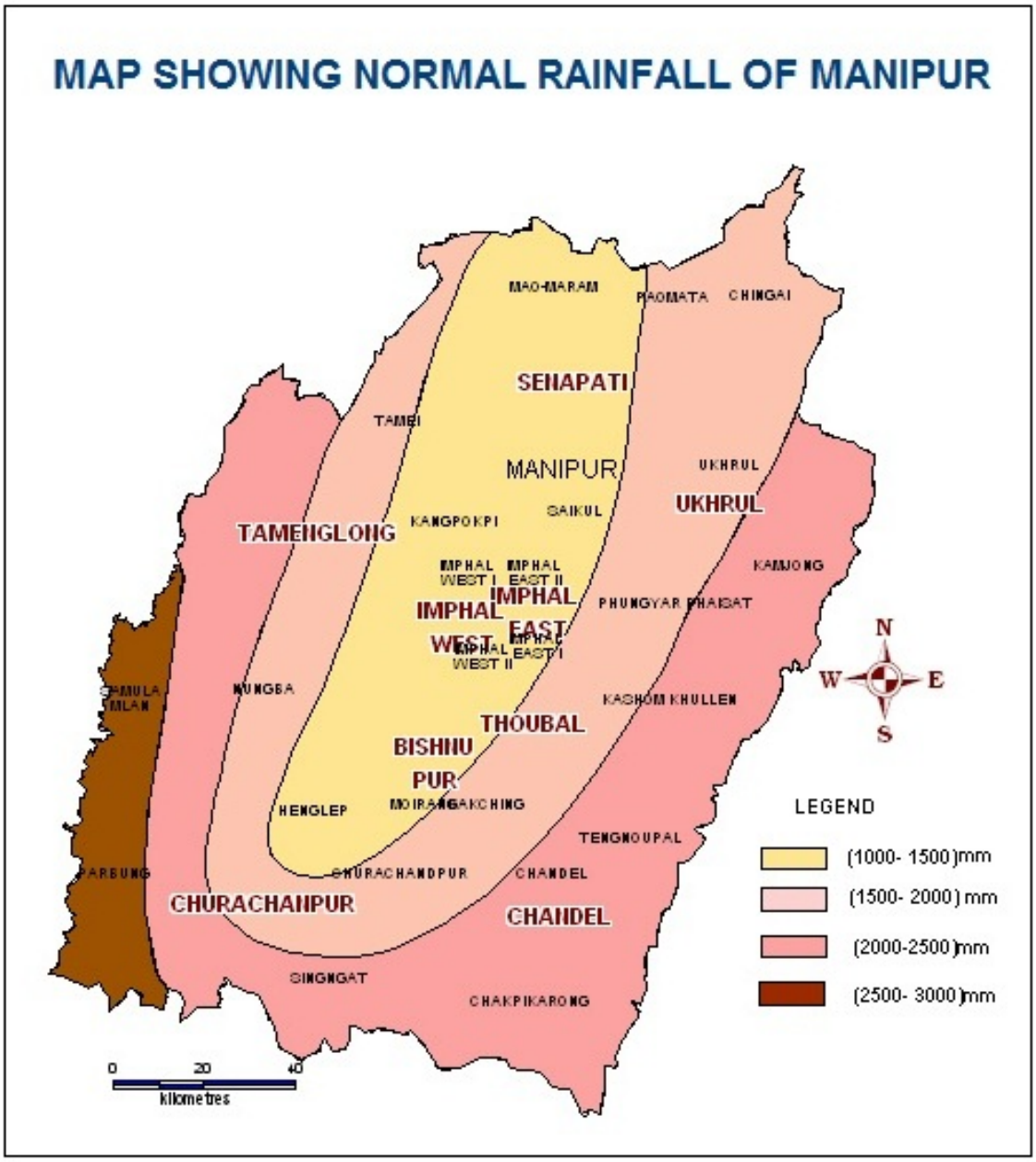

Fig.3. Map showing normal rainfall of Manipur as on March, 2022 (Rainfall data after IMD, Hydromel station Data, Manipur)

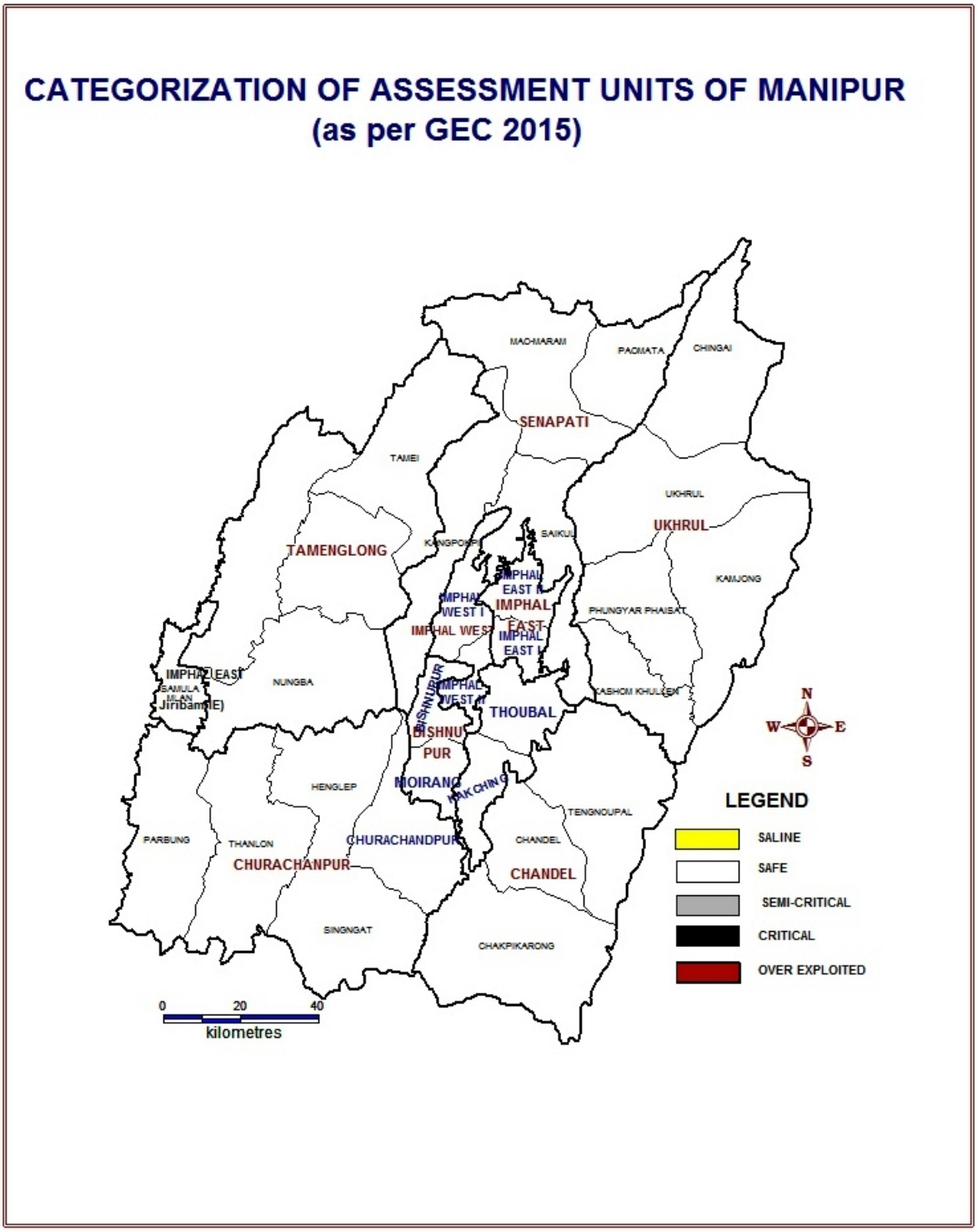

Fig.4. Categorization of Assessment Units of Manipur State as on March 2022