DYNAMIC GROUND WATER RESOURCES OF JAMMU AND KASHMIR, 2024

Central Ground Water Board

Department of Water Resources,

River Development & Ganga Rejuvenation

Ministry of Jal Shakti

Government of India

North western Himalayan Region

JAMMU

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प्रमोद कुमार त्रिपाठी
सदस्य
Pramod Kumar Tripathi
Member

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन,
नदी विकास और गंगा संरक्षण विभाग
केन्द्रीय भूमि जल बोर्ड
Government of India
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Department of Water Resources,
River Development & Ganga Rejuvention
Central Ground Water Board

MESSAGE

Water is essential for life on Earth. Rising demand for freshwater driven by population growth, shifting agriculture, and industrial expansion has strained the groundwater resources, exacerbated by surface water pollution leading to widespread groundwater depletion. Groundwater supports irrigation, domestic, and industrial needs, but its unregulated extraction fuels sectoral conflicts. Sustainable development in India requires effective groundwater management, grounded in quantitative assessments of aquifers and flow dynamics.

Assessing the availability and use of natural resources is crucial for developing strategies that promote sustainable development and management. Population growth, rapid urbanization, and industrialization have led to declining groundwater levels, aquifer desaturation, and water quality deterioration in some areas, while causing rising groundwater levels and waterlogging in others. This study combines fieldwork, advanced analysis, and thorough interpretation to ensure accurate and relevant findings. The results are vital for policymakers, stakeholders, and the general public.

The report on Ground Water Resources Estimation 2024 reveals that the overall stage of groundwater development in Union Territory is 32.28%. The district wise stage of groundwater development in in Jammu division ranges between 7.77% in Rajouri district and 33.28% in Ramban district, whereas, in Kashmir division it ranges between 11.53% Bandipora district and 63.24% Srinagar (Urban Agglomerates)

I extend my sincere appreciation to the officers of Central Ground Water Board, (NWHR), Jammu and officers of Jal Shakti Department, Government of Jammu and Kashmir (UT), for their dedicated efforts for ground water resource estimation and the preparation of this report. I am confident that this report will be highly beneficial to a wide range of stakeholders, including academicians, administrators, and the general public, and will serve as a crucial tool for the effective planning and management of groundwater resources in J&K.

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(P. K. Tripathi)
Member (N & W)

Faridabad

Bhujal Bhawan, NH-IV, Faridabad-121001 (Haryana) | Tel : 0129-2477120
E-mail : mnorth-cgwb@gov.in | Website : www.cgwb.gov.in

भारत सरकार
जल शक्ति मंत्रालय
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उत्तर पश्चिमी हिमालय क्षेत्र
जम्मू

Government of India
Ministry Of Jal Shakti
Department Of WR, RD & GR
Central Ground Water Board
North Western Himalayan Region
Jammu

Foreword

For efficient management and development of Groundwater Resources, it is imperative to have a reliable estimation of Groundwater Resources. Groundwater Resource Estimation - 2024 has been attempted with Development block as assessment Unit. Out of 285 Development blocks, 149 blocks have been assessed, remaining being hilly with slope of more than 20% have **not** been assessed. Srinagar Urban Agglomerate has been assessed by merging all four blocks/ municipal area of Srinagar and parts blocks from surrounding districts as, Ganderbal, Bandipora, Baramulla, Badgam and Pulwama. The report gives details on Total Annual Replenishable Ground water Resources, its present draft, and scope for future development in Union Territory of Jammu and Kashmir.

As per Ground Water Resources Estimation 2024, the overall stage of groundwater development in Union Territory is 32.28%. The block wise stage of groundwater development in in Jammu division ranges between 7.77% in Rajouri district and 33.28%in Ramban district. Whereas, in Kashmir division it ranges between 11.53 % in Bandipora district and 63.24% in Srinagar UA.

The efforts made by officers of Central Ground Water Board, NWHR, Jammu, Sh. Rayees Ahmed Pir, Scientist-B, Naresh Singh Barti, (AHG) and Gulshan Kumar (STA-GP) along with officers of Jal Shakti Department (J&K) are worth mentioning as it helped to complete the groundwater resource estimation assignment well in time.

The report is repository of useful information for all planners and user agencies engaged in the development and management of groundwater resources in Union Territory of Jammu and Kashmir, with hope that Report would be utilized fully for real-time management of groundwater resources.

M. L. Angurala
Head of Office

DYNAMIC GROUND WATER RESOURCES OF JAMMU AND KASHMIR, 2024

Contributors

Data analysis and Report preparation:	Naresh Singh Barti (Asst. Hydrogeologist) Rayees Ahmad Pir (Scientist–B)
Supervision:	Rayees Ahmad Pir (Scientist–B)
Technical Guidance:	Mohinder Lal Angurala (Head of Office)

EXECUTIVE SUMMARY

The Union Territory of Jammu & Kashmir comprises two regions, Jammu and Kashmir, each with 10 districts representing distinct groundwater regimes. In the Jammu Region, groundwater occurs in the outer plains, extending from Munawar Tawi in the northwest to the River Ravi in the southeast. It is found in piedmont deposits of upper Pleistocene to Recent age, consisting of unconsolidated sediments forming terraces and coalescent alluvial fans developed by streams from the Siwalik Hills. Isolated valleys in the middle Himalayas also contain groundwater in valley fill deposits under unconfined conditions.

The Kashmir valley, covering 5600 sq km, is occupied by Karewas — thick deposits of sand, silt, and clay interspersed with glacial boulder beds. The fine to very fine-grained sands show lateral facies variation, with sediments reaching an aggregate thickness of 2500-3000 m. Groundwater in the Karewas occurs under both confined and unconfined conditions.

The Outer Plains of Jammu span 3000 sq km between the Ravi River in the east and Munawar Tawi in the west. These plains consist of semi-consolidated sediments, ranging from boulders to gravel in a clayey matrix with alternating clay bands. Recent alluvium is found along river courses as terraces and coalesced alluvial fans. The Kandi belt, consisting of fan deposits below the Siwalik Hills, features steep slopes and heterogeneous sediments, with groundwater occurring at deep, unconfined levels. In contrast, the Sirowal belt has persistent near-surface clay beds, causing swampy or waterlogged conditions.

Jammu & Kashmir is divided into 20 districts and further subdivided into 285 development blocks, mostly characterized by high mountains and steep slopes. According to GEC-2015 guidelines, groundwater resources have been assessed in 149 out of 285 blocks, including Srinagar Urban Area, which spans parts of Srinagar, Ganderbal, Baramulla, Budgam, Pulwama, and Bandipora districts.

The total annual groundwater recharge in J&K is estimated at 2.55 BCM, with annual extractable groundwater resources at 2.30 BCM. Current annual groundwater extraction is 0.51 BCM, resulting in a Stage of Groundwater Extraction of 22.28%. All 149 assessed units, including the Srinagar Urban Agglomerate, are categorized as 'Safe.'

Compared to the 2023 assessment, total annual groundwater recharge and extractable groundwater resources have decreased from 4.94 BCM to 2.55 BCM and 4.46 BCM to 2.30 BCM, respectively. Annual groundwater extraction has reduced from 1.08 BCM to 0.51 BCM. The Stage of Groundwater Extraction has slightly increased from 24.20% to 22.28%, due to a shift from district-level to block-level assessments under GWRE-2024, incorporating more detailed aquifer data. This resulted in most assessment units falling in less permeable zones, reducing groundwater recharge and extraction estimates. Notably, the Stage of Groundwater Extraction in the Srinagar Urban Agglomerate improved from 78.21% (Semi-critical) in 2023 to 63.23% (Safe) in 2024. In conclusion, while Jammu & Kashmir's groundwater resources are currently categorized as ‘Safe,’ the decreasing trends in recharge and extraction emphasize the need for careful water management to maintain long-term sustainability.

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DYNAMIC GROUND WATER RESOURCES OF UT OF JAMMU & KASHMIR, 2024

AT A GLANCE

1.	Total Annual Ground Water Recharge	255192.53 ham
2.	Annual Extractable Ground Water Resources	230329.69 ham
3.	Annual Ground Water Extraction	51310.56 ham
4.	Stage of Ground Water Extraction	22.28 %

CATEGORIZATION OF ASSESSMENT UNITS

(Blocks/ Mandals/ Taluks)

Sl.No	**Category**	**Number of Assessment Units**		**Recharge worthy Area**		**Annual Extractable Ground Water Resource**	
		Number	**%**	**in lakh sq. km**	%	**(in bcm)**	%
1	Safe	149	100	8571.96	100	2.30	100
2	Semi Critical	-	-	-	-	-	-
3	Critical	-	-	-	-	-	-
4	Over-Exploited	-	-	-	-	-	-
5	Saline	-	-	-	-	-	-
	TOTAL	149	100	8571.96	100	2.30	100

CHAPTER-1

INTRODUCTION

1.0. BACKGROUND

Groundwater serves as a crucial source for fulfilling the water demands of various sectors, including irrigation, domestic use, and industries. Unregulated groundwater extraction can result in significant inter-sectoral conflicts, emphasizing the need for effective groundwater management to sustain agricultural and industrial growth in India. This management relies heavily on a scientifically sound, quantitative assessment of groundwater resources, with a focus on understanding aquifers and the dynamics of groundwater accumulation and movement.

The first formal estimation of groundwater resources was conducted in 1973 by the Ministry of Agriculture, in collaboration with Union Territory groundwater and minor irrigation organizations, to evaluate irrigation potential. In the early 1980s, this estimation was refined using the methodology proposed by the Ground Water Over Exploitation Committee (1977). Recognizing the need for further accuracy, the Government of India established the Ground Water Estimation Committee in 1982, which introduced the Ground Water Estimation Committee Methodology–1984 (GEC-84). This methodology was adopted by the Central Ground Water Board and State Ground Water Organizations, including for resource estimation in Jammu and Kashmir.

To address the limitations of GEC-84, a new Committee on Ground Water Estimation was formed in 1995 (GOI, MOWR Notification No. 3/9/93-GWII/2333 dated 13.11.1995). This led to the development of the Ground Water Resource Estimation Methodology–1997 (GEC-97), which became the national standard for groundwater assessment. Each State was instructed to form a Working Group to provide data to the Planning Commission and review GEC-97 for possible updates.

Recognizing the need for ongoing refinement, the R&D Advisory Committee on Ground Water Estimation recommended strengthening parameters such as specific yield, canal seepage factor, rainfall recharge factor, and irrigation return flow factor. The 11th Meeting of the R&D Advisory Committee on 13.11.2009 concluded that groundwater estimation in alluvial areas should adhere to GEC-97 norms, with data refinements.

Over time, the experience gained from using GEC-97 and insights from research and pilot studies highlighted the need to update the methodology. The National Water Policy stressed the importance of periodic, scientifically-based assessments of groundwater potential. In 2010, the Ministry of Water Resources formed a Central Level Expert Group (CLEG) to oversee nationwide groundwater reassessment. The Ground Water Resource Estimation Committee - 2015 (GEC-2015) was finalized after detailed discussions and a workshop on 24th January 2017 at CWPRS, Khadakwasla, Pune.

GEC-2015 introduced several critical revisions, including:

1. Aquifer-wise groundwater resource assessments, requiring clear delineation of lateral and vertical aquifer extents.
2. Recommendations to assess groundwater resources to a depth of 100m in hard rock areas and 300m in soft rock areas until comprehensive aquifer mapping is achieved.
3. The estimation of both replenishable and in-storage groundwater resources for unconfined and confined aquifers.
4. A recommendation for resource estimation every three years, given the dynamic nature of groundwater extraction.
5. The addition of quality flags for salinity, fluoride, and arsenic during assessments.
6. The use of spring discharge data as a proxy for groundwater resources in hilly areas where water balance components are difficult to compute.

In line with these advancements, the Ministry of Jal Shakti Department of Water Resources RD&GR instructed all State/UT Governments to form State/UT Level Committees. As per the Government of J&K's Order No. 1053-JK (GAD) of 2023, dated 30-08-2023 (Appendix–1), the Union Territory Level Ground Water Estimation Committee (UTLEC) was notified in March 2023 to undertake groundwater resource assessments. The current assessment for 2023-2024 incorporates the principles and methodologies outlined in GEC-2015.

The dynamic studies of groundwater estimation in Jammu and Kashmir, conducted in 2004, 2009, 2011, and 2013, were based on the GEC-97 methodology. However, the present study integrates the updated GEC-2015 recommendations, ensuring a more precise and scientifically robust evaluation of groundwater resources.

1.1. ASSESSMENT AREA

The Jammu & Kashmir is the northernmost Union territory of India and the 22nd largest state in geographical area. It lies between the latitudes 32º17’ to 35º08’ N and longitudes 73º23’ to 76º47’ E, covering a total geographical area of 42,241 sq. km. The Union Territory shares an international border with Pakistan in the west. The States of Punjab and Himachal Pradesh form its southern border, while the Union Territory of Ladakh lies to the north and northeast. The terrain of Jammu & Kashmir is largely high and rugged, characterized by mountainous landscapes.

Administratively, Jammu & Kashmir is divided into two divisions: Kashmir Division and Jammu Division. In the Jammu region, National Hydrological System (NHS) monitoring is conducted in the valley and alluvial plains of six districts: Jammu, Samba, Kathua, Rajouri, Reasi, and Udhampur. The remaining four districts, which are predominantly hilly, lack a representative water level monitoring network. Consequently, groundwater estimation in these areas is calculated using the rainfall infiltration method.

Jammu & Kashmir exhibits significant diversity in temperature and precipitation. Apart from the plains south of the Siwalik range in the Jammu Division, the climate across most of the Union Territory mirrors the mountainous and continental characteristics typical of temperate latitudes.

Like other states, the estimation of groundwater resources in the Union Territory of Jammu and Kashmir is conducted block-wise. The Union Territory is divided into 20 districts, further subdivided into 285 development blocks. Most of these blocks are characterized by high mountains and steep slopes. According to the GEC-2015 guidelines, only 149 assessment units have been identified as groundwater-worthy. Groundwater resources have been assessed for these 149 units, including the Srinagar Urban Area, which has a population exceeding 10 lakhs. The Srinagar Urban Area encompasses groundwater-worthy regions of Srinagar district as well as parts of Ganderbal, Baramulla, Budgam, Pulwama, and Bandipora districts.

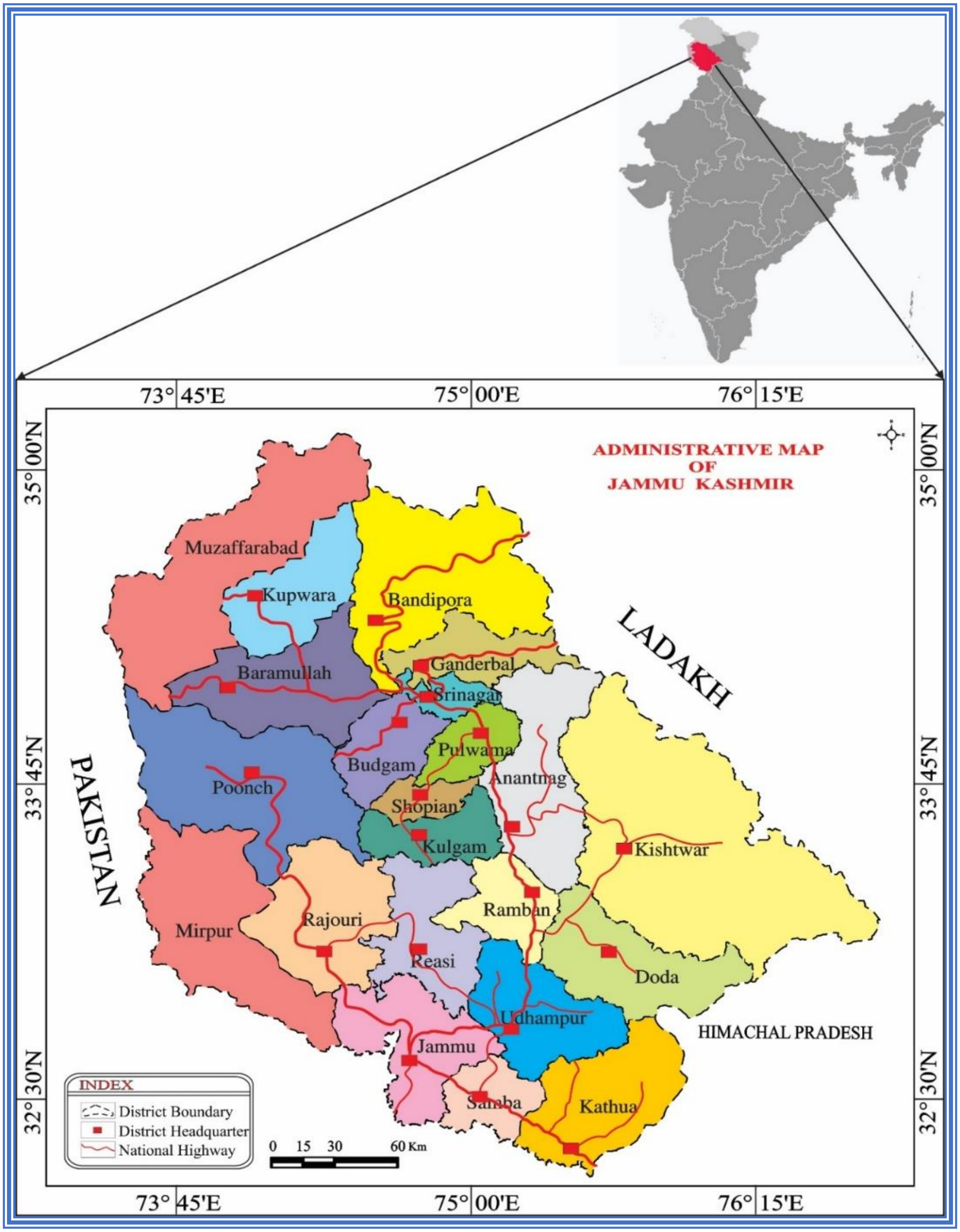

Figure 1 Administrative Map of UT of Jammu & Kashmir.

In Jammu and Kashmir, surface water resources are committed through IWT, and the Indian share is being fully utilized through a well-organized canal irrigation system. However, the available surface water resources of the UT being unable to meet the demand of agriculture; are increasing pressure on groundwater resources. In groundwater resources, the UT is facing the dual phenomenon of the rising water level in small valleys in Jammu divisions and some parts of Kashmir and the falling water table Kandi belt in certain parts of Jammu Province, where groundwater is generally fresh and fit for drinking and irrigation purpose.

1.2. GEOLOGY

Geological formations ranging in age from Pre-Cambrian to Recent were exposed in Kashmir Valley, and the brief geological succession is given below:-

Table 1: Geology of Jammu & Kashmir.

Stratigraphic Unit	LITHOLOGY	AGE
Alluvium	Heterogeneous Clastic sediments comprising Sand, Silt, Clay	Sub-Recent to Recent
Karewa formation	Fine greenish sands alternating with	Pleistocene
Siwalik Group	Clay, Sand, Sandstone, Silt stones	Middle Miocene to lower Pleistocene
Murre Group	Purple colored Clay, Shale, Silt stones, green sandstones	Middle Eocene to Oligocene
Subathu Group	Shales, sand Stones	Late Paleocene to Middle Eocene
----------Un Conformity--------		
Triassic Lime Stones and Shales	Limestones, Shales	Triassic
Zewan Formation	Lime Stones and Shales	Middle and Upper Permian
Panjal Volcanics	Andesitic and Basaltic flows	Permo – Carboniferous
Agglomeratic slate series	Slates, Quartzites	Late Carboniferous to Early Permian
Muth formation	Quartzites, Shales, Silt stones, dolomitic limestones	Upper Silurian – Devonian
----------Un Conformity--------		
Dogra Slates, Salkhala Series	Carbonaceous Shales, Schists, graphitic phyllites, carbonaceous limestones, dolomites, marbles, quartzites	Precambrian

The Salkhala outcrops have been traced in the form of a hairpin bend around the northwestern end of the Kashmir Valley. The salkhala group comprises a succession of Carbonaceous Shales, Schists, graphitic phyllites, carbonaceous limestones, dolomites, marbles, and quartzites. The Salkhala group is stratigraphically overlain by Dogra Slates, which conformably grades into the lower paleozoic succession. In the southern part of Kashmir, the Dogra Slates are conformably overlain by a succession of phyllites, sandstones, massive quartzites, grits, and conglomerates known as Tanawals and suggested that the succession bridges the gap between Dogra Slates and upper Paleozoic rocks in the south and southwestern Kashmir. The Palaeozoic formations of Kashmir exposed along with the pir-panjal range and great Himalayan ranges rest either over Dogra slates or pre-Cambrian crystalline rocks of the Salkhal group. A succession of white quartzites, shales, siltstones, and dolomitic limestones exposed around Kashmir synclinorium has been referred to as Muth formation. In the Northern part of Kashmir, the Muth Quartzites are conformably overlain by Syringothris limestone, a succession of Grey and dark blue limestone with a few interbedded shales, quartzites, and traps. The formation is exposed along the southern slopes of Pirpanjal near Banihal.

Agglomerates slate series is well exposed in the Pir Panjal range Baramulla district, Liddar valley, Anantnag District, and Kistwar in the Doda district. The polymictites consist of rock fragments derived from glacial erosion as well as from volcanic outbursts. It is a succession of slates, sandstone, quartzite, and a few bands of conglomerates.

The Agglomeratic slate series is overlain and often intermixed with a thick succession of Andesitic and basaltic traps known as Panjal volcanic. The volcanic occupy the steep slopes and high peaks of the pir panjal ranges and higher reaches of liddar valley. The volcanic activity seems to have persisted in Kashmir from the late Carboniferous to late Triassic epochs.

Permian rocks of Kashmir are conformably overlain by a thick succession of limestones and shales known as zeewan formation.

The outcrops of Jurassic rock have restricted distribution in Kashmir. A significant part of the rock is buried beneath the quarternary sediments and reported in the northern slopes of the Pir Panjal range Baltal and Joji-la areas. The Cretaceous rocks have not been found from the Kashmir Himalayas.

The Murres extensively exposed on the Jammu-Srinagar highway around Batote consists of a basal conglomerate bed overlain by intercalations of bright red-purple clay and green sandstones and is overlain by Siwalik group rock formations.

Most of the Kashmir valley is occupied by this gravel-sand and mud succession known in Indian Stratigraphy as ‘Karewa formation.’ There are different opinions about the deposition of Karewa formations. Based on detailed geological mapping, Bhatt (1978, 1982) proposed that sedimentation of Karewa deposits took place in a lake basin but suggested that during the deposition of Lower Karewa lake occupied the whole Kashmir valley floor, but during Upper Karewa time, the lake was localized only in the north-eastern flank of the basin.

Karawas covers an area of about 5600 sq.Km in Kashmir Valley. Karewa group is defned to include the more or less unconsolidated layered sedimentary succession deposited in fluvio-lacustrine environments in the Kashmir valley, overlying the Precambrian-Mesozoic basement and overlain by Holocene alluvium of modern rivers, etc.'. The Karewa group is divided into two formations viz., Lower Karewa and Upper Karewa. The Lower Karewa formation is characterized by plastic grey to bluish-grey clay, light grey sandy clay, lignite, lignitic clay, coarse to medium-grained sand, and conglomerates. It is about 1200-mt thick formations.

The Upper Karewa formation is characterized by brown, grey sandy clay, medium to coarse-grained sand, cream-colored marl, conglomerate, and loam (loess) sediments. In this upper Karewas lignitic shale and grey bluish shale are absent. The thickness of this formation is about 50 to 200 mt. The loamy sediments are present throughout the valley, making the top of the Karewa Plateau. The Upper Karewa formation sediments are exposed extensively on the Pir Panjal flank due to the uplift of the Pir Panjal range and its Karewa sediments.

A fine-grained predominantly silty succession caps the top of Karewa terraces without any bedding structures. These are mainly loam or loess formations. The formation is, in some places, extremely muddy, silty, or somewhat sandy. In some cases, sand layers are intercalated.

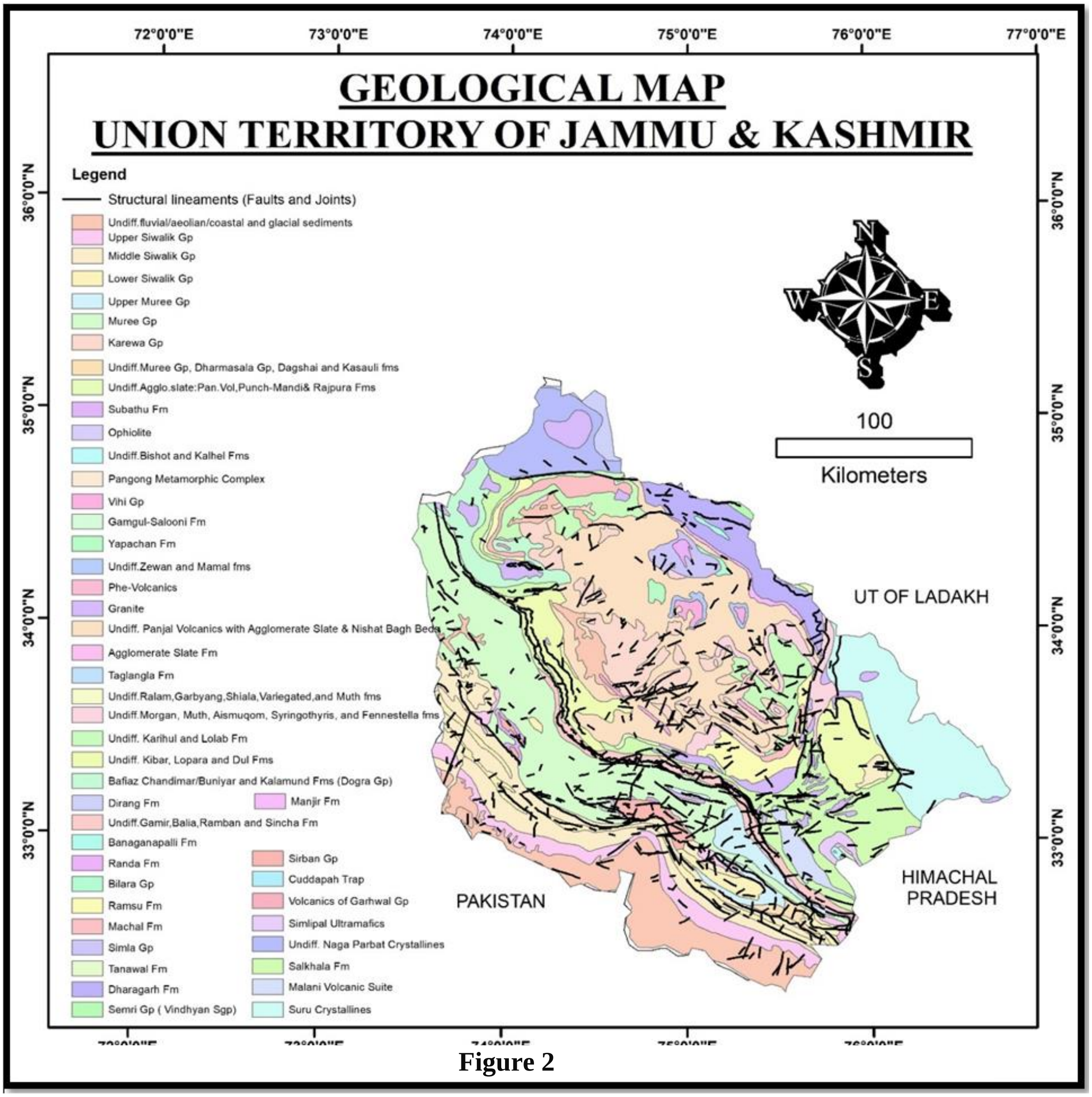

Figure 2: Geological Map of Union Territory of Jammu & Kashmir.

1.3. HYDROMETEOROLOGY

The climate of Jammu & Kashmir

The UT of Jammu and Kashmir is situated in the subtropical latitudes and has micro-level variation in the altitudes. Hence, it has a great diversity in its temperature and precipitation. Excepting the plain, south of the Siwaliks of the Jammu Division, the climate over the greater part of the UT resembles the mountainous and continental parts of the temperate latitudes. In Koppen's scheme of climatic types, the hilly parts of the Jammu Kashmir Divisions as Dfb (humid continental with severe and moist winters and short summers) while the plain areas of the Jammu Division/Region, adjacent to the plain of Punjab have been described as Ca (less most winter, long hot summers, followed by moderately heavy rains in July, August, and September.

The normal lapse rate of temperature entails an average decrease of about 60C per thousand meters increase of elevation. There are important exceptions to this are actual lapse rates, but on the whole, higher altitudes are associated with significantly lower temperatures and a smaller annual range of temperature. This is because air Pressure always decreases with altitude. In addition, the atmosphere at a higher elevation is ordinarily free from dust, smoke, and other non-gaseous material. The air is accordingly more transparent to the passage of both incoming and outgoing radiation during a cloudless period.

Jammu district has a subtropical climate with a hot and dry climate in summer and a cold climate in winter. It lies in the northern hemisphere above the tropic of Cancer. The sub-tropical climate zone of the world occurs between tropical and tempered zones (25^0 to 40^0 North and South latitudes). The district's minimum and Maximum temperatures vary between -8.8˚C to 47˚C, and the monsoon starts from the beginning of July to the first week of September. The average rainfall in the district is about 1151 mm. The climate of this region is characterized by a rhythm of seasons which is caused by the reversal of winds in the form of the south-west and north-east monsoon. The reversal of pressure takes place regularly twice a year.

Temperature

The monthly mean temperature in the Jammu district is about 20^0C, and the annual range of temperature is about 17^0C. The outstanding feature of the annual march of temperature is the maximum before the commencement of the summer monsoon. In April, the day and night temperatures become 32^0C and 18^0C, increasing to 38^0C to 25^0C in May. On Vidal day, the month of May or June, the maximum temperature goes up to 47^0C (June 1953). The relative humidity in May falls to below 20 percent. At the outbreak of the summer monsoon, the temperature decreases. The cloudy weather and high relative humidity help in the reduction of the day and night temperatures in July, August, and September.

1.4. LAND USE LAND COVER

The Union Territory of Jammu and Kashmir (J&K) exhibits a diverse Land Use and Land Cover (LULC) pattern, reflecting its unique topography, climate, and socio-economic activities. Here's an in-depth overview of the major LULC categories in the region:

1. Forest Cover

As of 2021, forests covered approximately 39.15% of J&K's geographical area. This includes various forest types, such as coniferous and broad-leaved forests, predominantly found in regions like the Pir Panjal range and the southern Kashmir Valley. However, between 2001 and 2020, J&K experienced a loss of 1.15 million hectares of natural forest, accounting for about 11% of its land area.

2. Agricultural Land

Agriculture plays a vital role in J&K's economy. The net sown area increased from 675,000 hectares in 1990 to 752,000 hectares in 2018, marking a net increase of 3.21%. Major crops include rice, maize, wheat, and barley, with paddy fields predominantly in the Kashmir Valley.

3. Horticulture and Plantation

J&K is renowned for its horticultural produce, especially apples, almonds, walnuts, and saffron. The area under horticultural plantations has expanded over the years, contributing significantly to the region's economy. Districts like Shopian, Baramulla, Anantnag, Budgam, and Ganderbal are notable for their extensive orchards.

4. Built-up/Urban Areas

Urbanization has been on the rise in J&K. For instance, in the Jammu district, settlements expanded by 96.97 km^2 (4.12%) over recent decades.

This growth has led to concerns about encroachment on agricultural lands and wetlands, particularly in rapidly expanding cities like Srinagar and Jammu.

5. Barren Land/Rocky Outcrops

Barren lands, including rocky outcrops and mountainous regions, have seen changes over time. In the Jammu district, barren land increased by 151.69 km^2 (6.45%), indicating shifts in land cover possibly due to climatic or anthropogenic factors.

6. Grasslands/Pastures

High-altitude meadows and pastures are integral to the traditional pastoral lifestyle in J&K. These grasslands support livestock grazing and are found in areas like Gurez Valley, Doda, and Kishtwar. However, precise statistics on their extent and changes over time are limited.

7. Snow-covered/Glacial Areas

The northern regions of J&K, including areas like Sonmarg, Gulmarg, and Pahalgam, are characterized by extensive snow cover and glaciers. These areas are crucial for sustaining the perennial rivers and maintaining the hydrological balance in the region.

8. Water Bodies

J&K is home to several significant water bodies, including lakes like Dal Lake and Wular Lake, and rivers such as the Jhelum and Chenab. These water bodies are vital for irrigation, drinking water, and supporting biodiversity. However, urban expansion and pollution have led to concerns about their shrinking sizes and deteriorating health.

9. Conservation Efforts

In recent years, conservation initiatives have been implemented to protect J&K's natural heritage. For example, authorities have geo-tagged thousands of 'Chinar' trees, attaching QR codes to each tree to monitor their health and growth patterns. This project aims to address risks from urbanization, infrastructure projects, and diseases, ensuring the preservation of these culturally and ecologically significant trees.

Understanding these LULC dynamics is essential for sustainable planning and management of J&K's natural resources. Continuous monitoring using remote sensing and GIS technologies can aid in making informed decisions to balance development and conservation in the region.

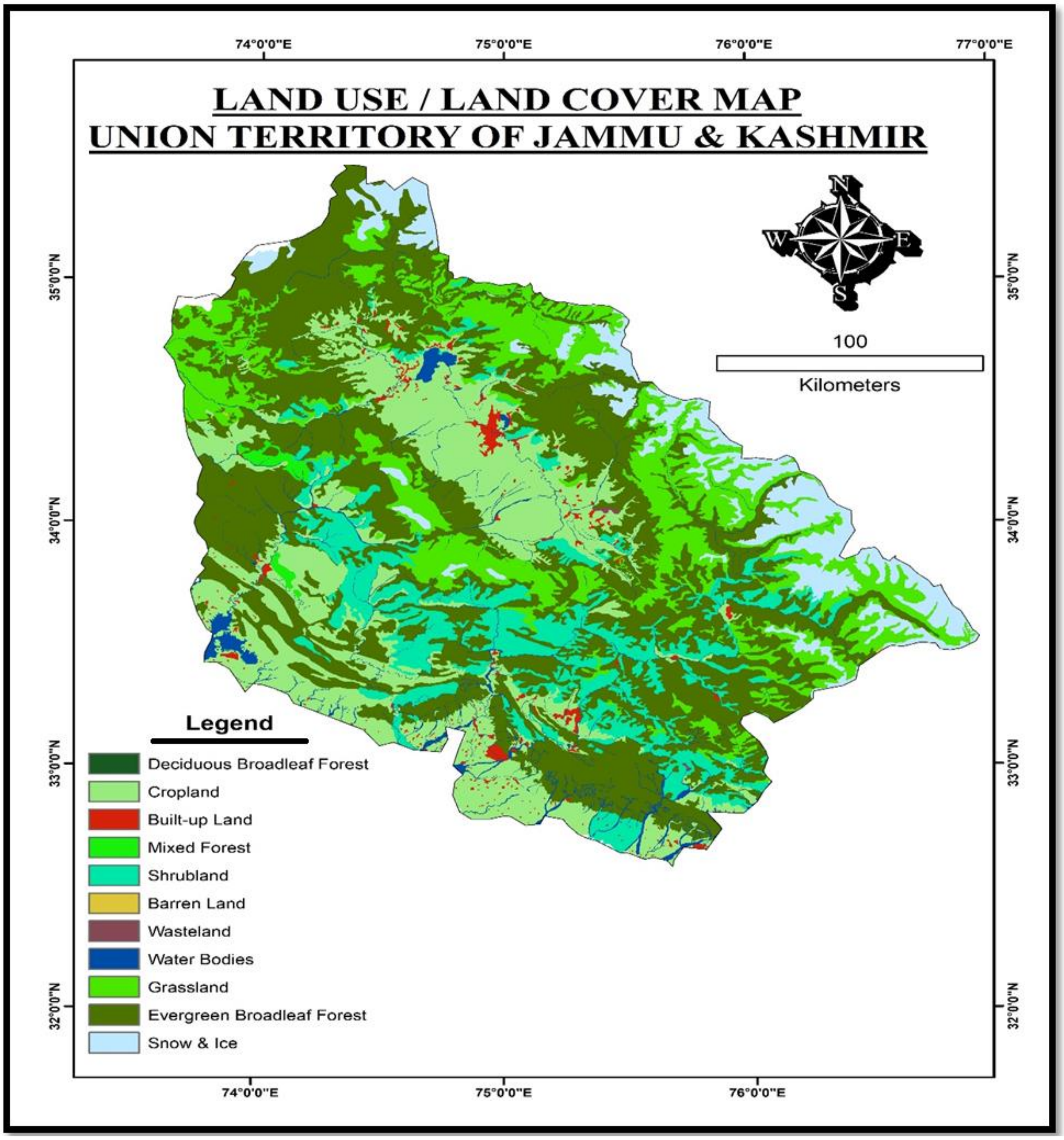

Figure 3: Land Use/land Cover Map of UT of J&K.

CHAPTER 2

GROUNDWATER RESOURCES ESTIMATION METHODOLOGY

2.0 GROUND WATER RESOURCE ESTIMATION METHODOLOGY

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

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

2.1 GROUND WATER ASSESSMENT OF UNCONFINED AQUIFER

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

2.1.1. Assessment of Annually Replenishable or Dynamic Ground Water Resources

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

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

Equation (1) can be further elaborated as –

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

Where,

ΔS - Change is storage
R_{RF} - Rainfall recharge
R_{STR} - Recharge from stream channels
R_{C} - Recharge from canals
R_{SWI} - Recharge from surface water irrigation
R_{GWI} - Recharge from ground water irrigation
R_{TP} - Recharge from Tanks & Ponds
R_{WCS} - Recharge from water conservation structures
VF - Vertical flow across the aquifer system
LF - Lateral flow along the aquifer system (through flow)
GE - Ground Water Extraction
T - Transpiration
E - Evaporation

B - Base flow

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

2.1.1.1. Rainfall Recharge

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

2.1.1.1.1. Ground Water Level Fluctuation Method

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

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

Where,

ΔS - Change is storage

R_{RF} - Rainfall recharge

R_{STR} - Recharge from stream channels

R_{SWI} - Recharge from surface water irrigation

R_{GWI} - Recharge from ground water irrigation

R_{TP} - Recharge from Tanks& Ponds

R_{WCS} - Recharge from water conservation structures

VF - Vertical flow across the aquifer system

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

GE - Ground water extraction

T - Transpiration

E - Evaporation

B - Base flow

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

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

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

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

Where,

ΔS - Change is storage

Δh - rise in water level in the monsoon season

A - Area for computation of recharge

S_Y - Specific Yield

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

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

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

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

Normalization of Rainfall Recharge

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

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

$$R = ar \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.(8)$$

Where,

R = Rainfall recharge during monsoon season

r = Monsoon season rainfall

a = a constant

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

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

Where,

R_{RF}(normal) - Normalized Rainfall Recharge in the monsoon season

R_i- Rainfall Recharge in the monsoon season for the i^{th}year

r(normal) - Normal monsoon season rainfall

r_i- Rainfall in the monsoon season for the i^{th} year

N - No. of years for which data is available

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

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

Where,

R_{RF}(normal) - Normalized Rainfall Recharge in the monsoon season

r(normal) - Normal monsoon season rainfall

a and b - Constants.

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

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

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

Where,

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

2.1.1.1.2. Rainfall Infiltration Factor Method

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

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

Where,

R_{RF} - Rainfall recharge in ham
A - Area in hectares
RFIF - Rainfall Infiltration Factor
R- Rainfall in mm
a - Minimum threshold value above which rainfall induces ground water recharge in mm

The threshold limit of minimum and maximum rainfall event which can induce recharge to the aquifer is considered while estimating ground water recharge using rainfall infiltration factor method. The minimum threshold limit is in accordance with the relation shown in equation (13) and the maximum threshold limit is based on the premise that after a certain limit, the rate of storm rain is too high to contribute to infiltration and they will only contribute to surface runoff. Thus, 10% of Normal annual rainfall has been taken as minimum rainfall threshold and 3000 mm as maximum rainfall limit. While computing the rainfall recharge, 10% of the normal annual rainfall has been deducted from the monsoon rainfall and balance rainfall is considered for computation of rainfall recharge. The same recharge factor is used for both monsoon and non-monsoon rainfall, with the condition that the recharge due to non-monsoon rainfall is taken as zero, if the normal rainfall during the non-monsoon season is less than 10% of normal annual rainfall. In using the method based on the specified norms, recharge due to both monsoon and non-monsoon rainfall has been estimated for normal rainfall, based on recent 30 to 50 years of data.

2.1.1.1.3. Percent Deviation

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

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

Where,

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

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

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

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

2.1.1.2. Recharge from Other Sources

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

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

Sl. No.	Source	Estimation Formula	Parameters
			RF = Recharge Factor
5	Recharge due to Water Conservation Structures	$R_{WCS} = GS \times RF$	RWCS = Recharge due to Water Conservation Structures GS = Gross Storage = Storage Capacity multiplied by number of fillings. RF = Recharge Factor

2.1.1.3. Evaporation and Transpiration

Evaporation is estimated for the aquifer in the assessment unit if water levels in the aquifer are within the capillary zone. For areas with water levels within 1.0mbgl, evaporation is estimated using the evaporation rates available for other adjoining areas. If depth to water level is more than 1.0mbgl, the evaporation losses from the aquifer is taken as zero.
Transpiration through vegetation has been estimated if water levels in the aquifer are within the maximum root zone of the local vegetation. If water levels are within 3.5mbgl, transpiration is estimated using the transpiration rates available for other areas. If it is greater than3.5m bgl, the transpiration has been taken as zero.

2.1.1.4. Recharge During Monsoon Season

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

2.1.1.5. Recharge During Non-Monsoon Season

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

2.1.1.6. Total Annual Ground Water Recharge

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

2.1.1.7. Annual Extractable Ground Water Resource (EGR)

The Annual Extractable Ground Water Resource (EGR) is computed by deducting the Total Annual Natural Discharge from Total Annual Ground Water Recharge.

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

2.1.1.8. Estimation of Ground Water Extraction

Ground water draft or extraction is assessed as follows.

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

Where,

GE_{ALL} = Ground water extraction for all uses
GE_{IRR} = Ground water extraction for irrigation
GE_{DOM} = Ground water extraction for domestic uses
GE_{IND} = Ground water extraction for industrial uses

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

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

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

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

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

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

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

***Unit Draft Method:* –** In this method, unit draft of each type of well is multiplied by the number of wells used for domestic purpose to obtain the domestic ground water extraction.

***Consumptive Use Method:* –** In this method, population is multiplied with per capita consumption usually expressed in litre per capita per day (lpcd). It can be expressed using following equation.

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

Where,

L_g = Fractional Load on Ground Water for Domestic Water Supply.

The Load on Ground water can be obtained from the Information based on Civic water supply agencies in urban areas.

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

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

Unit Draft Method: - In this method, unit draft of each type of well is multiplied by the number of wells used for industrial purpose to obtain the industrial ground water extraction.

Consumptive Use Pattern Method: – In this method, water consumption of different industrial units is determined. Numbers of Industrial units which are dependent on ground water are multiplied with unit water consumption to obtain ground water extraction for industrial use.

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

Where,

L_g = Fractional load on ground water for industrial water supply.

The load on ground water for industrial water supply can be obtained from water supply agencies in the Industrial belt.

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

2.1.1.9. Stage of Ground Water Extraction

The stage of ground water extraction is defined by,

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

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

2.1.1.10. Validation of Stage of Ground Water Extraction

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

Long term Water Level trends are prepared for a minimum period of 10 years for both pre-monsoon and post-monsoon period. If the ground water resource assessment and the trend of long term water levels contradict each other, this anomalous situation requires a review of the ground water resource computation, as well as the reliability of water level data. The mismatch conditions are enumerated below.

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

2.1.1.11. Categorisation of Assessment Unit

2.1.1.11.1. Categorisation of Assessment Unit Based on Quantity

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

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

2.1.1.11.2. Categorisation of Assessment Unit Based on Quality

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

2.1.1.12. Allocation of Ground Water Resource for Utilisation

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

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

Where,

Alloc = Allocation for domestic water requirement

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

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

2.1.1.13. Net Annual Ground Water Availability for Future Use

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

2.1.1.14. Additional Potential Resources under Specific Conditions

2.1.1.14.1. Potential Resource Due to Spring Discharge

Spring discharge occurs at the places where ground water level cuts the surface topography. The spring discharge is equal to the ground water recharge minus the outflow through evaporation and evapotranspiration and vertical and lateral sub-surface flow. Thus, Spring Discharge is a form of 'Annual Extractable Ground Water Recharge'. It is a renewable resource, though has not been used for Categorisation. Spring discharge measurement has been carried out by volumetric measurement of discharge of the springs. Spring discharges multiplied with time in days of each season will give the quantum of spring resources available during that season.

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

Where,

Q = Spring Discharge

No of days = No of days spring yields.

2.1.1.14.2. Potential Resource in Waterlogged and Shallow Water Table Areas

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

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

Where,

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

A = Area of shallow water table zone.

S_Y = Specific Yield

2.1.1.14.3. Potential Resource in Flood Prone Areas

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

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

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

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

Where,

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

A = Flood Prone Area

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

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

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

2.2. GROUND WATER ASSESSMENT IN URBAN AREAS

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

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

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

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

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

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

2.3. GROUND WATER ASSESSMENT IN WATER LEVEL DEPLETION ZONES

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

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

2.4. NORMS HAS BEEN USED IN THE ASSESSMENT

2.4.1. Specific Yield

Recently under Aquifer Mapping Project, Central Ground Water Board has classified all the aquifers into 14 Principal Aquifers which in turn were divided into 42 Major Aquifers. Hence, it is required to assign Specific Yield values to all these aquifer units. The values recommended in the ***Table-2*** has been followed in the present assessments, unless sufficient data based on field studies are available to justify the minimum, maximum or other intermediate values

Table 2: Norms Recommended for Specific Yield.

Sl. No.	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
1	Alluvium	AL01	Younger Alluvium (Clay/Silt/Sand/ Calcareous concretions)	Quaternary	10	8	12
2	Alluvium	AL02	Pebble / Gravel/ Bazada/ Kandi	Quaternary	16	12	20
3	Alluvium	AL03	Older Alluvium (Silt/Sand/Gravel/Lithomargic clay)	Quaternary	6	4	8
4	Alluvium	AL04	Aeolian Alluvium (Silt/ Sand)	Quaternary	16	12	20
5	Alluvium	AL05	Coastal Alluvium (Sand/Silt/Clay)	Quaternary	10	8	12
6	Alluvium	AL06	Valley Fills	Quaternary	16	12	20
7	Alluvium	AL07	Glacial Deposits	Quaternary	16	12	20
8	Laterite	LT01	Laterite / Ferruginous concretions	Quaternary	2.5	2	3
9	Basalt	BS01	Basic Rocks (Basalt) - Weathered, Vesicular or Jointed	Mesozoic to Cenozoic	2	1	3
10	Basalt	BS01	Basic Rocks (Basalt) - Massive Poorly Jointed	Mesozoic to Cenozoic	0.35	0.2	0.5
11	Basalt	BS02	Ultra Basic - Weathered, Vesicular or Jointed	Mesozoic to Cenozoic	2	1	3
12	Basalt	BS02	Ultra Basic - Massive Poorly Jointed	Mesozoic to Cenozoic	0.35	0.2	0.5
13	Sandstone	ST01	Sandstone/Conglomerate	Upper Palaeozoic to Cenozoic	3	1	5
14	Sandstone	ST02	Sandstone with Shale	Upper Palaeozoic to Cenozoic	3	1	5
15	Sandstone	ST03	Sandstone with shale/ coal beds	Upper Palaeozoic to Cenozoic	3	1	5
16	Sandstone	ST04	Sandstone with Clay	Upper Palaeozoic to Cenozoic	3	1	5
17	Sandstone	ST05	Sandstone/Conglomerate	Proterozoic to Cenozoic	3	1	5

Sl. No.	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
18	Sandstone	ST06	Sandstone with Shale	Proterozoic to Cenozoic	3	1	5
19	Shale	SH01	Shale with limestone	Upper Palaeozoic to Cenozoic	1.5	1	2
20	Shale	SH02	Shale with Sandstone	Upper Palaeozoic to Cenozoic	1.5	1	2
21	Shale	SH03	Shale, limestone and sandstone	Upper Palaeozoic to Cenozoic	1.5	1	2
22	Shale	SH04	Shale	Upper Palaeozoic to Cenozoic	1.5	1	2
23	Shale	SH05	Shale/Shale with Sandstone	Proterozoic to Cenozoic	1.5	1	2
24	Shale	SH06	Shale with Limestone	Proterozoic to Cenozoic	1.5	1	2
25	Limestone	LS01	Miliolitic Limestone	Quarternary	2	1	3
26	Limestone	LS01	KarstifiedMiliolitic Limestone	Quarternary	10	5	15
27	Limestone	LS02	Limestone / Dolomite	Upper Palaeozoic to Cenozoic	2	1	3
28	Limestone	LS02	Karstified Limestone / Dolomite	Upper Palaeozoic to Cenozoic	10	5	15
29	Limestone	LS03	Limestone/Dolomite	Proterozoic	2	1	3
30	Limestone	LS03	Karstified Limestone/Dolomite	Proterozoic	10	5	15
31	Limestone	LS04	Limestone with Shale	Proterozoic	2	1	3
32	Limestone	LS04	Karstified Limestone with Shale	Proterozoic	10	5	15
33	Limestone	LS05	Marble	Azoic to Proterozoic	2	1	3
34	Limestone	LS05	Karstified Marble	Azoic to Proterozoic	10	5	15
35	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.) - Weathered , Jointed	Mesozoic to Cenozoic	1.5	1	2
36	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.)- Massive or Poorly Fractured	Mesozoic to Cenozoic	0.35	0.2	0.5
37	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) - Weathered, Jointed	Proterozoic to Cenozoic	3	2	4
38	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	0.35	0.2	0.5
39	Schist	SC01	Schist - Weathered, Jointed	Azoic to Proterozoic	1.5	1	2
40	Schist	SC01	Schist - Massive, Poorly Fractured	Azoic to Proterozoic	0.35	0.2	0.5
41	Schist	SC02	Phyllite	Azoic to Proterozoic	1.5	1	2
42	Schist	SC03	Slate	Azoic to Proterozoic	1.5	1	2
43	Quartzite	QZ01	Quartzite - Weathered, Jointed	Proterozoic to Cenozoic	1.5	1	2
44	Quartzite	QZ01	Quartzite - Massive, Poorly Fractured	Proterozoic to Cenozoic	0.3	0.2	0.4
45	Quartzite	QZ02	Quartzite - Weathered, Jointed	Azoic to Proterozoic	1.5	1	2
46	Quartzite	QZ02	Quartzite- Massive, Poorly Fractured	Azoic to Proterozoic	0.3	0.2	0.4
47	Charnockite	CK01	Charnockite - Weathered, Jointed	Azoic	3	2	4

Sl. No.	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
48	Charnockite	CK01	Charnockite - Massive, Poorly Fractured	Azoic	0.3	0.2	0.4
49	Khondalite	KH01	Khondalites, Granulites - Weathered, Jointed	Azoic	1.5	1	2
50	Khondalite	KH01	Khondalites, Granulites - Mssive, Poorly Fractured	Azoic	0.3	0.2	0.4
51	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Weathered, Jointed	Azoic	1.5	1	2
52	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Massive, Poorly Fractured	Azoic	0.3	0.2	0.4
53	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Weathered, Jointed	Azoic to Proterozoic	1.5	1	2
54	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Massive, Poorly Fractured	Azoic to Proterozoic	0.3	0.2	0.4
55	Gneiss	GN02	Gneiss -Weathered, Jointed	Azoic to Proterozoic	3	2	4
56	Gneiss	GN02	Gneiss-Massive, Poorly Fractured	Azoic to Proterozoic	0.3	0.2	0.4
57	Gneiss	GN03	Migmatitic Gneiss - Weathered, Jointed	Azoic	1.5	1	2
58	Gneiss	GN03	Migmatitic Gneiss - Massive, Poorly Fractured	Azoic	0.3	0.2	0.4
59	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Weathered, Jointed	Proterozoic to Cenozoic	2	1	3
60	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	0.35	0.2	0.5
61	Intrusive	IN02	Ultrabasics (Epidiorite, Granophyre etc.) - Weathered, Jointed	Proterozoic to Cenozoic	2	1	3
62	Intrusive	IN02	Ultrabasics (Epidiorite, Granophyre etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	0.35	0.2	0.5

2.4.2. Rainfall Infiltration Factor

The values mentioned in ***Table-3*** has been used in the present assessment. The recommended Rainfall Infiltration Factor values has been used for assessment, unless sufficient data based on field studies are available to justify the minimum, maximum or other intermediate values.

Table 3: Norms Recommended for Rainfall Infiltration Factor.

Sl. No.	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
1	Alluvium	AL01	Younger Alluvium (Clay/Silt/Sand/ Calcareous concretions)	Quaternary	22	20	24
2	Alluvium	AL02	Pebble / Gravel/ Bazada/ Kandi	Quaternary	22	20	24
3	Alluvium	AL03	Older Alluvium (Silt/Sand/Gravel/Lithomargic clay)	Quaternary	22	20	24
4	Alluvium	AL04	Aeolian Alluvium (Silt/ Sand)	Quaternary	22	20	24
5	Alluvium	AL05	Coastal Alluvium (Sand/Silt/Clay) -East Coast	Quaternary	16	14	18

Sl. No.	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
5	Alluvium	AL05	Coastal Alluvium (Sand/Silt/Clay) - West Coast	Quaternary	10	8	12
6	Alluvium	AL06	Valley Fills	Quaternary	22	20	24
7	Alluvium	AL07	Glacial Deposits	Quaternary	22	20	24
8	Laterite	LT01	Laterite / Ferruginous concretions	Quaternary	7	6	8
9	Basalt	BS01	Basic Rocks (Basalt) - Vesicular or Jointed	Mesozoic to Cenozoic	13	12	14
9	Basalt	BS01	Basic Rocks (Basalt) - Weathered	Mesozoic to Cenozoic	7	6	8
10	Basalt	BS01	Basic Rocks (Basalt) - Massive Poorly Jointed	Mesozoic to Cenozoic	2	1	3
11	Basalt	BS02	Ultra Basic - Vesicular or Jointed	Mesozoic to Cenozoic	13	12	14
11	Basalt	BS02	Ultra Basic - Weathered	Mesozoic to Cenozoic	7	6	8
12	Basalt	BS02	Ultra Basic - Massive Poorly Jointed	Mesozoic to Cenozoic	2	1	3
13	Sandstone	ST01	Sandstone/Conglomerate	Upper Palaeozoic to Cenozoic	12	10	14
14	Sandstone	ST02	Sandstone with Shale	Upper Palaeozoic to Cenozoic	12	10	14
15	Sandstone	ST03	Sandstone with shale/ coal beds	Upper Palaeozoic to Cenozoic	12	10	14
16	Sandstone	ST04	Sandstone with Clay	Upper Palaeozoic to Cenozoic	12	10	14
17	Sandstone	ST05	Sandstone/Conglomerate	Proterozoic to Cenozoic	6	5	7
18	Sandstone	ST06	Sandstone with Shale	Proterozoic to Cenozoic	6	5	7
19	Shale	SH01	Shale with limestone	Upper Palaeozoic to Cenozoic	4	3	5
20	Shale	SH02	Shale with Sandstone	Upper Palaeozoic to Cenozoic	4	3	5
21	Shale	SH03	Shale, limestone and sandstone	Upper Palaeozoic to Cenozoic	4	3	5
22	Shale	SH04	Shale	Upper Palaeozoic to Cenozoic	4	3	5
23	Shale	SH05	Shale/Shale with Sandstone	Proterozoic to Cenozoic	4	3	5
24	Shale	SH06	Shale with Limestone	Proterozoic to Cenozoic	4	3	5
25	Limestone	LS01	Miliolitic Limestone	Quarternary	6	5	7
27	Limestone	LS02	Limestone / Dolomite	Upper Palaeozoic to Cenozoic	6	5	7
29	Limestone	LS03	Limestone/Dolomite	Proterozoic	6	5	7
31	Limestone	LS04	Limestone with Shale	Proterozoic	6	5	7
33	Limestone	LS05	Marble	Azoic to Proterozoic	6	5	7
35	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.) - Weathered , Jointed	Mesozoic to Cenozoic	7	5	9
36	Granite	GR01	Acidic Rocks (Granite,Syenite, Rhyolite etc.)- Massive or Poorly Fractured	Mesozoic to Cenozoic	2	1	3

Sl. No.	Principal Aquifer	Major Aquifers		Age	Recommended (%)	Minimum (%)	Maximum (%)
		Code	Name				
37	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) - Weathered, Jointed	Proterozoic to Cenozoic	11	10	12
38	Granite	GR02	Acidic Rocks (Pegmatite, Granite, Syenite, Rhyolite etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	2	1	3
39	Schist	SC01	Schist - Weathered, Jointed	Azoic to Proterozoic	7	5	9
40	Schist	SC01	Schist - Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
41	Schist	SC02	Phyllite	Azoic to Proterozoic	4	3	5
42	Schist	SC03	Slate	Azoic to Proterozoic	4	3	5
43	Quartzite	QZ01	Quartzite - Weathered, Jointed	Proterozoic to Cenozoic	6	5	7
44	Quartzite	QZ01	Quartzite - Massive, Poorly Fractured	Proterozoic to Cenozoic	2	1	3
45	Quartzite	QZ02	Quartzite - Weathered, Jointed	Azoic to Proterozoic	6	5	7
46	Quartzite	QZ02	Quartzite- Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
47	Charnockite	CK01	Charnockite - Weathered, Jointed	Azoic	5	4	6
48	Charnockite	CK01	Charnockite - Massive, Poorly Fractured	Azoic	2	1	3
49	Khondalite	KH01	Khondalites, Granulites - Weathered, Jointed	Azoic	7	5	9
50	Khondalite	KH01	Khondalites, Granulites - Mssive, Poorly Fractured	Azoic	2	1	3
51	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Weathered, Jointed	Azoic	7	5	9
52	Banded Gneissic Complex	BG01	Banded Gneissic Complex - Massive, Poorly Fractured	Azoic	2	1	3
53	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Weathered, Jointed	Azoic to Proterozoic	7	5	9
54	Gneiss	GN01	Undifferentiated metasedimentaries/ Undifferentiated metamorphic - Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
55	Gneiss	GN02	Gneiss -Weathered, Jointed	Azoic to Proterozoic	11	10	12
56	Gneiss	GN02	Gneiss-Massive, Poorly Fractured	Azoic to Proterozoic	2	1	3
57	Gneiss	GN03	Migmatitic Gneiss - Weathered, Jointed	Azoic	7	5	9
58	Gneiss	GN03	Migmatitic Gneiss - Massive, Poorly Fractured	Azoic	2	1	3
59	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Weathered, Jointed	Proterozoic to Cenozoic	7	6	8
60	Intrusive	IN01	Basic Rocks (Dolerite, Anorthosite etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	2	1	3
61	Intrusive	IN02	Ulrta Basics (Epidiorite, Granophyre etc.) - Weathered, Jointed	Proterozoic to Cenozoic	7	6	8
62	Intrusive	IN02	Ulrta Basics (Epidiorite, Granophyre etc.) - Massive, Poorly Fractured	Proterozoic to Cenozoic	2	1	3

2.4.3. Norms for Canal Recharge

The Norms suggested in ***Table-4*** has been used for estimating the recharge from Canals, where sufficient data based on field studies are not available.

Table 4: Norms Recommended for Recharge due to Canals.

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

2.4.4. Norms for Recharge Due to Irrigation

The Recommended Norms are presented in ***Table-5***.

Table 5:Norms Recommended for Recharge from Irrigation.

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

2.4.5. Norms for Recharge due to Tanks & Ponds

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

2.4.6. Norms for Recharge due to Water Conservation Structures

The data on the field studies for computing recharge from Water Conservation Structures are very limited, hence, the norm recommended by GEC-2015 for the seepage from Water Conservation

Structures is 40% of gross storage during a year which means 20% during monsoon season and 20% during non-monsoon Season is adopted.

2.4.7. Unit Draft

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

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

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

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

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

2.5. INDIA -GROUNDWATER RESOURCE ESTIMATION SYSTEM (IN-GRES)

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

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

CHAPTER 3

RAINFALL

3.0. Normal Rainfall of the UT

The rainfall in Jammu and Kashmir is primarily shaped by Southwest monsoon (June to September) and western disturbances (December to February). The normal annual rainfall for the UT has been estimated as 1305 mm.

Table 6: District Wise Normal Rainfall of the State/UT.

S.No.	Districts	Normal Rainfall (mm)		
		Monsoon	Non-Monsoon	Total
1	**Anantnag**	338.4	896.7	1235.1
2	**Bandipora**	252.2	816.9	1069.1
3	**Baramulla**	370	1165	1535
4	**Budgam**	204.1	517.7	721.8
5	**Doda**	429	833.8	1262.8
6	**Ganderbal**	204.1	517.7	721.8
7	**Jammu**	1004	334.9	1338.9
8	**Kathua**	1004	334.9	1338.9
9	**Kishtwar**	429	833.8	1262.8
10	**Kulgam**	338.4	896.7	1235.1
11	**Kupwarar**	252.2	816.9	1069.1
12	**Poonch**	298.1	1052	1350.1
13	**Pulwama**	204.1	517.7	721.8
14	**Rajouri**	1562	636.8	2198.8
15	**Ramban**	298.1	1052	1350.1
16	**Reasi**	1562	636.8	2198.8
17	**Samba**	1004	334.9	1338.9
18	**Shopian**	338.4	896.7	1235.1
19	**Srinagar**	204.1	517.7	721.8
20	**Udhampur**	1562	636.8	2198.8
	Total	**11858.2**	**14246.4**	**26104.6**

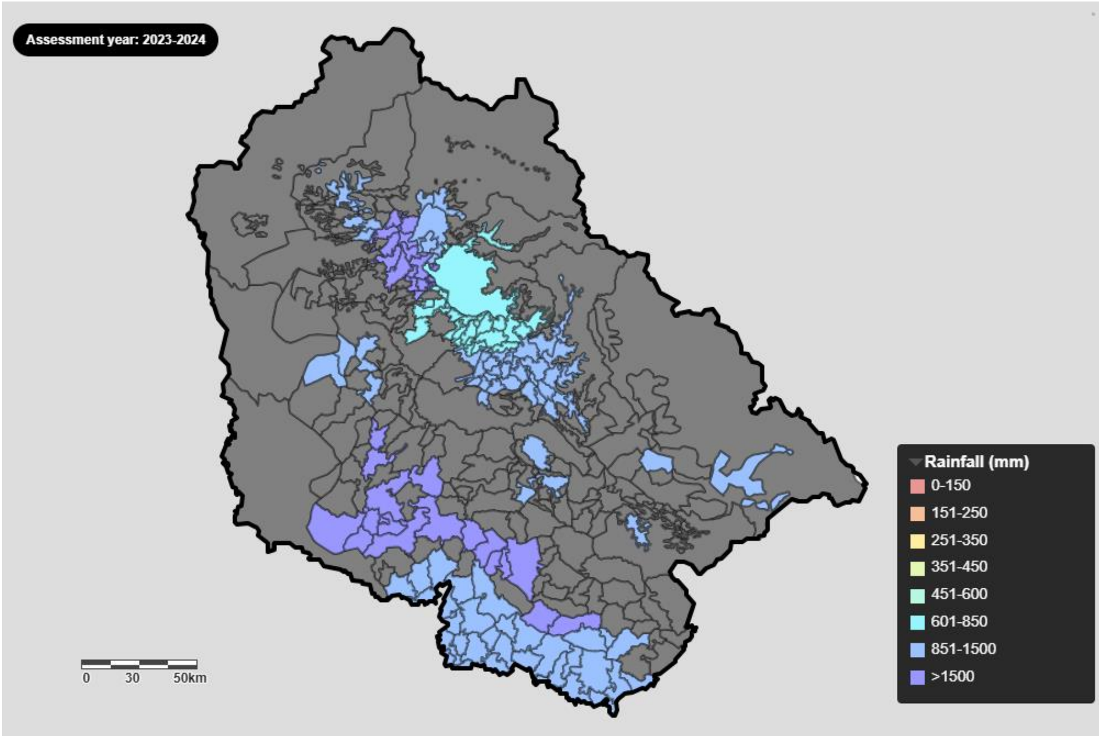

Figure 4: Annual Normal Rainfall in mm.

Table 7:Rainfall during the Calendar Year 2023 for the State/UT and District Wise.

S.No.	Districts	Monsoon Rainfall (mm)	Non-monsoon Rainfall (mm)	Total Rainfall (mm)
1	Anantnag	281.6	661.6	943.2
2	Bandipora	206.5	406.8	613.3
3	Barmulla	198.1	734.6	932.7
4	Budgam	134.2	336.2	470.4
5	Doda	555.7	921.6	1477.3
6	Ganderbal	300.2	544.7	844.9
7	Jammu	910.8	367.9	1278.7
8	Kathua	1372.1	354.2	1726.3
9	Kisthwar	90.7	448	538.7
10	Kulgam	295.3	800.4	1095.7
11	Kupwara	175.2	575.2	750.4
12	Poonch	338	651	989
13	Pulwama	196.3	387.5	583.8
14	Rajouri	568.8	488.3	1057.1
15	Ramban	389.1	978.8	1367.9
16	Reasi	1611.1	592.1	2203.2
17	Samba	1074	333	1407
18	Shopian	134.4	291.7	426.1
19	Srinagar	300.2	484.3	784.5
20	Udhampur	993.2	585	1578.2

Table 8: Rainfall during Ground Water Assessment Year 2023-24 for the State/UT and District wise.

S.No.	Districts	Monsoon Rainfall (mm)	Non-monsoon Rainfall (mm)	Total Rainfall (mm)
1	Anantnag	281.6	627.7	909.3
2	Bandipora	206.5	521.6	728.1
3	Baramulla	198.1	763.1	961.2
4	Budgam	134.2	429	563.2
5	Doda	555.7	893.5	1449.2
6	Ganderbal	300.2	557.1	857.3
7	Jammu	910.8	391.5	1302.3
8	Kathua	1372.1	313.2	1685.3
9	Kisthwar	90.7	99	189.7
10	Kulgam	295.3	733.7	1029
11	Kupwara	175.2	638.3	813.5
12	Poonch	338	490.5	828.5
13	Pulwama	196.3	401.8	598.1
14	Rajouri	568.8	595.2	1164
15	Ramban	389.1	1053.5	1442.6
16	Reasi	1611.1	629.6	2240.7
17	Samba	1074	278	1352
18	Shopian	134.4	285.2	419.6
19	Srinagar	300.2	589.2	889.4
20	Udhampur	993.2	565.5	1558.7

CHAPTER 4

HYDROGEOLOGICAL SETUP OF JAMMU & KASHMIR

4.0. Hydrogeology Of Jammu & Kashmir

The hydrogeological set up in the Union Territory is very complicated owing to varied geological settings and groundwater conditions. The hydrogeological map of J&K is shown in Figure 5. Both the regions of Jammu & Kashmir UT viz. Kashmir and Jammu represent entirely different groundwater regimes. Based on geology and aquifer characteristics, the area of the UT can be divided into two broad hydrogeological units. These units are

A Porous formation

B Fissured formation

4.1. Porous Formation

Porous formations are best suitable for exploration and development. Potential zones are encountered in these formations. These formations are:

4.1.1. Jammu Region

In the Outer Plains of the Jammu region extending between River Ravi in the east to Munnawar Tawi in the west, the groundwater occurs in Piedmont deposits belonging to the upper Pleistocene to the Recent age. The deposits comprise unconsolidated sediments in terraces and coalescent alluvial fans developed by streams debauching out of Siwalik Hills. The sediments consist of coarse clastics ranging in size from boulders to gravel in the loose clay matrix and occasionally alternating bands of clay of varying thickness. Kankar is also intercalated with these sediments at different intervals and variable quantities.

These deposits are graded into finer sediments from north to south in that order. Down south, it comprises alternate bands of sands of all grades and clay with subordinate packs of gravel and pebbles.

Kandi Formation

The typical Kandi formation comprises coarse material with little clay, but the typical Kandi formation is not seen in the Outer Plain of Jammu & Kashmir UT. Instead, they comprise boulder gravel, pebble, and coarse sand with substantial clay, sometimes hard and sticky of varying thickness.

The clay proportion increases towards the southwest. The occurrence of perched water bodies is a common phenomenon in the Kandi belt of Jammu & Kashmir UT. The groundwater generally occurs under unconfined conditions in the Kandi formation.

Sirowal Formation

The Kandi formation coalesces into Sirowal formations in the south, which are finer outwash of Siwalik debris brought by streams. Groundwater occurs under both the confined as well as unconfined conditions in Sirowal formation. A spring line demarcates the contact between Kandi and Sirowal formations because the water table oozes out along this line causing marshy conditions. The spring line has undergone deformation due to a decline in water level resulting from groundwater development in the Sirowal area. However, the base flow could be seen in streams south of this line and in the Sirowal formation, which shows auto-flow conditions in the deeper aquifer system.

The Dun Belt separates the Siwalik hills in the middle Himalayas and runs as a series of river terraces between Basoli (32°30', 76°49'30") in the east to Reasi (33°05', 74°50') and beyond in the west. The sediments are in the form of isolated sub-recent to recent valley-fill deposits ranging in thickness between a few meters to a few tens of meters. These deposits are often dissected as a result of the present-day drainage pattern. The deposits comprise coarse clastics such as boulders, cobbles, pebbles, etc., interbedded with lenticular clays.

Isolated Valley Fills in the Middle Himalayas

There are many isolated valleys in the middle Himalayas where groundwater occurs in valley-fill deposits comprising lacustrine to fluvioglacial sediments. A few meter-thick layers of loess overlies these deposits, which is windblown. Groundwater in such valleys generally occurs under confined conditions. One of the prominent, isolated valleys in the middle Himalayas is Kistwar valley (33°18' 30", 75°46’) in the Doda district of the Jammu region.

4.1.2. Kashmir Region

Kashmir valley covers an area of 5600 km and is occupied by Karewas, which consists of a huge pile of alternating bands of sand, silt, and clay interspersed by glacial boulder beds. The sands are mostly fine to very fine-grained, and it is infrequent that they are medium to coarse-grained. There is considerable lateral facies variation in the nature of the sediments. The aggregate thickness of these sediments is of the order of 2500-3000 m.

Groundwater in the Karewas of Kashmir valley occurs under both confined as well as unconfined conditions.

4.2. Fissured Formation

About 15000 Sq. Km. The area in the Jammu region is occupied by hilly terrain. It comprises rocks ranging in age from the Pre-Cambrian (Salkhala series) to the Miocene or even Pliocene (Murees and upper-middle Siwaliks). The rock types range from soft or friable sandstones, Clays, Shales, and Conglomerates to hard rocks such as traps and metamorphic rocks such as quartzite and crystalline limestone. The Siwalik terrain where groundwater is tapped comes mainly from the weathered mantle or the joints or cracks in these rocks. Friable Siwalik sandstone does possess primary porosity but is not a very potential aquifer.

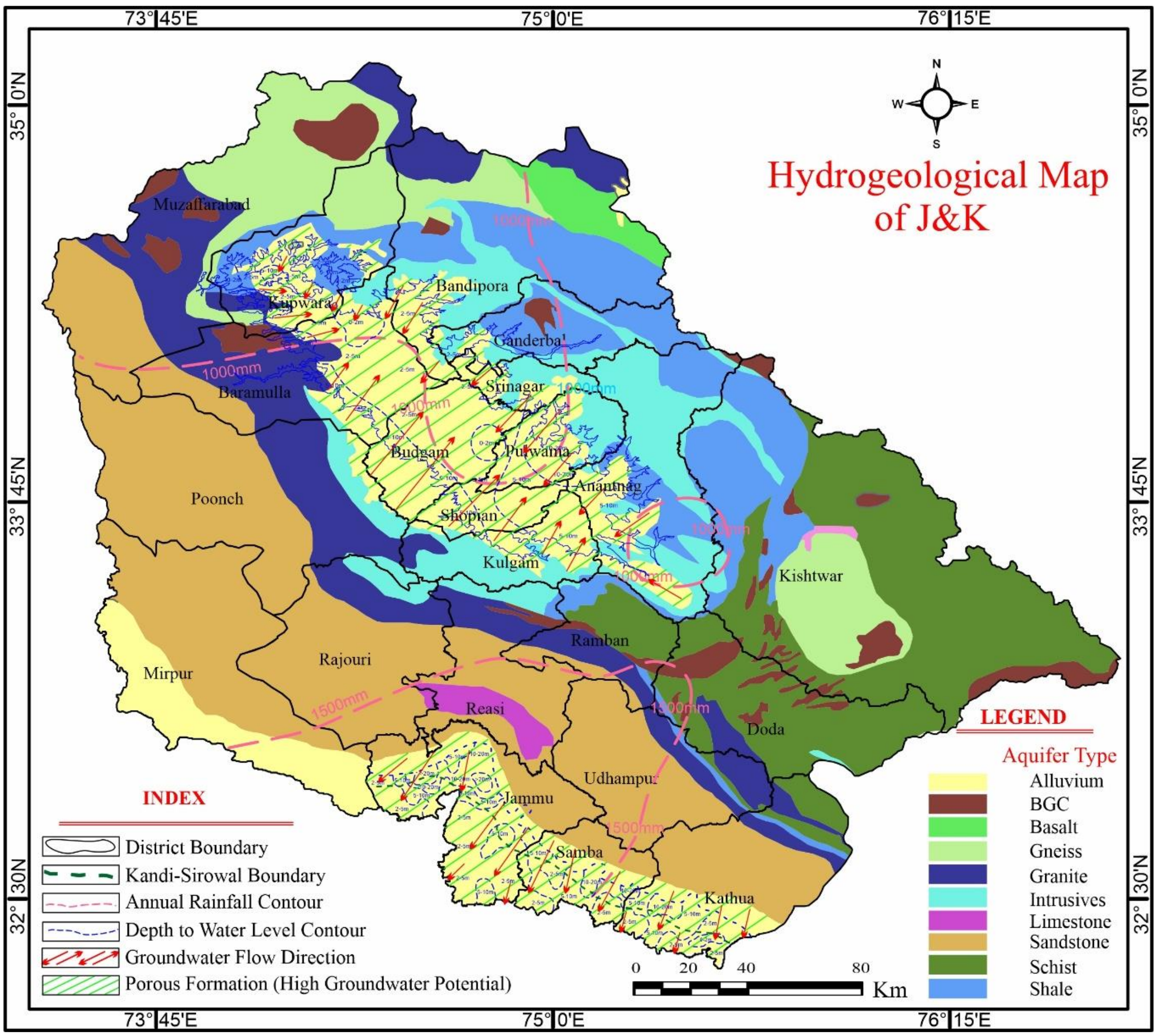

Figure 5: Hydrogeology of UT of J&K.

CHAPTER-5
GROUND WATER LEVEL SCENARIO IN THE UT

5.1. Groundwater Level Scenario (2023)

5.1.1. Groundwater level data of pre-monsoon 2023

Jammu Region: The water level data in respect of 210 wells for May 2023 were analysed. The depth to water level varied from 0.30 m bgl to 38.46 m bgl. The categorization of depth to the water level in May 2023 is given in table 9.

18 wells (8.6%) have recorded a water level of less than 2.0 m bgl. About 110 (52.4%) of the total wells analysed have shown depth to water level in the range 2-5 m bgl. Whereas 59 wells (28.1%) have shown water levels in the range of 5-10 m bgl. 12 (5.7%) wells have registered deeper water levels, in the range of 10-20 m bgl. Another 11 wells (5.2%) of the total wells analysed have shown water levels in the range of >20 m bgl.

Valley areas of the Jammu outer plains below the contact of Kandi Sirowal show water level between 2-5 m bgl except few patches that show water levels between 0-2m bgl. In Sirowal area of Outer Plains, most of the water levels have been recorded between 2 - 10 m bgl except a few small patches that show water levels from 0 to 2 m & above 10 m bgl. In Kandi Belt, the water levels are deeper ranging between 10-20 m bgl and a few patches northern and north western Jammu, water levels are more than 20 m bgl (Figure 6).

Kashmir Region: The water level data in respect of 80 wells for the month of May 2023 were analysed. The depth to water level varied from 0.17 m bgl to 14.46 m bgl. 50 wells (62.5%) have recorded the water level less than 2.0 m bgl. About 27 wells 33.8% of the total wells analysed have shown depth to water level in the range 2-5 m bgl. Whereas 2 wells (2.5%) have shown water levels in the range of 5-10 m bgl. 1 (1.3%) wells have registered deeper water levels, in the range of 10-20 m bgl. No well (0%) has shown water levels in the range of >20 m bgl

Valley areas of Kashmir Region have shown water levels in all ranges. Major portion has shown within 2m bgl in Kupwara and Baramulla districts. Water levels above 2 but under 5 m have been shown in the northern parts of Baramulla few patches in Kupwara and Srinagar and Pulwama districts. The water level is deeper towards northern and north-eastern parts of Pulwama & Anantnag district (Figure 7).

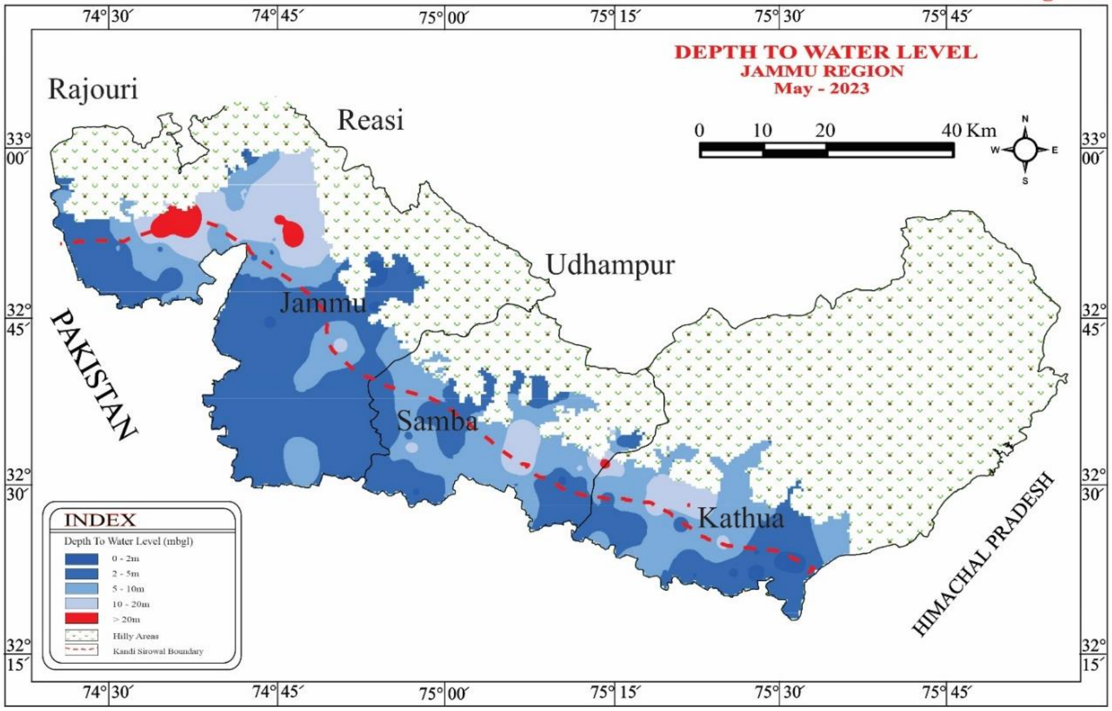

Figure 6: Depth to Water Level Jammu Region May-2023.

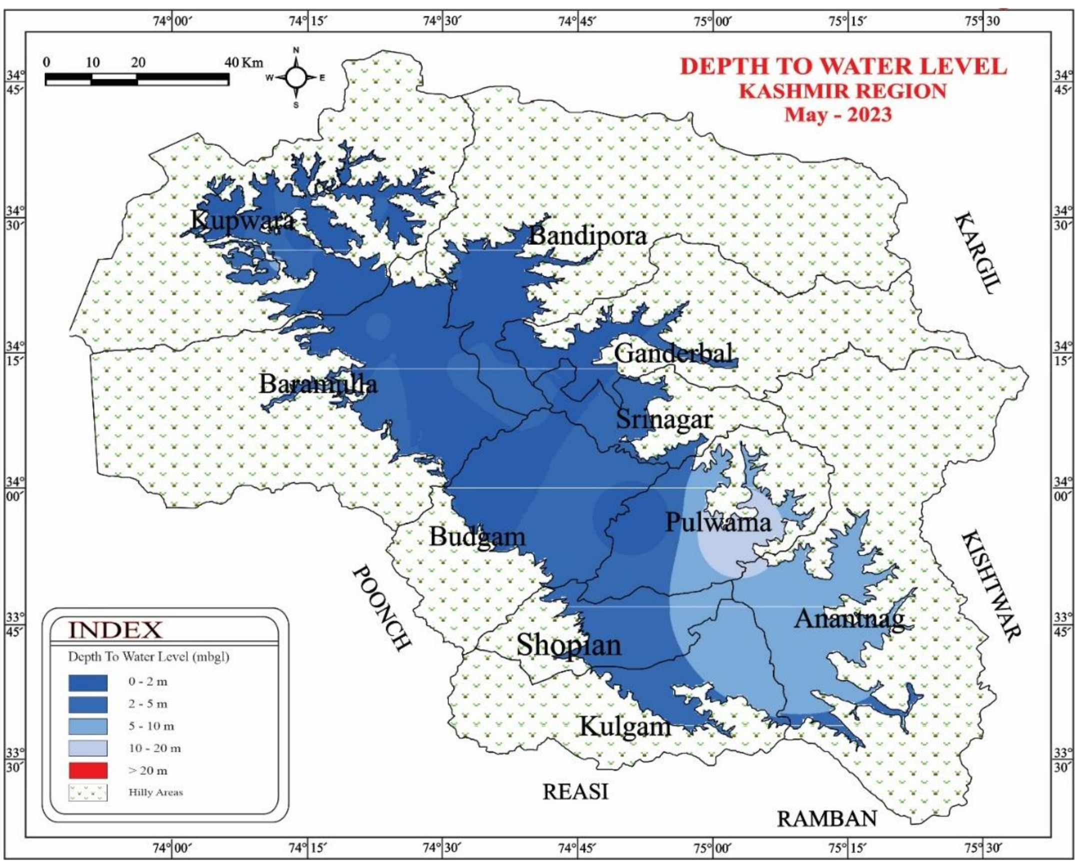

Figure 7: Depth to Water level Kashmir Region May-2023.

Table 9: Categorization Of Depth To Water Level- May 2023.

REGION	District	No. Of wells Analyzed	Depth to Water Level (mbgl)		Number of Wells Showing Depth to Water Level (mbgl) in the Range of					Percentage of Wells Showing Depth to Water Level (mbgl) in the Range of				
			Min	Max	0–2	2–5	5–10	10–20	> 20	0–2	2–5	5–10	10–20	> 20
KASHMIR REGION	Bandipora	**5**	**0.50**	**2.35**	**2**	**3**	**0**	**0**	**0**	**40**	**60**	**0**	**0**	**0**
	Baramulla	26	0.20	6.65	15	10	1	0	0	57.7	38.5	3.8	0.0	0.0
	Kupwara	46	0.18	6.68	31	14	1	0	0	67.4	30.4	2.2	0.0	0.0
	Pulwama	2	0.17	14.46	1	0	0	1	0	50.0	0.0	0.0	50.0	0.0
	Srinagar	1			1	0	0	0		100.0	0.0	0.0	0.0	0.0
	Total	**80**	**0.17**	**14.46**	**50**	**27**	**2**	**1**	**0**	**62.5**	**33.8**	**2.5**	**1.3**	**0.0**
JAMMU REGION	Jammu	74	0.60	38.46	3	40	22	4	5	4.1	54.1	29.7	5.4	6.8
	Kathua	33	0.65	29.74	4	12	11	3	3	12.1	36.4	33.3	9.1	9.1
	Rajauri	37	0.30	8.70	4	26	7	0	0	10.8	70.3	18.9	0.0	0.0
	Reasi	8	1.90	25.03	1	5	1	0	1	12.5	62.5	12.5	0.0	12.5
	Samba	36	1.20	22.67	3	13	13	5	2	8.3	36.1	36.1	13.9	5.6
	Udhampur	22	0.95	8.80	3	14	5	0	0	13.6	63.6	22.7	0.0	0.0
	Total	**210**	**0.30**	**38.46**	**18**	**110**	**59**	**12**	**11**	**8.6**	**52.4**	**28.1**	**5.7**	**5.2**
	TOTAL J&K	**290**			**68**	**137**	**61**	**13**	**11**	**23.4**	**47.2**	**21.0**	**4.5**	**3.8**

5.1.2. Groundwater level data for post-monsoon 2023

Jammu Region: The water level data in respect of 228 wells for the month of November 2023 were analysed. The depth to water level ranges from 0.1 m bgl to 35.46 m bgl. Categorization of DTWL Nov. 2022 is given in table 10.

A total of 67 numbers of wells (29.4%) have recorded the water level less than 2.0 m bgl. Majority of the wells 111 wells (48.7%) analysed have shown depth to water level in the range of 2-5 m bgl. Whereas 31 wells (13.6%) have shown water levels in the range of 5-10 m bgl. 10 wells (4.4%) have registered deeper water levels, in the range of 10-20 m bgl. Another 9 wells (3.9%) of the total wells analysed have shown water levels in the range of >20 m bgl.

In Sirowal formation of Jammu, Samba and Kathua, water levels varied between 0 to 5 in major parts and 0-2 m bgl at a few parts. Major part of Sirowal belt in all the three districts shows water levels between 2 and 5 m bgl and water levels in the range of 2-5 m & 5 – 10 m bgl have been observed at a few patches. In Kandi belt, the water levels generally found are within the range of 5 - 20 mbgl. Water levels deeper than 20m bgl were observed in the extreme north & north-western portion of Jammu district in Kandi belt and central parts in Samba district (Figure 8).

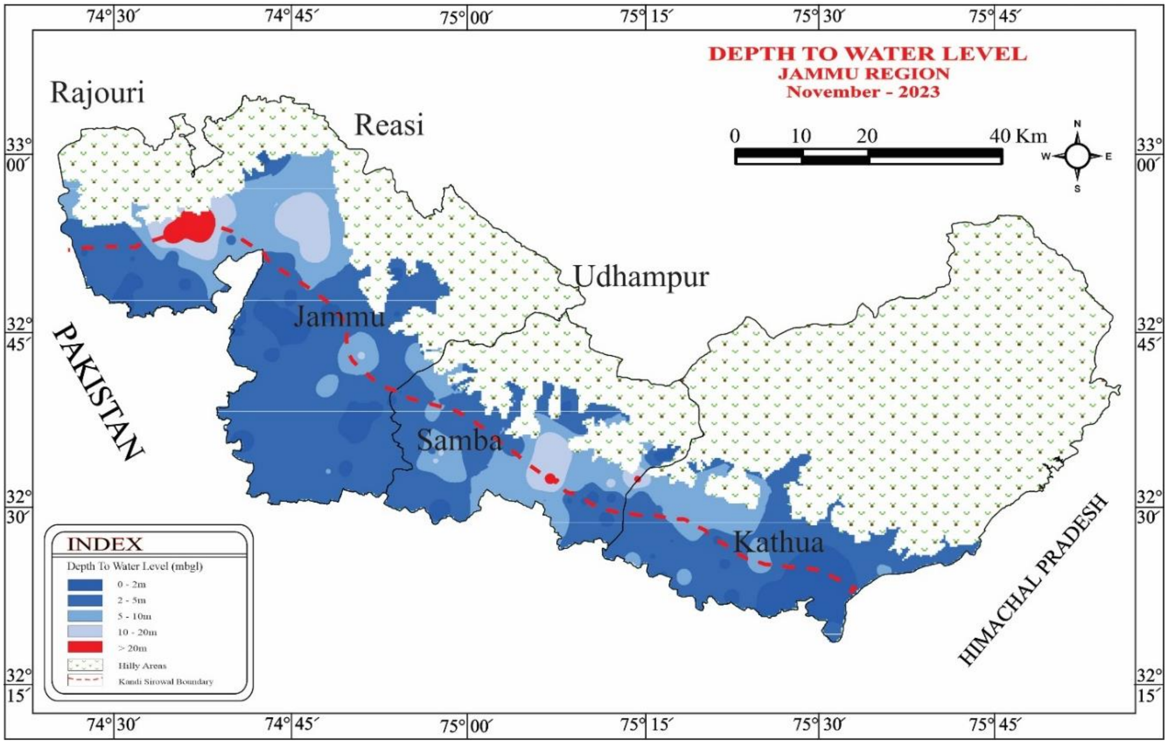

Figure 8: Depth to Water Level Jammu Region November- 2023.

Kashmir Region: The water level data in respect of 78 wells for the month of November 2023 were analysed. The depth to water level varied from 0.35 m bgl to 15.29 m bgl. 18 wells (23.1%) have recorded the water level less than 2.0 m bgl. About 50 wells (64.1%) have shown depth to water level in the range 2-5 m bgl. Whereas 9 wells (11.5%) have shown water levels in the range of 5-10 m bgl. 01 well (1.3%) has registered deeper water levels, in the range of 10-20 m bgl. No well has shown water levels in the range of >20 m bgl.

Valley areas of Kashmir Region have shown water levels in all ranges. Major portion has shown within 2m to 5 m bgl. In Baramulla and pulwama districts water levels above 2 but under 5 m have been shown in the northern parts of Baramulla few patches in Kupwara and Srinagar and Pulwama districts. The water level is deeper towards northern and north-eastern parts of Anantnag & Pulwama district (figure 9).

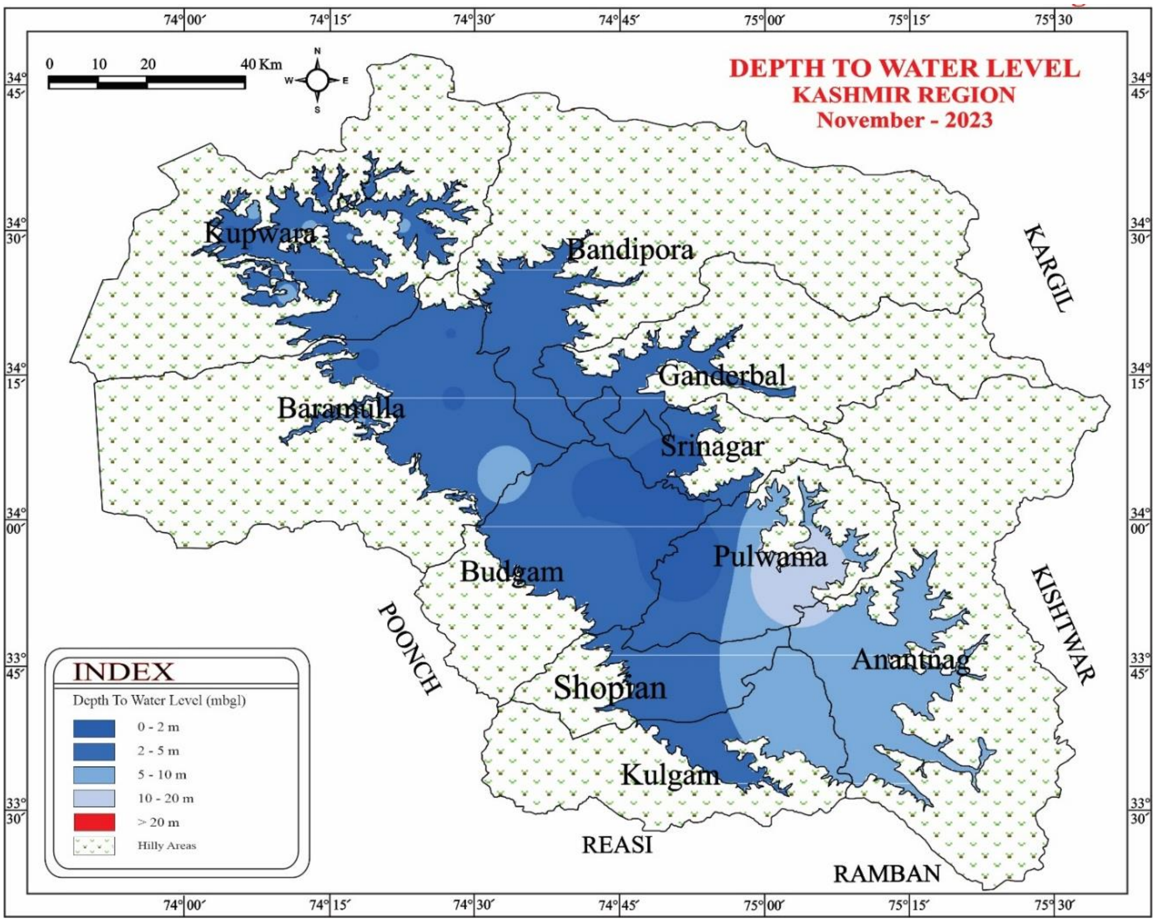

Figure 9:Depth to Water Level Kashmir Region November 2023.

Table 10:Categorization Of Depth To Water Level- November 2023.

REGION	District	No. Of wells Analyzed	Depth to Water Level (mbgl)		Number of Wells Showing Depth to Water Level (mbgl) in the Range of					Percentage of Wells Showing Depth to Water Level (mbgl) in the Range of				
			Min	Max	0–2	2–5	5–10	10–20	> 20	0–2	2–5	5–10	10–20	> 20
KASHMIR REGION	Bandipora	5	2.10	2.75	0	5	0	0	0	0	100	0	0	0
	Baramulla	24	1.05	7.20	5	16	3	0	0	20.8	66.7	12.5	0.0	0.0
	Budgam	1			1					100.0				
	Kupwara	45	0.65	7.8	10	29	6	0	0	22.2	64.4	13.3	0.0	0.0
	Pulwama	2	0.35	15.29	1	0	0	1	0	50.0	0.0	0.0	50.0	0.0
	Srinagar	1			1	0	0	0	0	100.0	0.0	0.0	0.0	0.0
	Total	**78**	**0.35**	**15.29**	**18**	**50**	**9**	**1**	**0**	**23.1**	**64.1**	**11.5**	**1.3**	**0.0**
JAMMU REGION	Jammu	85	0.21	34.17	16	49	9	6	5	18.8	57.6	10.6	7.1	5.9
	Kathua	41	0.38	55.75	12	16	9	2	2	29.3	39.0	22.0	4.9	4.9
	Rajauri	36	0.93	6.40	14	18	4	0	0	38.9	50.0	11.1	0.0	0.0
	Reasi	8	1.61	24.99	3	4	0	0	1	37.5	50.0	0.0	0.0	12.5
	Samba	36	0.35	20.15	10	15	8	2	1	27.8	41.7	22.2	5.6	2.8
	Udhampur	22	0.10	5.63	12	9	1	0	0	54.5	40.9	4.5	0.0	0.0
	Total	**228**	**0.10**	**55.75**	**67**	**111**	**31**	**10**	**9**	**29.4**	**48.7**	**13.6**	**4.4**	**3.9**
	TOTAL J&K	**306**			**85**	**161**	**40**	**11**	**9**	**27.8**	**52.6**	**13.1**	**3.6**	**2.9**

5.2. Fluctuation of Groundwater Level

5.2.1. Comparison of Pre-monsoon 2023 to Pre-monsoon 2022

Jammu Region: The water level data in respect of 196 National Hydrograph Stations for the month of May 2023 was analysed. It was compared with May 2022. Majority of the wells have shown rise in water levels. A total of 127 wells have shown rise and 69 wells have shown fall in water levels in the range of 0-2 m, 2-4 m and >4 m. The minimum rise 0.01 m to maximum rise of 5.5 m is shown. Whereas minimum decline of 0.02 m is recorded to a maximum of 4.62 m. Categorization of fluctuations in water levels is given in table 11.

Rise is shown by 115 wells in the range of 0-2 m. 9 wells have registered rise from 2-4 m bgl and 3 wells are showing rise of >4 m. Among 69 wells showing fall, 61 wells have shown fall in water level in the range 0-2 m, 6 wells have shown fall between 2-4 m, and 2 well have shown fall of >4 m.

All the districts have shown rise in water levels where as a significant portion have shown decline in water level. The decline in water levels in the range of 0-2 m is observed in sufficient portions in all the districts. Major parts of Jammu district, entire Samba and most of Kathua districts shown decline. South Jammu, northern western parts of Kathua shows >4m decline in water levels (Figure 10).

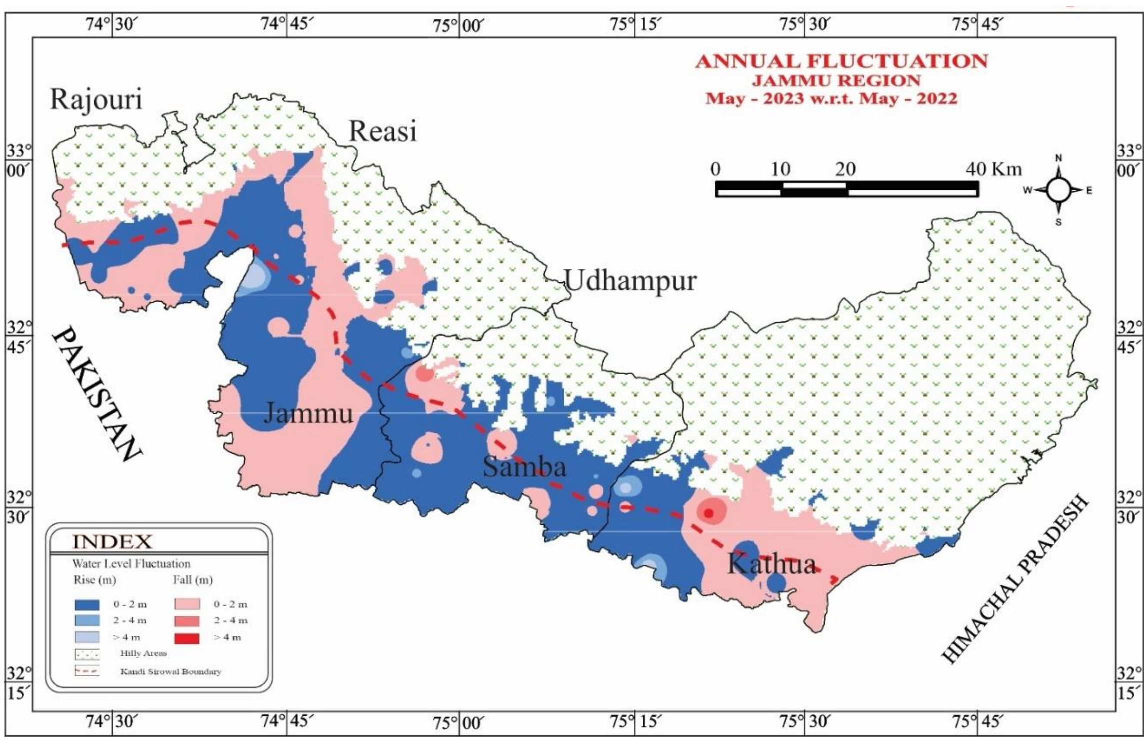

Figure 10: Annual Fluctuation Jammu Region May-2023 w.r.t. May-2022.

Table 11: Categorization Of Changes In Water Level Between May 2022 And May 2023.																			
District	No. Of wells Analyzed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation (m)						Percentage of wells Showing Fluctuation						Total No. Of Wells	
		Rise		Fall		Rise			Fall			Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4		
Jammu	72	0.01	5.50	0.05	3.25	39	1	1	28	3	0	54.2	1.4	1.4	38.9	4.2	0.0	41	31
Kathua	31	0.07	5.50	0.07	4.62	19	1	2	8	0	1	61.3	3.2	6.5	25.8	0.0	3.2	22	9
Rajouri	33	0.10	2.90	0.10	4.54	20	2	0	9	1	1	60.6	6.1	0.0	27.3	3.0	3.0	22	11
Reasi	5	0.23	2.92			3	1	0	1	0	0	60.0	20.0	0.0	20.0	0.0	0.0	4	1
Samba	33	0.05	2.65	0.02	3.70	21	3	0	8	1	0	63.6	9.1	0.0	24.2	3.0	0.0	24	9
Udhampur	22	0.04	2.68	0.15	2.39	13	1	0	7	1	0	59.1	4.5	0.0	31.8	4.5	0.0	14	8
Total	**196**	**0.01**	**5.50**	**0.02**	**4.62**	**115**	**9**	**3**	**61**	**6**	**2**	**58.7**	**4.6**	**1.5**	**31.1**	**3.1**	**1.0**	127	69

Kashmir Region: The water level data in respect of 49 National Hydrograph Stations for the month of May 2023 was analysed. It was compared with May 2022. Majority of the wells have shown rise in water levels. A total of 47 wells have shown rise and 2 wells have shown fall in water levels. The minimum rise 0.08 m to maximum rise of 2.97 m is shown. Whereas minimum decline of 0.15 m is recorded to a maximum of 0.25 m. Categorization of fluctuations in water levels is given in table 12.

Rise is shown by 44 wells in the range of 0-2 m. 3 wells have registered rise from 2-4 m bgl and 9 wells are showing rise of >4 m. Among 2 wells showing fall, all 2 wells have shown fall in water level in the range 0-2 m, whereas no well has shown decline below 2m.

Due to insufficient No of wells mapping not possible.

Table 12: Categorization Of Changes In Water Level Between May 2022 And May 2023.																			
District	No. Of wells Analyzed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation (m)						Percentage of wells Showing Fluctuation						Total No. Of Wells	
		Rise		Fall		Rise			Fall			Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4		
Baramulla	16	0.14	1.40			16	0	0	0	0	0	100.0	0.0	0.0	0.0	0.0	0.0	16	0
Kupwara	30	0.08	2.97	0.15	0.25	25	3	0	2	0	0	83.3	10.0	0.0	6.7	0.0	0.0	28	2
Pulwama	2	0.18	0.58			2	0	0	0	0	0	100.0	0.0	0.0	0.0	0.0	0.0	2	0
Srinagar	1					1	0	0	0	0	0	100.0	0.0	0.0	0.0	0.0	0.0	1	0
Total	**49**	**0.08**	**2.97**	**0.15**	**0.25**	**44**	**3**	**0**	**2**	**0**	**0**	**89.8**	**6.1**	**0.0**	**4.1**	**0.0**	**0.0**	**47**	**2**

5.2.2. Comparison of November 2023 to November 2022

Jammu Region: The water level data, in respect of 228 National Hydrograph Stations for the month of November 2023 was analysed. It was compared with those monitored during November 2022. Majority of the wells have shown rise in water levels. A total of 144 wells have shown rise and 84 wells have shown fall in water levels. The minimum rise 0.02 m to a maximum rise of 4.2 m is observed. Whereas minimum decline of 0.01 m is recorded to a maximum of 5.12 m is recorded. Categorization of fluctuations in water levels is given in table 13.

Rise is shown by 138 wells in the range of 0-2 m. 5 wells have recorded rise in the range of 2-4 m bgl and only 1 well has shown rise of >4 m. Among 84 wells showing fall, 77 wells have shown fall in the range of 0-2 m. 6 wells have shown fall between 2-4 m, and 1 well have shown fall of >4 m.

Major parts of all the districts have shown rise in water levels in the range of 0-4 m. Major parts of each district have shown decline in 0-2m with few exceptions. The decline is shown in central northwestern Jammu, central Samba and & north-western and eastern Kathua district (Figure 11).

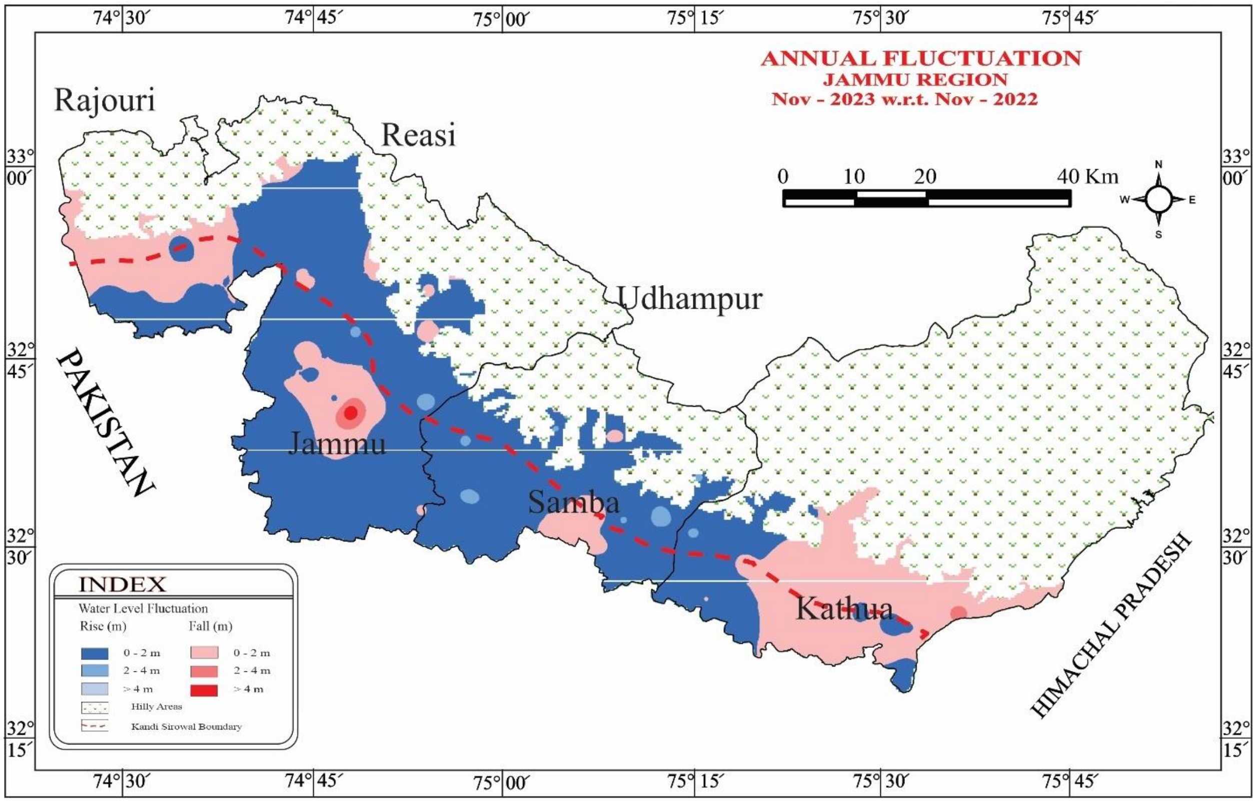

Figure 11: Annual Fluctuation Jammu Region Nov-2023 w.r.t. Nov-2022.

Table 13: Categorization Of Changes In Water Level Between November 2022 And November 23.

District	No. Of wells Analyzed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation (m)						Percentage of wells Showing Fluctuation						Total No. Of Wells	
		Rise		Fall		Rise			Fall			Rise			Fall				
		Min	Max	Min	Max	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	Rise	Fall
Jammu	85	0.02	2.32	0.01	5.12	65	1	0	17	1	1	76.5	1.2	0.0	20.0	1.2	1.2	66	19
Kathua	41	0.02	1.68	0.03	2.26	21	0	0	19	1	0	51.2	0.0	0.0	46.3	2.4	0.0	21	20
Rajouri	36	0.10	1.58	0.04	3.62	9	0	0	24	3	0	25.0	0.0	0.0	66.7	8.3	0.0	9	27
Reasi	8	0.23	2.63	0.02	0.50	4	1	0	3	0	0	50.0	12.5	0.0	37.5	0.0	0.0	5	3
Samba	36	0.08	4.20	0.13	0.64	26	2	1	7	0	0	72.2	5.6	2.8	19.4	0.0	0.0	29	7
Udhampur	22	0.05	2.67	0.15	2.08	13	1	0	7	1	0	59.1	4.5	0.0	31.8	4.5	0.0	14	8
Total	**228**	**0.02**	**4.20**	**0.01**	**5.12**	**138**	**5**	**1**	**77**	**6**	**1**	**60.5**	**2.2**	**0.4**	**33.8**	**2.6**	**0.4**	**144**	**84**

Kashmir Region: The water level data in respect of 47 National Hydrograph Stations for the month of May 2023 was analysed. It was compared with May 2022. Majority of the wells have decline in water levels. A total of 15 wells have shown rise and 32 wells have shown fall in water levels. The minimum rise 0.07 m to maximum rise of 2.4 m is shown. Whereas minimum decline of 0.15 m is recorded to a maximum of 2.6 m. Categorization of fluctuations in water levels is given in table 14.

Rise is shown by 13 wells in the range of 0-2 m. 2 well have registered rise from 2-4 m bgl and no well shows rise of >4 m. Among 32 wells showing fall, 26 wells have shown fall in water level in the range 0-2 m, 6 wells have shown fall in water level in the range 2-4 m, whereas no well has shown decline below 4m.

Due to insufficient No of wells mapping not possible

Table 14: Categorization Of Changes In Water Level Between Nov 2022 And Nov 23.

District	No. Of wells Analyzed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation (m)						Percentage of wells Showing Fluctuation						Total No. Of Wells	
		Rise		Fall		Rise			Fall			Rise			Fall				
		Min	Max	Min	Max	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	Rise	Fall
Baramulla	14	0.40	0.55	0.15	0.25	3	0	0	11	0	0	21.4	0.0	0.0	78.6	0.0	0.0	3	11
Kupwara	30	0.07	2.40	0.20	2.60	9	1	0	14	6	0	30.0	3.3	0.0	46.7	20.0	0.0	10	20
Pulwama	2					1	0	0	1	0	0	50.0	0.0	0.0	50.0	0.0	0.0	1	1
Srinagar	1					0	1	0	0	0	0	0.0	100.0	0.0	0.0	0.0	0.0	1	0
Total	**47**	**0.07**	**2.40**	**0.15**	**2.60**	**13**	**2**	**0**	**26**	**6**	**0**	**27.7**	**4.3**	**0.0**	**55.3**	**12.8**	**0.0**	**15**	**32**

5.2.3. Comparison of Pre-Monsoon 2023 with decadal mean of Pre-Monsoon (2013 to 2022)

The water level fluctuation for the month of May 2023 Vs. (Mean of May 2013 – May 2022) has been worked out in respect of 207 observation wells. It is observed that a total of 127 wells have shown rise and 80 wells have shown decline in water level (especially in Kandi areas of Outer plains). The minimum rise 0.01 m to a maximum rise of 5.8 m. Whereas minimum decline of 0.02 m to a maximum of 6.43 m. Categorisation of fluctuations in water level is given in table 15.

Out of 127 number of wells showing rise, 112 wells have shown rise less than 2 m, 11 wells have shown rise from 2-4 m and 4wells have shown rise of > 4 m. Out of 80 wells showing fall, 75 wells have shown fall in the range of 0-2 m, 3 wells have shown fall between 2-4 m and 2 wells have shown fall of >4 m.

Majority of the area shows a decline in water levels in all ranges in Jammu Region. In Jammu district, the decline in range of 0-5m was found in entire area except western and southern patches. In Samba major areas have shown decline except few portions, and in Jammu & Kathua district major area is in declining trend except in the central Jammu & western Kathua. (Figure 12).

Kashmir Region: Due to insufficient No of well data analysis and mapping not possible

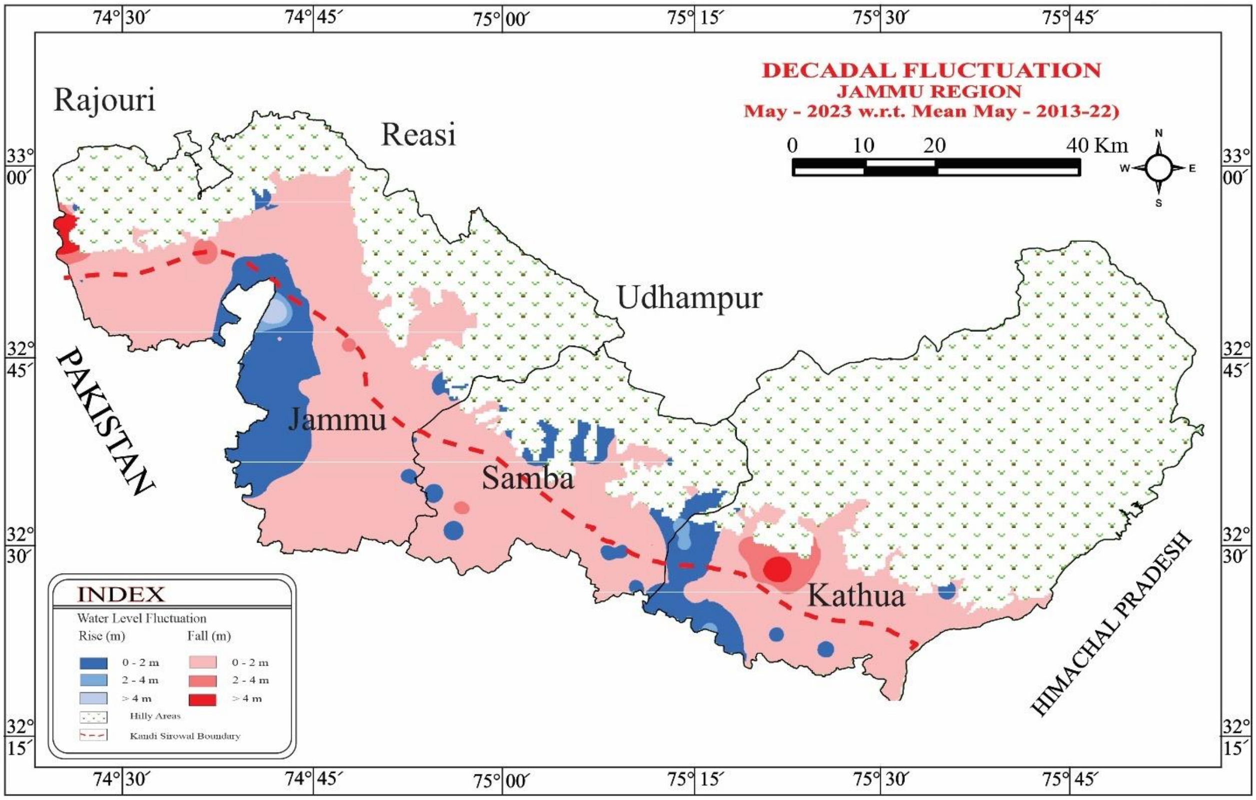

Figure 12: Decadal Fluctuation Jammu Region May 2023 w.r.t. Mean May - 2013-22.

Table 15: Categorisation Of Changes In Water Level Between May 2023 To Decadal Mean (May 2013-May 2022)

District	No. Of wells Analyzed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation (m)						Percentage of wells Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4		
Jammu	71	0.02	8.67	0.05	3.75	18	0	1	48	4	0	25.4	0.0	1.4	67.6	5.6	0.0	19	52
Kathua	27	0.01	3.04	0.03	6.63	13	3	0	9	1	1	48.1	11.1	0.0	33.3	3.7	3.7	16	11
Rajouri	37	0.00	3.36	0.04	2.76	16	0	0	15	6	0	43.2	0.0	0.0	40.5	16.2	0.0	16	21
Reasi	8	0.15	0.92	0.30	0.57	5	0	0	3	0	0	62.5	0.0	0.0	37.5	0.0	0.0	5	3
Samba	36	0.14	1.99	0.06	3.94	12	0	0	21	3	0	33.3	0.0	0.0	58.3	8.3	0.0	12	24
Udhampur	22	0.06	1.14	0.20	2.67	11	0	0	9	2	0	50.0	0.0	0.0	40.9	9.1	0.0	11	11
TOTAL	**201**	**0.00**	**8.67**	**0.03**	**6.63**	**75**	**3**	**1**	**105**	**16**	**1**	**37.3**	**1.5**	**0.5**	**52.2**	**8.0**	**0.5**	**79**	**122**

5.2.4. Comparison of post-monsoon 2023 with decadal mean of post-monsoon (2013 to 2022)

The water level fluctuation for the month of November 2023 w.r.t. (mean of November 2013 to November 2022) has been worked out in respect of 218 observation wells. It is observed that a total of 90 wells have shown rise and 128 wells have shown decline in water levels. The minimum rise 0.02 m to a maximum rise of 13.12 m is observed. Whereas minimum decline of 0.01 m to a maximum of 3.54 m is recorded. Categorisation of fluctuations in water level is given in table 16.

Out of 90 number of wells showing rise, 88 wells are showing rise less than 2 m, 1 well have shown rise from 2-4 m and 1 wells have shown rise of more than 4 m. Out of 128 wells, which are showing fall, 118 wells have shown fall in water levels in the range of 0-2 m, 10 wells have shown fall between 2-4 m and 0 wells have shown fall of >4 m.

Decline in water levels was observed in all the districts of Jammu Region. A few areas have shown rise in water levels above 0- 2m in all districts. Western areas of Jammu district, northern and south eastern Samba and northern areas of Kathua districts have shown decline in water levels. Small portions in Jammu show rise above 2 m. (Figure 16).

Kashmir Region: Due to insufficient No of wells analysis and mapping not possible

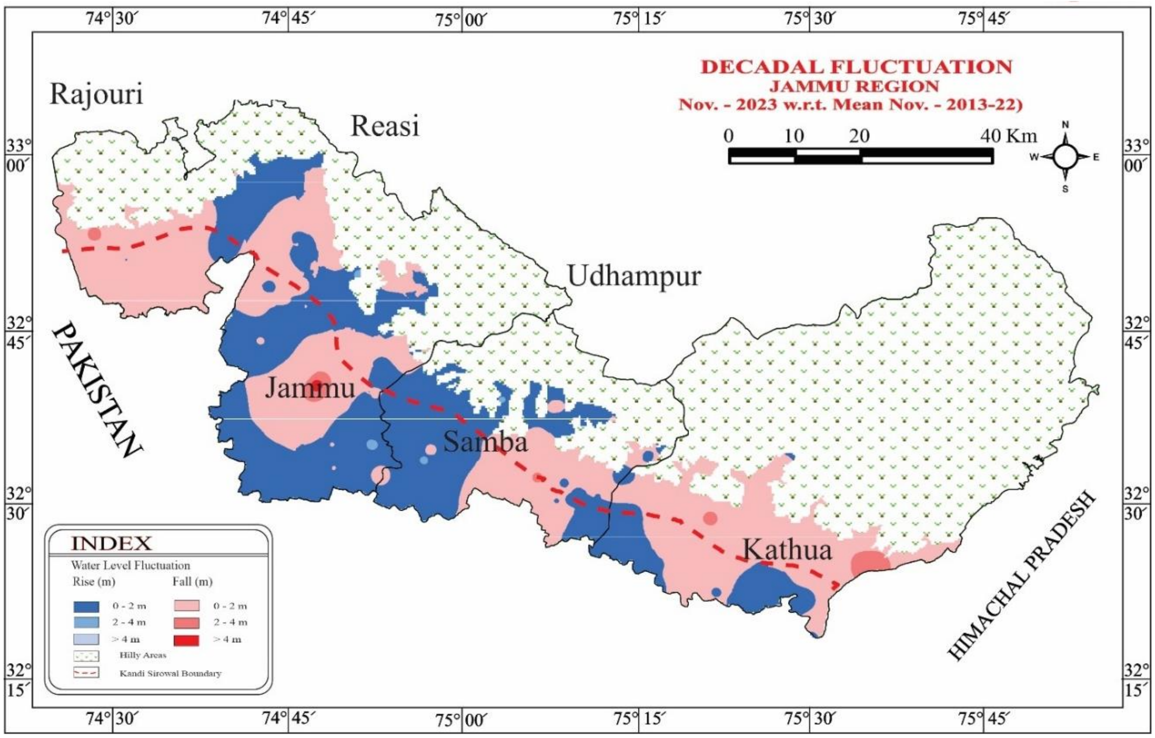

Figure 13: Decadal Fluctuation Jammu Region November 2023 w.r.t. Mean Nov. - 2013-22.

Table 16: Categorisation of changes in water level between november 2023 to decadal mean (november 2013-november 2022).

District	No. Of wells Analyzed	Range of Fluctuation (m)				No. of Wells Showing Fluctuation (m)						Percentage of wells Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise			Fall				
		Min	Max	Min	Max	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	0 – 2	2 – 4	> 4	Rise	Fall
Jammu	83	0.02	2.78	0.01	4.88	38	2	0	40	1	2	45.8	2.4	0.0	48.2	1.2	2.4	40	43
Kathua	33	0.01	0.88	0.01	3.35	19	0	0	12	2	0	57.6	0.0	0.0	36.4	6.1	0.0	19	14
Rajouri	36	0.02	1.84	0.06	3.14	15	0	0	18	3	0	41.7	0.0	0.0	50.0	8.3	0.0	15	21
Reasi	7	0.11	0.92			6	0	0	1	0	0	85.7	0.0	0.0	14.3	0.0	0.0	6	1
Samba	35	0.01	5.10	0.17	2.34	22	2	1	9	1	0	62.9	5.7	2.9	25.7	2.9	0.0	25	10
Udhampur	22	0.03	2.27	1.30	2.34	19	1	0	1	1	0	86.4	4.5	0.0	4.5	4.5	0.0	20	2
TOTAL	**216**	**0.01**	**5.10**	**0.01**	**4.88**	**119**	**5**	**1**	**81**	**8**	**2**	**55.1**	**2.3**	**0.5**	**37.5**	**3.7**	**0.9**	125	91

CHAPTER 6

GROUND WATER RESOURCES OF THE STATE/UT

6.1. ANNUAL GROUND WATER RECHARGE

Total Annual Ground Water Recharge is 2.55 bcm and total Natural Discharge is 0.25 bcm. (Figure-14 & 15)

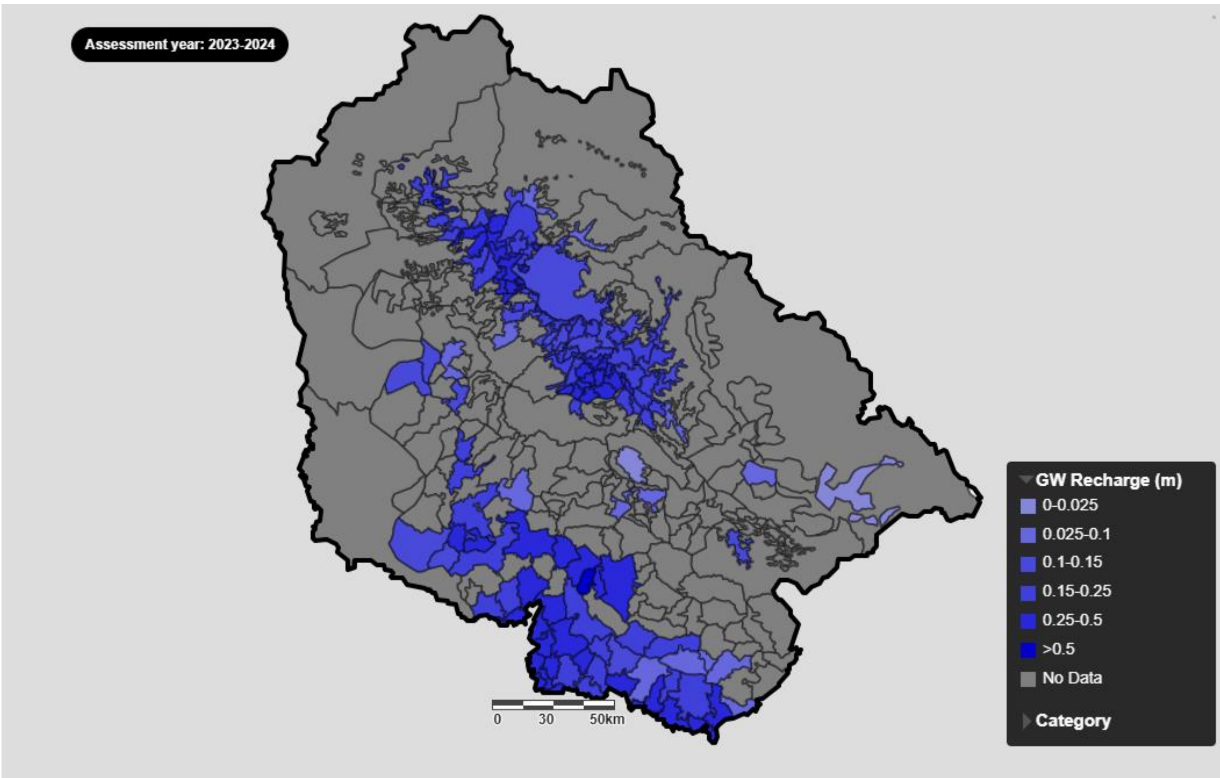

Figure 14: Annual Groundwater Recharge Unit Map.

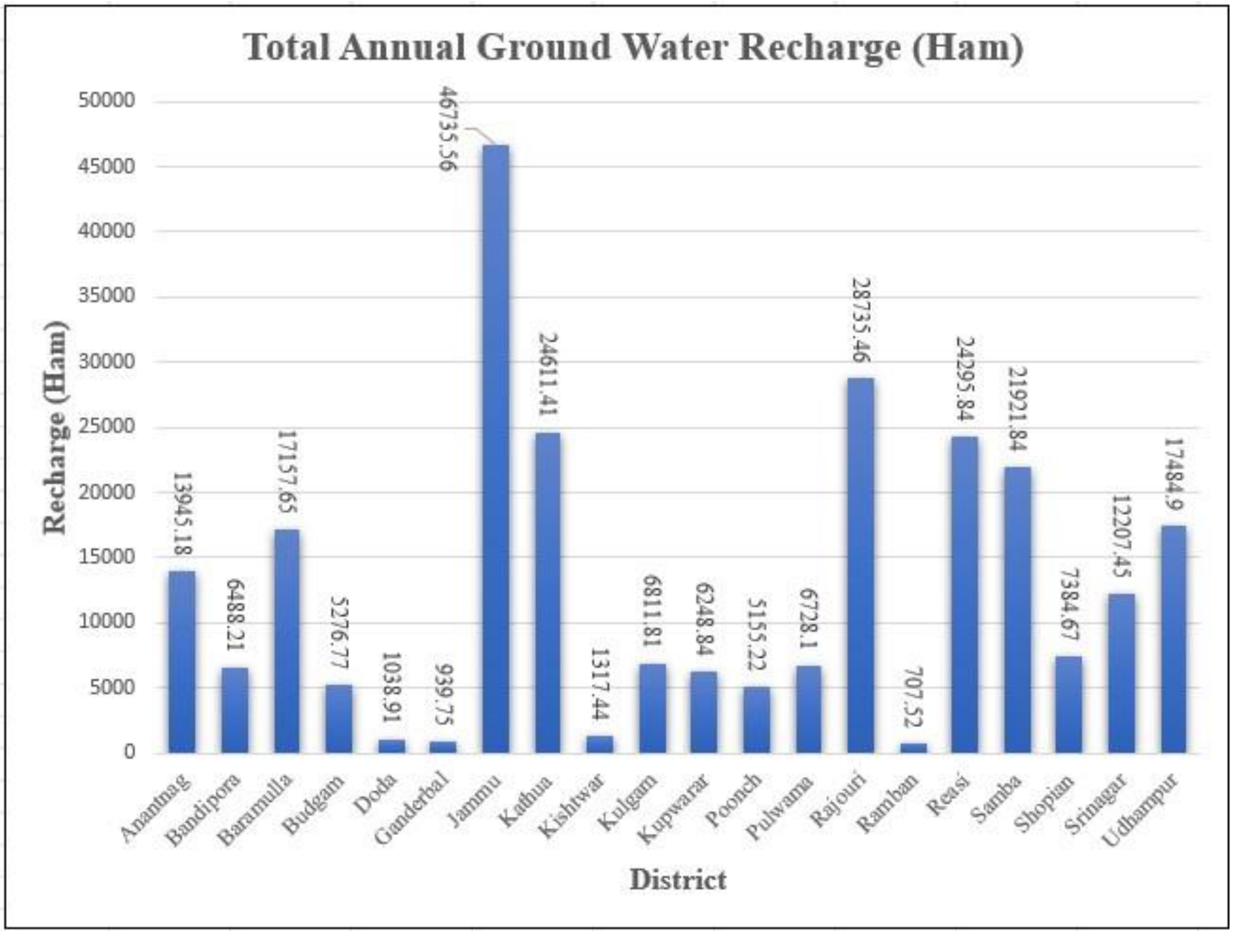

Figure 15:District wise Total Annual ground Water Recharge.

6.2. ANNUAL EXTRACTABLE GROUND WATER RESOURCES

The Annual Extractable Ground Water Resource of the UT is 2.30 bcm. (Figure-16)

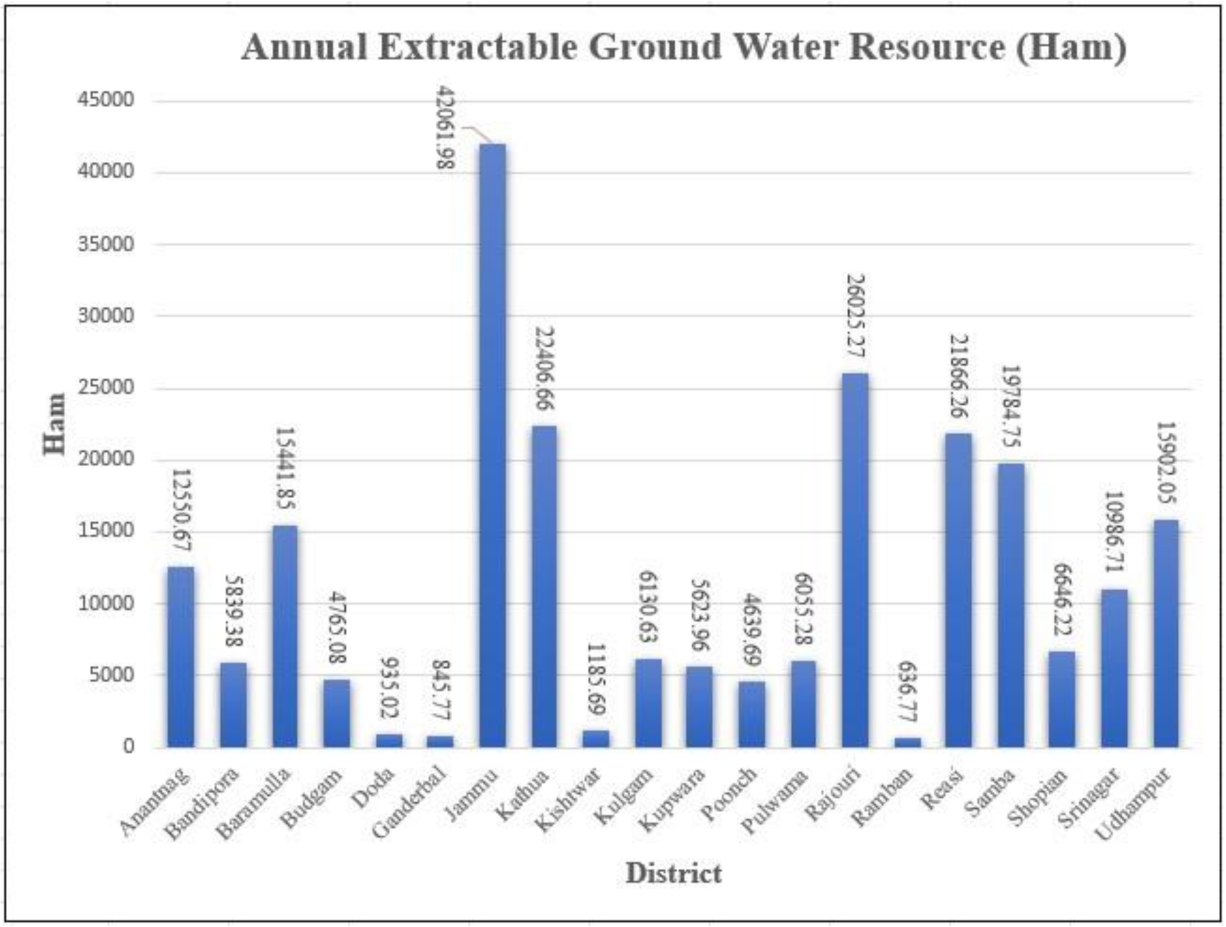

Figure 16: Annual Extractable Ground Water Resource.

6.3. ANNUAL TOTAL GROUND WATER EXTRACTION

The existing ground water extraction for all uses in the state is 0.51 bcm with Jammu district having the highest extraction of ground water (13639.44 Ham) and Kishtwar district having the lowest (186.34 Ham) ground water extraction. (Figure-17 & 18)

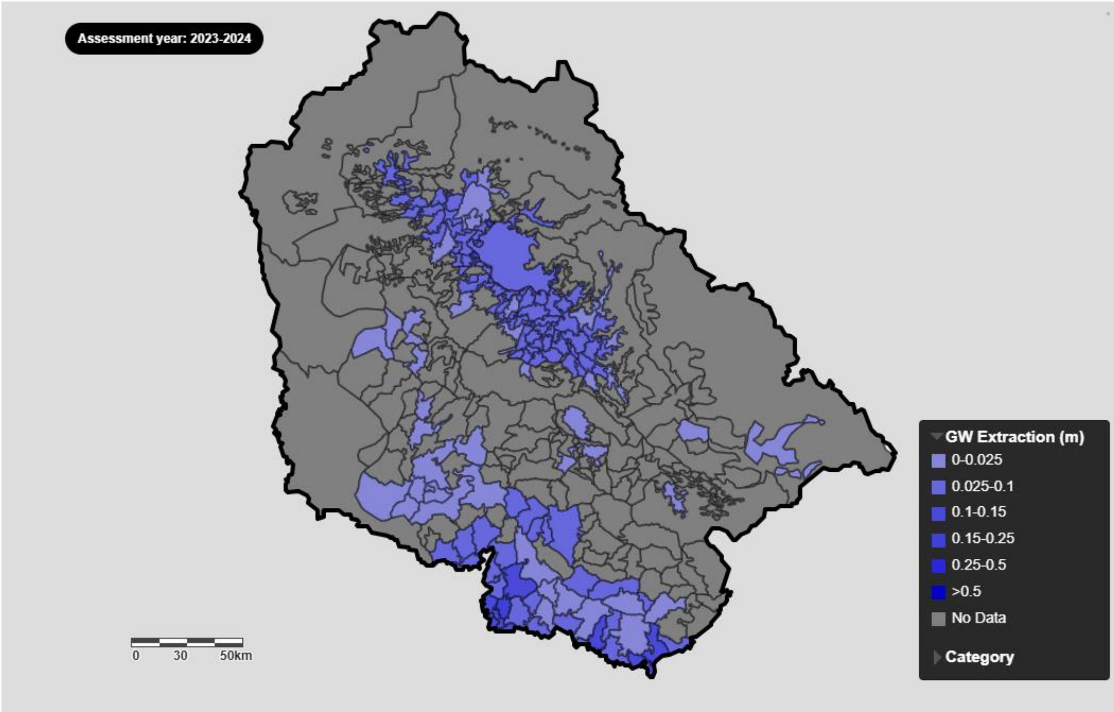

Figure 17: Annual Groundwater Extraction Unit Map.

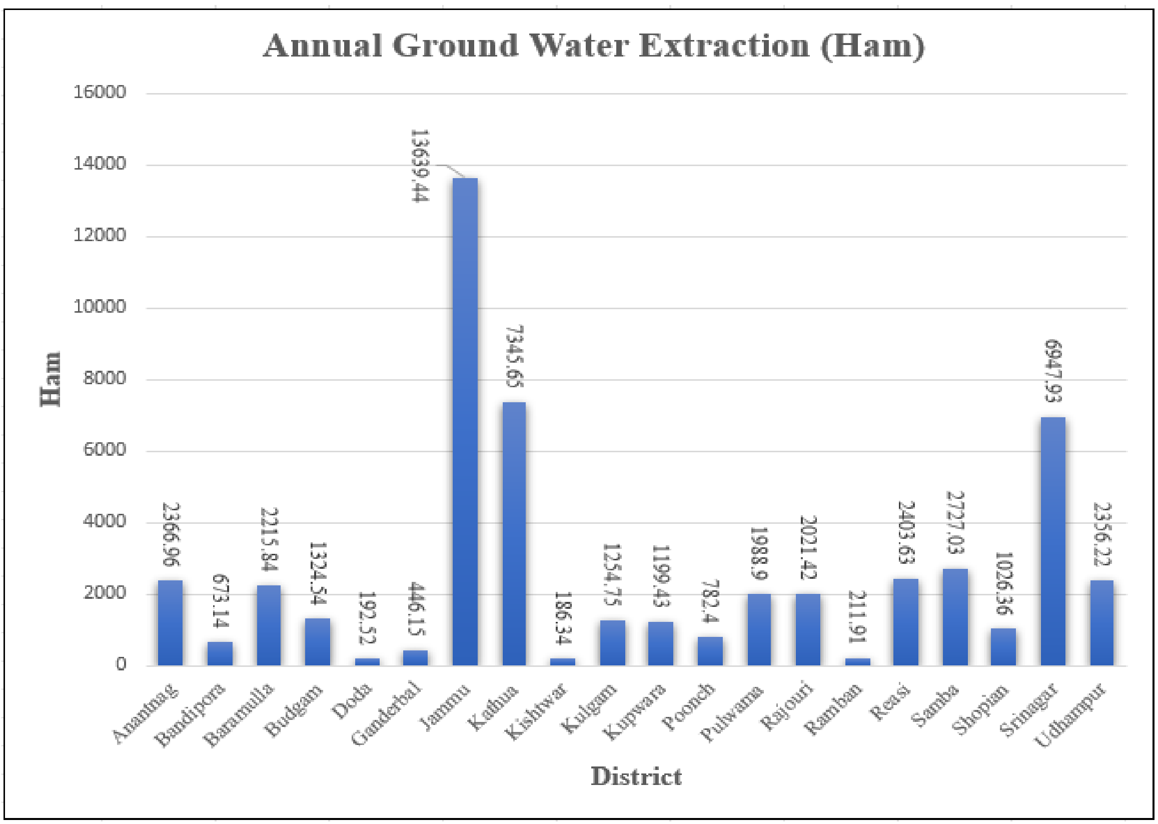

Figure 18: District wise Groundwater Extraction.

6.4. STAGE OF GROUND WATER EXTRACTION

The Srinagar Urban Area has reached the highest stage of groundwater extraction at 63.24%, while Rajouri district has the lowest stage of groundwater development at 7.77%. Out of the 149 blocks, all are in the safe category. The block-wise stage of groundwater development varies from 2.06% in the Hajin block of Bandipora district to a maximum of 67.84% in the Ganderbal block. The overall stage of groundwater extraction for the Union Territory is 22.28%. (Figure-19)

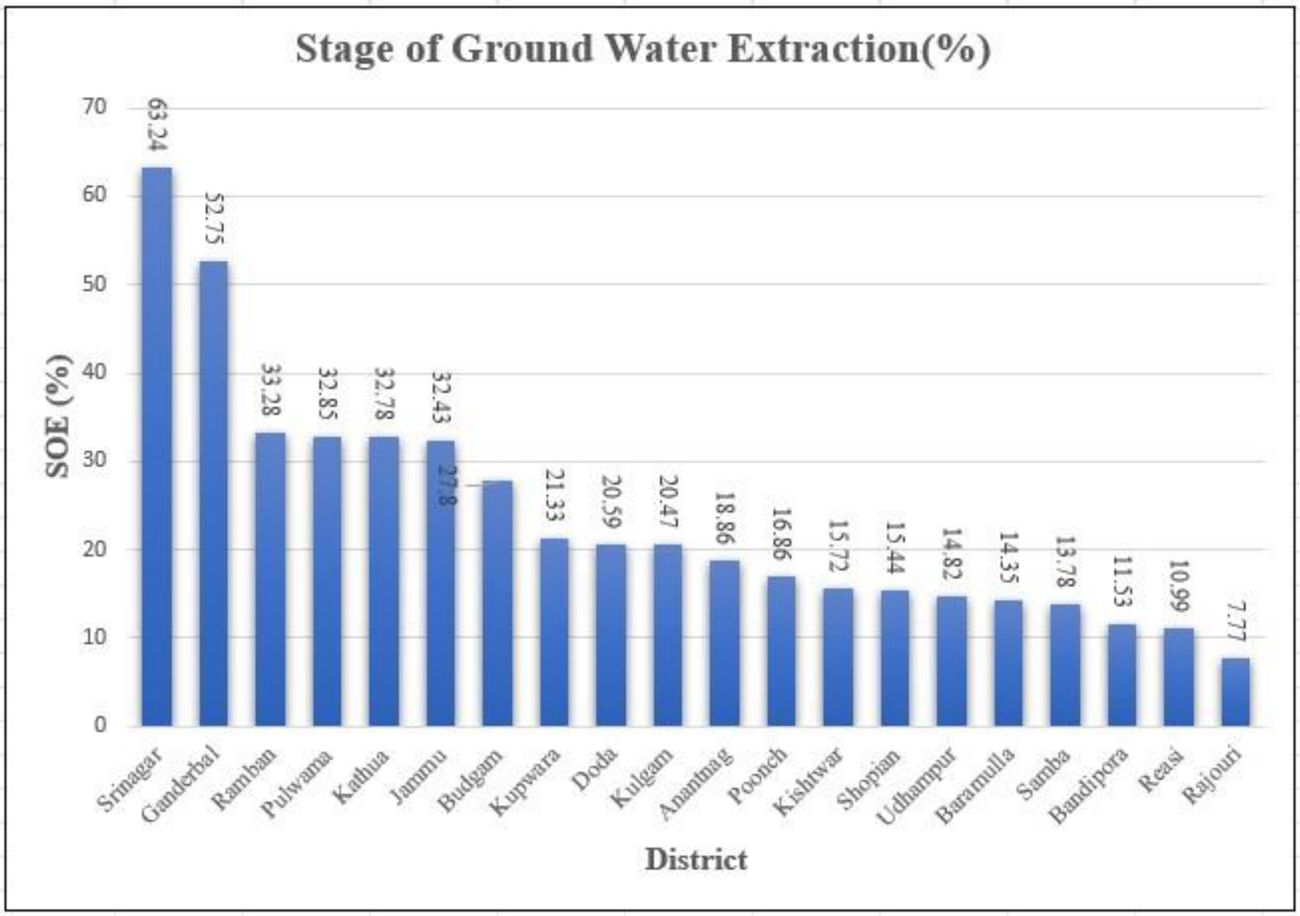

Figure 19: Graph Depicting District Wise Stage of Extraction.

6.5. CATEGORIZATION OF ASSESSMENT UNITS

Out of a total of 149 assessment units studied, there are no 'Over-Exploited,' 'Critical,' or 'Semi-Critical' blocks, and all 149 blocks (100%) fall under the 'Safe' category. (Figure-20)

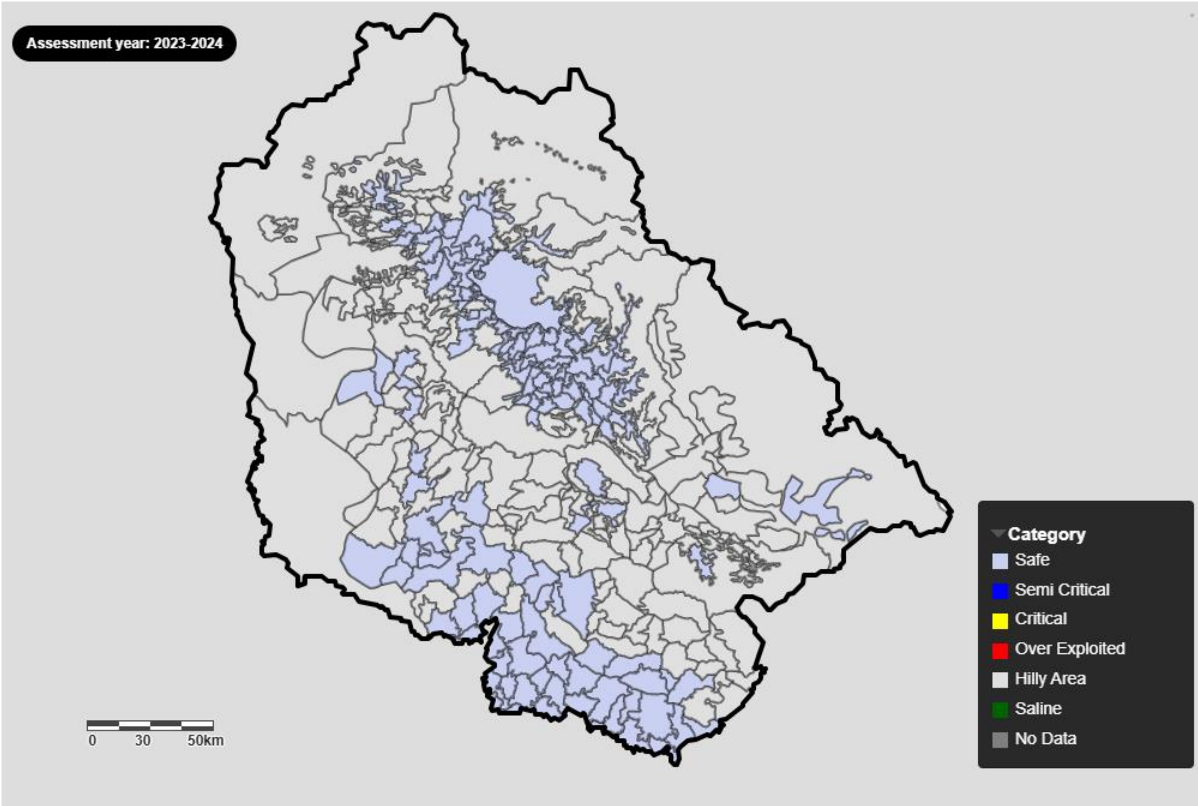

Figure 20: Categorization of Assessment Unit UT Of J&K.

6.6. COMPARIOSN WITH PREVIOUS ASSESSMENT

The number of district/block categories of overexploited/critical/semi-critical/safe time as per various Ground Water Estimation Studies carried out from time to time, as shown below in **Table: 17 and Annexure-6**

Table 17: Ground Water Assessment Comparison.

Study Year	2004	2009	2011	2013	2017	2020	2022	2023	2024
Assesment Unit	Districts	Districts	Districts	Districts	Districts	Districts	Districts	Districts	Blocks
Over- exploited	-	-	-	-	-	-	-	-	-
Critical	-	-	-	-	-	-	-	-	-
Semi Critical	-	-	-	-	-	-	1	1	-
Safe	12	12	20	20	20	20	19	19	149
Total	12	12	20	20	20	20	20	20	149

CHAPTER 7

CONCLUSIONS

The Dynamic Ground Water Estimation has been done as per the GEC-2015 Methodology adopted by CGWB and based on data observed in the field for the last five years i.e. 2019-23. The Administrative Block has been taken as an assessment unit for computing the block rainfall recharge during monsoon season. The rainfall Infiltration Factor (RIF) Method has been mostly applied as the Water Level fluctuation (WLF) Method was not considered due to random and erratic data.

There is no overexploitation of Ground Water for the agriculture requirement of the UT, as surface water is limited to certain parts of the UT and there is a good scope for development of ground water in agriculture, drinking, and Industrial uses. The overall stage of ground water extraction of the UT is 22.28 % as estimated in this report. As per this report, all 149 assessment units are in the “safe” category.

ANNEXURE I: Ground Water Resources Availability, Utilization and Stage of Extraction (As In 2024).

DYNAMIC GROUND WATER RESOURCES OF INDIA, 2024															
S.NO	**States / Union Territories**	**Ground Water Recharge**					**Total Natural Discharges**	**Annual Extractable Ground Water Resource**	**Current Annual Ground Water Extraction**				**Annual GW Allocation for Domestic use as on 2025**	**Net Ground Water Availability for future use**	**Stage of Ground Water Extraction%)**
		Monsoon Season		**Non-Monsoon Season**		**Total Annual Ground Water Recharge**			**Irrigation**	**Industrial**	**Domestic**	**Total**			
		Recharge from rainfall	**Recharge from other Sources**	**Recharge from Rainfall**	**Recharge from other Sources**										
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
1	**J&k**	1.19	0.35	0.85	0.15	2.55	0.25	2.3	0.13	0.02	0.37	0.51	0.37	1.79	22.28
	Total(bcm)	**1.19**	**0.35**	**0.85**	**0.15**	**2.55**	**0.25**	**2.3**	**0.13**	**0.02**	**0.37**	**0.51**	**0.37**	**1.79**	**22.28**

ANNEXURE II: District-wise ground water resources availability, utilization and stage of extraction (as in 2024).

DYNAMIC GROUND WATER RESOURCES OF INDIA, 2024															
JAMMU AND KASHMIR															
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	**Anantnag**	2859.55	595.48	10288.85	201.3	13945.18	1394.51	12550.67	369.25	37.8	1959.88	2366.96	1959.88	10183.71	**18.86**
2	**Bandipora**	1084.76	102.35	5300.9	0.2	6488.21	648.83	5839.38	11.2	1.08	660.86	673.14	660.85	5166.25	**11.53**
3	**Baramulla**	2685.07	1230.72	12823.78	418.08	17157.65	1715.8	15441.85	364.12	5.4	1846.32	2215.84	1846.31	13226.02	**14.35**
4	**Budgam**	830.09	1329.3	2858.94	258.44	5276.77	511.69	4765.08	106.43	5.4	1212.71	1324.54	1212.72	3440.54	**27.8**
5	**Doda**	64.93	661.15	151.76	161.07	1038.91	103.89	935.02	16.81	5.4	170.32	192.52	170.32	742.51	**20.59**
6	**Ganderbal**	118.96	224.57	401.75	194.47	939.75	93.98	845.77	190.46	10.43	245.27	446.15	245.27	399.62	**52.75**
7	**Jammu**	32569.62	4632.75	7492.26	2040.93	46735.56	4673.58	42061.98	5187.27	719.39	7732.75	13639.44	7732.74	28422.55	**32.43**
8	**Kathua**	16775.04	2539.46	3666.44	1630.47	24611.41	2204.75	22406.66	2991.36	641.2	3713.08	7345.65	3713.08	15061.02	**32.78**
9	**Kishtwar**	224.72	372.5	525.22	195	1317.44	131.75	1185.69	31.5	4.32	150.5	186.34	150.5	999.35	**15.72**
10	**Kulgam**	1173.59	1112.51	4222.68	303.03	6811.81	681.18	6130.63	157.8	29.16	1067.78	1254.75	1067.78	4875.88	**20.47**
11	**Kupwara**	629.85	1933.65	3077.84	607.5	6248.84	624.88	5623.96	16.81	10.8	1171.84	1199.43	1171.82	4424.53	**21.33**
12	**Poonch**	291.25	2561.6	1637.61	664.76	5155.22	515.53	4639.69	332.5	5.4	444.5	782.4	444.5	3857.29	**16.86**
13	**Pulwama**	1087.05	1502.5	3800.95	337.6	6728.1	672.82	6055.28	481.75	15.12	1492.05	1988.9	1492.04	4066.39	**32.85**
14	**Rajouri**	19612.89	2108.04	6012.14	1002.39	28735.46	2710.18	26025.27	787.5	5.4	1228.5	2021.42	1228.5	24003.85	**7.77**
15	**Ramban**	55.74	221.85	313.38	116.55	707.52	70.75	636.77	59.5	5.4	147	211.91	147	424.86	**33.28**
16	**Reasi**	8051.09	9283.22	2510.85	4450.68	24295.84	2429.58	21866.26	364.12	36.49	2003.02	2403.63	2003.02	19462.63	**10.99**
17	**Samba**	15932.45	1410.3	3501.07	1078.02	21921.84	2137.09	19784.75	431.34	156.39	2139.28	2727.03	2139.27	17057.75	**13.78**
18	**Shopian**	1322.94	904.5	4759.97	397.26	7384.67	738.45	6646.22	129.6	27	869.76	1026.36	869.76	5619.86	**15.44**
19	**Srinagar**	2539.46	468.27	8576.26	623.46	12207.45	1220.74	10986.71	44.81	328.42	6574.7	6947.93	6574.7	4038.78	**63.24**
20	**Udhampur**	11468.81	2108.87	3177.43	729.79	17484.9	1582.85	15902.05	464.95	119.9	1771.38	2356.22	1771.36	13545.84	**14.82**
	Total (Ham)	**119377.86**	**35303.59**	**85100.08**	**15411**	**255192.53**	**24862.83**	**230329.69**	**12539.08**	**2169.9**	**36601.51**	**51310.56**	**36601.42**	**179019.23**	**22.28**
	Total (Bcm)	**1.19**	**0.35**	**0.85**	**0.15**	**2.55**	**0.25**	**2.3**	**0.13**	**0.02**	**0.37**	**0.51**	**0.37**	**1.79**	**22.28**

ANNEXURE III: Categorization of blocks/ mandals/ taluks in India (as in 2024) for the State/UT.

CATEGORIZATION OF BLOCKS/ MANDALS/ TALUKAS IN INDIA (2024)													
S.No	**States / Union Territories**	**Total No. of Assessed Units**	**Safe**		**Semi-Critical**		**Critical**		**Over-Exploited**		**Saline**		
			Nos.	**%**	**Nos.**	**%**	**Nos.**	**%**	**Nos.**	**%**	**Nos.**	**%**	
1	**JAMMU AND KASHMIR**	149	149	100	-	-	-	-	-	-	-	-	
	Total	**149**	**149**	**100**	-	-	-	-	-	-	-	-	
	Grand Total	**149**	**149**	**100**	-	-	-	-	-	-	-	-	

ANNEXURE IV: District Wise Categorization of blocks/ mandals/ taluks for the State/UT (as in 2024).

DYNAMIC GROUND WATER RESOURCES OF INDIA, 2024												
JAMMU AND KASHMIR												
S.No	**Name of District**	**Total No. of Assessed Units**	**Safe**		**Semi-Critical**		**Critical**		**Over-Exploited**		**Saline**	
			No	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
1	**Baramulla**	16	16	100	-	-	-	-	-	-	-	-
2	**Poonch**	4	4	100	-	-	-	-	-	-	-	-
3	**Kupwarar**	9	9	100	-	-	-	-	-	-	-	-
4	**Reasi**	4	4	100	-	-	-	-	-	-	-	-
5	**Ramban**	3	3	100	-	-	-	-	-	-	-	-
6	**Kishtwar**	2	2	100	-	-	-	-	-	-	-	-
7	**Doda**	1	1	100	-	-	-	-	-	-	-	-
8	**Ganderbal**	3	3	100	-	-	-	-	-	-	-	-
9	**Kulgam**	7	7	100	-	-	-	-	-	-	-	-
10	**Pulwama**	10	10	100	-	-	-	-	-	-	-	-
11	**Rajouri**	9	9	100	-	-	-	-	-	-	-	-
12	**Budgam**	14	14	100	-	-	-	-	-	-	-	-
13	**Srinagar**	1	1	100	-	-	-	-	-	-	-	-
14	**Udhampur**	4	4	100	-	-	-	-	-	-	-	-
15	**Jammu**	14	14	100	-	-	-	-	-	-	-	-
16	**Bandipora**	6	6	100	-	-	-	-	-	-	-	-
17	**Shopian**	9	9	100	-	-	-	-	-	-	-	-
18	**Samba**	9	9	100	-	-	-	-	-	-	-	-
19	**Kathua**	10	10	100	-	-	-	-	-	-	-	-
20	**Anantnag**	14	14	100	-	-	-	-	-	-	-	-
	Total	**149**	**149**	**100**	-	-	-	-	-	-	-	-

ANNEXURE V: Annual Extractable Ground Water Resource of Assessment Units under Different Category for the State/UT (as in 2024).

ANNUAL EXTRACTABLE RESOURCE OF ASSESSMENT UNITS UNDER DIFFERENT CATEGORIES, 2024												
S.No	**State/Union Territories**	**Total Annual Extractable Resource of Assessed Units (in mcm)**	**Safe**		**Semi-Critical**		**Critical**		**Over-Exploited**		**Saline**	
			Total Annual Extractable Resource (in mcm)	**%**	**Total Annual Extractable Resource (in mcm)**	**%**	**Total Annual Extractable Resource (in mcm)**	**%**	**Total Annual Extractable Resource (in mcm)**	**%**	**Total Annual Extractable Resource (in mcm)**	**%**
1	**J&K**	2303.3	2303.3	100	-	-	-	-	-	-	-	-
	Total	2303.3	2303.3	100	-	-	-	-	-	-	-	-
	Grand Total	**2303.3**	**2303.3**	**100**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

ANNEXURE VI: District Wise Annual Extractable Ground Water Resource of Assessment Units under Different Category for the UT (as in 2024).

S.No	**Total Annual Extractable Resource of Assessed Units (in mcm)**	**Safe**		**Semi-Critical**		**Critical**		**Over-Exploited**		**Saline**	
		Total Annual Extractable Resource (in mcm)	**%**	**Total Annual Extractable Resource (in mcm)**	**%**	**Total Annual Extractable Resource (in mcm)**	**%**	**Total Annual Extractable Resource (in mcm)**	**%**	**Total Annual Extractable Resource (in mcm)**	**%**
1	154.42	154.42	100	-	-	-	-	-	-	-	-
2	46.4	46.4	100	-	-	-	-	-	-	-	-
3	56.24	56.24	100	-	-	-	-	-	-	-	-
4	218.66	218.66	100	-	-	-	-	-	-	-	-
5	6.37	6.37	100	-	-	-	-	-	-	-	-
6	11.86	11.86	100	-	-	-	-	-	-	-	-
7	9.35	9.35	100	-	-	-	-	-	-	-	-
8	8.46	8.46	100	-	-	-	-	-	-	-	-
9	61.31	61.31	100	-	-	-	-	-	-	-	-
10	60.55	60.55	100	-	-	-	-	-	-	-	-
11	260.25	260.25	100	-	-	-	-	-	-	-	-
12	47.65	47.65	100	-	-	-	-	-	-	-	-
13	109.87	109.87	100	-	-	-	-	-	-	-	-
14	159.02	159.02	100	-	-	-	-	-	-	-	-
15	420.62	420.62	100	-	-	-	-	-	-	-	-
16	58.39	58.39	100	-	-	-	-	-	-	-	-
17	66.46	66.46	100	-	-	-	-	-	-	-	-
18	197.85	197.85	100	-	-	-	-	-	-	-	-
19	224.07	224.07	100	-	-	-	-	-	-	-	-
20	125.51	125.51	100	-	-	-	-	-	-	-	-
	2303.3	**2303.3**	**100**	-	-	-	-	-	-		
	2303.3	**2303.3**	**100**	-	-	-	-	-	-		

ANNEXURE VII: Recharge Worthy Area of Assessment unit under Different Category for the State/UT (as in 2024).

AREA OF ASSESSMENT UNITS UNDER DIFFERENT CATEGORIES IN INDIA (2024)														
S.No	States / Union Territories	Total Geographical Area of Assessed Units (in sq km)	Recharge Worthy Area (in sq km)	Safe		Semi-Critical		Critical		Over-Exploited		Saline	
				Recharge Worthy Area in sq km	%	Recharge Worthy Area in sq km	%	Recharge Worthy Area in sq km	%	Recharge Worthy Area in sq km	%	Recharge Worthy Area in sq km	%
1	J&K	25821.86	8571.96	8571.96	100	-	-	-	-	-	-	-	-
	Total	25821.86	8571.96	8571.96	100	-	-	-	-	-	-	-	-

ANNEXURE VIII: District Wise Recharge Worthy Area of Assessment unit under Different Category for the State/UT (as in 2024).

DYNAMIC GROUND WATER RESOURCES OF INDIA, 2024													
JAMMU AND KASHMIR													
S.No	Name of District	Total Recharge Worthy Area of Assessed Units (in sq.km)	Safe		Semi-Critical		Critical		Over-Exploited		Saline	
			Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%	Recharge Worthy Area of Assessed Units (in sq.km)	%
1	Baramulla	576.27	576.27	100	-	-	-	-	-	-	-	-
2	Poonch	81.18	81.18	100	-	-	-	-	-	-	-	-
3	Kupwarar	197.05	197.05	100	-	-	-	-	-	-	-	-
4	Reasi	273.74	273.74	100	-	-	-	-	-	-	-	-
5	Ramban	15.53	15.53	100	-	-	-	-	-	-	-	-
6	Kishtwar	33.74	33.74	100	-	-	-	-	-	-	-	-
7	Doda	9.75	9.75	100	-	-	-	-	-	-	-	-
8	Ganderbal	40.99	40.99	100	-	-	-	-	-	-	-	-
9	Kulgam	248.24	248.24	100	-	-	-	-	-	-	-	-
10	Pulwama	387.79	387.79	100	-	-	-	-	-	-	-	-
11	Rajouri	655.47	655.47	100	-	-	-	-	-	-	-	-
12	Budgam	291.68	291.68	100	-	-	-	-	-	-	-	-
13	Srinagar	875.0	875.0	100	-	-	-	-	-	-	-	-
14	Udhampur	346.42	346.42	100	-	-	-	-	-	-	-	-
18	Jammu	1694.23	1694.23	100	-	-	-	-	-	-	-	-
19	Bandipora	339.37	339.37	100	-	-	-	-	-	-	-	-
21	Shopian	279.83	279.83	100	-	-	-	-	-	-	-	-
23	Samba	791.7	791.7	100	-	-	-	-	-	-	-	-
24	Kathua	829.09	829.09	100	-	-	-	-	-	-	-	-
25	Anantnag	604.87	604.87	100	-	-	-	-	-	-	-	-
	Total	**8571.96**	**8571.96**	**100**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

ANNEXURE IX: Categorization of Over Exploited, Critical and Semi Critical blocks/ mandals/ taluks (as in 2024).

CATEGORISATION OF ASSESSMENT UNIT, 2024							
JAMMU AND KASHMIR							
S.NO	**Name of District**	**S.NO**	**Name of Semi-Critical Assessment Units**	**S.NO**	**Name of Critical Assessment Units**	**S.NO**	**Name of Over-Exploited Assessment Units**

ABSTRACT			
Total No. of Assessed Units	**Number of Semicritical Assessment Units**	**Number of Critical Assessment Units**	**Number of Over Exploited Assessment Units**
149	0	0	0

ANNEXURE X: Quality Problems in Assessment units (as in 2024).

QUALITY PROBLEMS IN ASSESSMENT UNITS, 2024							
JAMMU AND KASHMIR							
S.NO	**Name of District**	**S.NO**	**Name of Assessment Units affected by Fluoride**	**S.NO**	**Name of Assessment Units affected by Arsenic**	**S.NO**	**Name of Assessment Units affected by Salinity**

ABSTRACT			
Total No. of Assessed Units	**Number of Assessment Units affected by Fluoride**	**Number of Assessment Units affected by Arsenic**	**Number of Assessment Units affected by Salinity**
0	0	0	0

ANNEXURE XI: Summary of Assessment units improved or deteriorated from 2023 to 2024 assessment.

State-Wise Summary Of Assessmet Units Improved Or Deteriorated From 2023 To 2024 Assessment				
S.No	**Name of States / Union Territories**	**Number of Assessment Units Improved**	**Number of Assessment Units Deteriorated**	**Number of Assessment Units With No Change**
1	**JAMMU AND KASHMIR**	1	0	-

ANNEXURE XII: Comparison of categorization of assessment units (2023 to 2024).

COMPARISON OF CATEGORIZATION OF ASSESSMENT UNITS (2023 AND 2024)									
JAMMU AND KASHMIR									
S.No	**Name of District**	**Name of Assessment Unit**	**Stage of Ground Water Extraction (%)2023**	**Categorization in2023**	**Name of District**	**Name of Assessment Unit**	**Stage of Ground Water Extraction (%)2024**	**Categorization in2024**	**Remark**
1	**Srinagar**	Srinagar UA	78.21	Semi-Critical	Srinagar	Srinagar UA	63.23940469894992	safe	Improved

ANNEXURE XIII: Assessment Unit Wise Report (Attribute Table).

S. No	District	Assessment Unit Name	Total Geographical Area	Recharge Worthy Area	Recharge from Rainfall-MON	Recharge from Other Sources-MON	Recharge from Rainfall-NM	Recharge from Other Sources-NM	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)	Irrigation Use (Ham)	Industrial Use (Ham)	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 (%)	Categorization (OE/ Critical /Semicritical/ Safe)
1	**Anantnag**	**Achabal**	5987.66	5481.51	259.14	46.64	932.41	20.13	1258.32	125.83	1132.49	21.04	21.6	231.44	274.08	231.44	858.41	24.20154	safe
2	**Anantnag**	**Anantnag**	7953.22	7782.51	367.92	46.64	1323.82	20.13	1758.51	175.84	1582.67	31.56	16.2	362.94	410.7	362.94	1171.97	25.94982	safe
3	**Anantnag**	**Bijbehara**	8343.9	7965.73	376.59	46.64	1354.99	20.13	1798.35	179.84	1618.51	31.56	0	241.96	273.52	241.96	1344.99	16.89949	safe
4	**Anantnag**	**Breng**	5366.21	1596.06	75.46	32.27	271.49	0	379.22	37.92	341.3	10.52	0	63.12	73.64	63.12	267.66	21.57633	safe
5	**Anantnag**	**Chhathergul**	4401.01	2545.67	120.35	32.27	433.02	0	585.64	58.56	527.08	0	0	84.16	84.16	84.16	442.92	15.96722	safe
6	**Anantnag**	**Dachnipora**	8904.38	6340.05	299.73	46.64	1078.45	20.13	1444.95	144.5	1300.45	31.56	0	147.28	178.84	147.28	1121.61	13.75216	safe
7	**Anantnag**	**Hillar Shahabad**	4315.33	2878.86	136.1	32.27	489.7	0	658.07	65.81	592.26	10.52	0	42.08	52.6	42.08	539.66	8.881235	safe
8	**Anantnag**	**Khoveripora**	8706.49	7513.04	355.19	46.64	1277.98	20.13	1699.94	169.99	1529.95	63.12	0	231.44	294.56	231.44	1235.39	19.25292	safe
9	**Anantnag**	**Pahalgam**	8741.44	4010.8	189.61	32.27	682.24	0	904.12	90.41	813.71	11.572	0	92.576	104.16	92.58	709.55	12.80063	safe
10	**Anantnag**	**Qazigund**	2609.03	2609.03	123.35	46.64	443.8	20.13	633.92	63.39	570.53	31.56	0	136.76	168.32	136.76	402.21	29.50239	safe
11	**Anantnag**	**Sagam**	3777.86	2638.28	124.73	46.64	448.78	20.13	640.28	64.03	576.25	31.56	0	99.94	131.5	99.94	444.75	22.81996	safe
12	**Anantnag**	**Shahabad**	4438.78	4238.08	200.36	46.64	720.91	20.13	988.04	98.8	889.24	42.08	0	89.42	131.5	89.42	757.74	14.78791	safe
13	**Anantnag**	**Shangas**	4105.75	2881.26	136.21	46.64	490.1	20.13	693.08	69.31	623.77	31.56	0	73.64	105.21	73.64	518.56	16.86679	safe
14	**Anantnag**	**Vessu**	2005.62	2005.62	94.81	46.64	341.16	20.13	502.74	50.28	452.46	21.04	0	63.12	84.17	63.12	368.29	18.60275	safe
15	**Bandipora**	**Aloosa**	4502.63	2756.16	88.1	20.47	430.51	0.04	539.12	53.92	485.2	5.6018	0	122.634	128.23	122.63	356.97	26.42828	safe
16	**Bandipora**	**Bandipora**	7293.06	2940.31	93.98	20.47	459.27	0.04	573.76	57.38	516.38	5.6018	1.08	156.699	163.38	156.7	353	31.63949	safe
17	**Bandipora**	**Hajin**	21594.72	19521.7	623.99	0	3049.25	0	3673.24	367.33	3305.91	0	0	68.13	68.13	68.13	3237.78	2.060855	safe
18	**Bandipora**	**Naidkhay**	5338.88	5338.88	170.65	20.47	833.92	0.04	1025.08	102.51	922.57	0	0	115.821	115.82	115.82	806.75	12.55406	safe
19	**Bandipora**	**Nowgam**	1650.84	1650.84	52.77	20.47	257.86	0.04	331.14	33.11	298.03	0	0	102.195	102.2	102.19	195.84	34.29185	safe
20	**Bandipora**	**Sumbal**	1729.13	1729.13	55.27	20.47	270.09	0.04	345.87	34.58	311.29	0	0	95.382	95.38	95.38	215.91	30.64024	safe
21	**Baramulla**	**Baramula**	7250.05	5093.48	242.6	76.92	1133.45	26.13	1479.1	147.91	1331.19	22.4072	0	190.764	213.18	190.76	1118.01	16.01424	safe
22	**Baramulla**	**Hardaboora**	2825.4	2476.12	117.94	76.92	551.01	26.13	772	77.2	694.8	16.8054	0	74.943	91.75	74.94	603.05	13.20524	safe

23	**Baramulla**	**Kandi Rafiabad**	1364.15	1000.15	47.64	76.92	222.56	26.13	373.25	37.33	335.92	22.4072	0	54.504	76.91	54.5	259.01	22.89533	safe
24	**Baramulla**	**Kunzer**	2922.79	2922.79	139.21	76.92	650.41	26.13	892.67	89.26	803.41	16.8054	0	122.634	139.43	122.63	663.98	17.35478	safe
25	**Baramulla**	**Lalpora**	2379.91	2379.91	113.36	76.92	529.6	26.13	746.01	74.6	671.41	16.8054	0	81.756	98.55	81.76	572.86	14.67807	safe
26	**Baramulla**	**Nadihal**	5427.7	4954.65	235.99	76.92	1102.56	26.13	1441.6	144.16	1297.44	22.4072	0	149.886	172.29	149.89	1125.15	13.27923	safe
27	**Baramulla**	**Pattan**	6670.04	6269.23	238.88	76.92	1395.09	26.13	1737.02	173.7	1563.32	33.6108	0	163.512	197.12	163.51	1366.2	12.60906	safe
28	**Baramulla**	**Rafiabad**	4614.72	4445.42	211.74	76.92	989.24	26.13	1304.03	130.41	1173.62	33.6108	0	122.634	156.24	122.63	1017.38	13.31266	safe
29	**Baramulla**	**Sangrama**	4523.68	4523.68	215.46	76.92	1006.65	26.13	1325.16	132.52	1192.64	22.4072	0	129.447	151.86	129.45	1040.78	12.7331	safe
30	**Baramulla**	**Sheerabad Khore**	559.25	559.25	26.64	76.92	124.45	26.13	254.14	25.42	228.72	11.2036	0	47.691	58.9	47.69	169.82	25.75201	safe
31	**Baramulla**	**Singhpora**	730.9	730.9	34.81	76.92	162.65	26.13	300.51	30.05	270.46	16.8054	0	40.878	57.68	40.88	212.78	21.32663	safe
32	**Baramulla**	**Sopore**	4374.91	4374.91	208.38	76.92	973.55	26.13	1284.98	128.5	1156.48	33.6108	5.4	163.512	202.52	163.51	953.96	17.51176	safe
33	**Baramulla**	**Tujjer Sharief**	4212.74	3496.47	166.54	76.92	778.07	26.13	1047.66	104.77	942.89	28.009	0	102.195	130.21	102.19	812.69	13.80967	safe
34	**Baramulla**	**Wagoora**	9775.8	7584.73	361.26	76.92	1687.83	26.13	2152.14	215.22	1936.92	22.4072	0	197.577	219.99	197.58	1716.93	11.35772	safe
35	**Baramulla**	**Wailoo**	1832.23	1832.23	87.27	76.92	407.73	26.13	598.05	59.81	538.24	22.4072	0	68.13	90.54	68.13	447.7	16.82149	safe
36	**Baramulla**	**Zaingeer**	5169.43	4983.27	237.35	76.92	1108.93	26.13	1449.33	144.94	1304.39	22.4072	0	136.26	158.67	136.26	1145.72	12.16431	safe
37	**Budgam**	**B K Pora**	1507.31	1345.19	39.04	94.95	131.85	18.46	284.3	28.43	255.87	5.6018	0	61.317	66.92	61.32	188.95	26.15391	safe
38	**Budgam**	**Badgam**	509.64	305.784	8.87	94.95	29.97	18.46	152.25	15.22	137.03	5.6018	5.4	27.252	38.25	27.25	98.78	27.9136	safe
39	**Budgam**	**Beerwah**	7195.76	6434.56	186.75	94.95	630.68	18.46	930.84	93.08	837.76	11.2036	0	218.016	229.23	218.02	608.53	27.36225	safe
40	**Budgam**	**Chadoora**	2148.47	2006.12	58.22	94.95	196.63	18.46	368.26	36.83	331.43	11.2036	0	74.943	86.16	74.94	245.27	25.99644	safe
41	**Budgam**	**Charisharief**	4260.54	2882.69	66.93	94.95	282.55	18.46	462.89	46.29	416.6	5.6018	0	95.382	100.98	95.38	315.62	24.23908	safe
42	**Budgam**	**Nagam**	2845.68	1532.44	44.48	94.95	150.2	18.46	308.09	30.81	277.28	5.6018	0	68.13	73.73	68.13	203.55	26.59045	safe
43	**Budgam**	**Narbal**	1173.45	935.43	27.15	94.95	91.69	18.46	232.25	23.23	209.02	11.2036	0	61.317	72.53	61.32	136.49	34.70003	safe
44	**Budgam**	**Pakherpora**	2484.01	1763.11	51.17	94.95	172.81	18.46	337.39	33.74	303.65	16.8054	0	74.943	91.75	74.94	211.9	30.21571	safe
45	**Budgam**	**Parnewa**	2477.65	2373.11	68.87	94.95	232.6	18.46	414.88	41.49	373.39	5.6018	0	109.008	114.6	109.01	258.79	30.69177	safe
46	**Budgam**	**Rathsun**	2038.49	1824.66	52.96	94.95	178.84	18.46	345.21	34.52	310.69	5.6018	0	81.756	87.35	81.76	223.34	28.11484	safe
47	**Budgam**	**Soibugh**	1597.45	1428.27	41.45	94.95	139.99	18.46	294.85	29.48	265.37	5.6018	0	68.13	73.73	68.13	191.64	27.78385	safe
48	**Budgam**	**Sukhnag Hard Panzoo**	7905.02	3268.18	94.85	94.95	320.33	18.46	528.59	52.86	475.73	5.6018	0	122.634	128.23	122.63	347.5	26.95436	safe
49	**Budgam**	**Surasyar**	2568.44	1621.58	47.34	94.95	158.94	18.46	319.69	15.98	303.71	5.6018	0	81.756	87.35	81.76	216.36	28.76099	safe
50	**Budgam**	**Waterhail**	1990.96	1447.36	42.01	94.95	141.86	18.46	297.28	29.73	267.55	5.6018	0	68.13	73.73	68.13	193.82	27.55747	safe

51	**Doda**	**Bhaderwah**	9371.53	974.99	64.93	661.15	151.76	161.07	1038.91	103.89	935.02	16.8054	5.4	170.325	192.52	170.32	742.51	20.58993	safe
52	**Ganderbal**	**Ganderbal**	1990.45	834.94	24.23	59.86	81.84	34.15	200.08	20.01	180.07	50.4162	10.426	61.317	122.16	61.32	57.91	67.84028	safe
53	**Ganderbal**	**Kangan**	5908.33	2675.13	77.64	58.75	262.2	31.97	430.56	43.06	387.5	95.2306	0	115.821	211.05	115.82	176.45	54.46452	safe
54	**Ganderbal**	**Safapora**	905.87	588.82	17.09	105.96	57.71	128.35	309.11	30.91	278.2	44.8144	0	68.13	112.94	68.13	165.26	40.59669	safe
55	**Jammu**	**Akhnoor**	16247.84	13836.63	3178.39	309.89	611.89	47.54	4147.71	414.77	3732.94	280.09	156.39	415.593	852.08	415.59	2880.86	22.82598	safe
56	**Jammu**	**Arnia**	6884.9	6884.9	1317.93	516.75	304.46	304.66	2443.8	244.38	2199.42	414.5332	0	449.658	864.19	449.66	1335.23	39.29172	safe
57	**Jammu**	**Bhalwal**	13283.2	13283.2	2542.73	329	587.42	72.43	3531.58	353.15	3178.43	476.153	0	395.154	871.31	395.15	2307.12	27.41322	safe
58	**Jammu**	**Bhalwal Brahmana**	12833.64	11596.21	2219.8	308.5	512.81	44.82	3085.93	308.6	2777.33	347.3116	0	408.78	756.11	408.78	2021.22	27.22435	safe
59	**Jammu**	**Bishnah**	13244.46	13244.46	2028.25	307.58	585.7	43	2964.53	296.45	2668.08	459.3476	0	592.731	1052.08	592.73	1616	39.4321	safe
60	**Jammu**	**Jammu UA**	18691.15	18432.85	4234.19	26.71	815.14	34.38	5110.42	511.05	4599.37	476.153	563.004	1505.673	2544.82	1505.67	2054.55	55.32975	safe
61	**Jammu**	**Khour**	14798.8	14798.8	2266.28	307.58	654.43	43	3271.29	327.13	2944.16	442.5422	0	497.349	939.9	497.35	2004.26	31.92422	safe
62	**Jammu**	**Mandal Phallain**	10553.66	10553.66	1616.18	516.47	466.71	304.11	2903.47	290.35	2613.12	336.108	0	524.601	860.7	524.6	1752.42	32.93764	safe
63	**Jammu**	**Marh**	13118	13118	2008.89	460.77	580.11	234.48	3284.25	328.42	2955.83	302.4972	0	510.975	813.47	510.97	2142.36	27.52087	safe
64	**Jammu**	**Miran Sahib**	6055.71	6055.71	1112.84	516.47	267.8	304.11	2201.22	220.12	1981.1	358.5152	0	599.544	958.06	599.55	1023.04	48.36	safe
65	**Jammu**	**Nagrota**	26204.6	18135.75	4165.95	0	802	0	4967.95	496.8	4471.15	117.6378	0	177.138	294.78	177.14	4176.37	6.592935	safe
66	**Jammu**	**Pargwal**	6125.15	6125.15	1407	0	270.87	0	1677.87	167.79	1510.08	78.4252	0	245.268	323.69	245.27	1186.39	21.43529	safe
67	**Jammu**	**R.S PURA**	10753.46	10753.46	2058.47	516.47	475.54	304.11	3354.59	335.47	3019.12	487.3566	0	722.178	1209.55	722.17	1809.58	40.063	safe
68	**Jammu**	**Suchetgarh**	12604.08	12604.08	2412.72	516.56	557.38	304.29	3790.95	379.1	3411.85	610.5962	0	688.113	1298.7	688.11	2113.15	38.06439	safe
69	**Kathua**	**Barnoti**	26957.95	22067.12	5069.02	57.16	975.86	62.63	6164.67	616.47	5548.2	134.4432	0	347.463	481.91	347.46	5066.29	8.68588	safe
70	**Kathua**	**Billawar**	15745.5	3149.1	723.38	57.16	139.26	62.63	982.43	98.24	884.19	39.2126	0	129.447	168.67	129.45	715.52	19.07622	safe
71	**Kathua**	**Dinga Amb**	7791.93	6439.07	1479.11	57.16	284.75	62.63	1883.65	188.37	1695.28	100.8324	0	306.585	407.41	306.58	1287.88	24.03202	safe
72	**Kathua**	**Hiranagar**	9318.66	9318.66	1783.81	536.94	412.1	298.44	3031.29	303.14	2728.15	593.7908	0	660.861	1254.65	660.86	1473.5	45.98904	safe
73	**Kathua**	**Kathua**	12341.69	9940.5	2283.42	585.68	439.59	359.37	3668.06	366.81	3301.25	537.7728	641.199	510.975	1689.95	510.97	1611.31	51.19122	safe
74	**Kathua**	**Keerian Gangyal**	8380.25	2095.06	430.18	57.16	92.65	62.63	642.62	32.13	610.49	173.6558	0	109.008	282.66	109.01	327.83	46.30051	safe
75	**Kathua**	**Mandli**	4101.5	1230.45	188.43	57.16	54.41	62.63	362.63	36.26	326.37	84.027	0	68.13	152.16	68.13	174.21	46.62193	safe
76	**Kathua**	**Marheen**	16330.33	16330.33	2928.09	536.94	722.16	298.44	4485.63	224.28	4261.35	683.4196	0	885.69	1569.11	885.69	2692.24	36.8219	safe
77	**Kathua**	**Nagri**	7597.52	7597.52	1163.48	536.94	335.98	298.44	2334.84	233.49	2101.35	560.18	0	510.975	1071.15	510.98	1030.19	50.97437	safe
78	**Kathua**	**Nagrota Gujroo**	15805.22	4741.56	726.12	57.16	209.68	62.63	1055.59	105.56	950.03	84.027	0	183.951	267.98	183.95	682.05	28.20753	safe

79	**Kishtwar**	**Kishtwar**	11783.75	1580.26	105.24	186.25	245.97	97.5	634.96	63.5	571.46	17.5	4.32	87.5	109.34	87.5	462.12	19.13345	safe
80	**Kishtwar**	**Padder**	40437.13	1794.04	119.48	186.25	279.25	97.5	682.48	68.25	614.23	14	0	63	77	63	537.23	12.53602	safe
81	**Kulgam**	**Behibagh**	2984.22	2984.22	141.08	158.93	507.62	43.29	850.92	85.09	765.83	21.04	0	173.58	194.62	173.58	571.21	25.41295	safe
82	**Kulgam**	**Devsar**	5609.37	5056.83	239.07	158.93	860.18	43.29	1301.47	130.15	1171.32	15.78	0	147.28	163.06	147.28	1008.26	13.92105	safe
83	**Kulgam**	**Frisal**	1647.42	1647.42	77.88	158.93	280.23	43.29	560.33	56.03	504.3	15.78	0	147.28	163.06	147.28	341.24	32.33393	safe
84	**Kulgam**	**Kulgam**	5374.51	5374.51	254.08	158.93	914.21	43.29	1370.51	137.05	1233.46	26.3	16.2	205.14	247.65	205.14	985.81	20.07767	safe
85	**Kulgam**	**Manzgam**	3267.93	1927.76	91.14	158.93	327.92	43.29	621.28	62.13	559.15	10.52	0	47.34	57.86	47.34	501.29	10.34785	safe
86	**Kulgam**	**Pombay**	3461.34	3461.34	163.64	158.93	588.78	43.29	954.64	95.47	859.17	31.56	0	152.54	184.1	152.54	675.07	21.42766	safe
87	**Kulgam**	**Qaimoh**	4372.32	4372.32	206.7	158.93	743.74	43.29	1152.66	115.26	1037.4	36.82	12.96	194.62	244.4	194.62	793	23.5589	safe
88	**Kupwarar**	**Drugmulla**	1706.24	1231.26	39.36	214.85	192.32	67.5	514.03	51.4	462.63	5.6018	0	95.382	100.98	95.38	361.65	21.82738	safe
89	**Kupwarar**	**Handwara**	4823.33	3120.9	99.76	214.85	487.48	67.5	869.59	86.96	782.63	0	3.24	163.512	166.75	163.51	615.88	21.30636	safe
90	**Kupwarar**	**Hayhama**	1463.5	1258.5	40.23	214.85	196.57	67.5	519.15	51.92	467.23	0	0	74.943	74.95	74.94	392.28	16.04135	safe
91	**Kupwarar**	**Kalarooch**	2767.94	1641.45	52.47	214.85	256.39	67.5	591.21	59.12	532.09	0	0	95.382	95.38	95.38	436.71	17.92554	safe
92	**Kupwarar**	**Kupwara**	5524.83	3631.3	116.07	214.85	567.2	67.5	965.62	96.56	869.06	5.6018	4.32	177.138	187.06	177.14	682	21.52441	safe
93	**Kupwarar**	**Langet**	3706.47	3031.74	96.91	214.85	473.55	67.5	852.81	85.28	767.53	0	0	211.203	211.2	211.2	556.33	27.51684	safe
94	**Kupwarar**	**Nutnoosa**	2084.47	1610.37	51.47	214.85	251.54	67.5	585.36	58.53	526.83	0	3.24	122.634	125.87	122.63	400.96	23.89196	safe
95	**Kupwarar**	**Qadirabad**	2686.43	1957.21	62.56	214.85	305.71	67.5	650.62	65.06	585.56	5.6018	0	115.821	121.42	115.82	464.14	20.73571	safe
96	**Kupwarar**	**Qaziabad Supernagama**	3354.41	2222.04	71.02	214.85	347.08	67.5	700.45	70.05	630.4	0	0	115.821	115.82	115.82	514.58	18.37246	safe
97	**Poonch**	**Mandi**	11439.46	896.72	32.17	640.4	180.9	166.19	1019.66	101.97	917.69	52.5	0	66.5	119	66.5	798.69	12.96734	safe
98	**Poonch**	**Nanglai sahib**	9866.88	1057.72	37.95	640.4	213.38	166.19	1057.92	105.8	952.12	35	0	56	91	56	861.12	9.557619	safe
99	**Poonch**	**Poonch**	19999.98	5112.05	183.42	640.4	1031.29	166.19	2021.3	202.13	1819.17	210	0	210	420	210	1399.17	23.08745	safe
100	**Poonch**	**Surankote**	7819.12	1051.07	37.71	640.4	212.04	166.19	1056.34	105.63	950.71	35	5.4	112	152.4	112	798.31	16.03012	safe
101	**Pulwama**	**Awantipora**	7380.19	6114.49	212.95	150.25	599.31	33.76	996.27	99.63	896.64	61.6198	0	211.203	272.82	211.2	623.82	30.42693	safe
102	**Pulwama**	**Dadsara**	3554.48	3181.57	92.34	150.25	311.84	33.76	588.19	58.82	529.37	61.6198	0	115.821	177.44	115.82	351.93	33.51909	safe
103	**Pulwama**	**Ichegoza**	1850.07	1320.46	38.32	150.25	129.42	33.76	351.75	35.18	316.57	39.2126	0	68.13	107.35	68.13	209.22	33.91035	safe
104	**Pulwama**	**Kakapora**	3884.57	3884.57	90.19	150.25	380.74	33.76	654.94	65.49	589.45	44.8144	0	163.512	208.32	163.51	381.13	35.34142	safe
105	**Pulwama**	**Litter**	3856.26	3856.26	111.92	150.25	377.97	33.76	673.9	67.39	606.51	44.8144	0	143.073	187.88	143.07	418.63	30.97723	safe
106	**Pulwama**	**Newa**	4469.49	4328	100.49	150.25	424.21	33.76	708.71	70.87	637.84	44.8144	0	149.886	194.69	149.89	443.15	30.52333	safe

107	**Pulwama**	**Pampore**	1839.9	240.04	6.97	150.25	23.53	33.76	214.51	21.45	193.06	22.4072	0	68.13	90.54	68.13	102.52	46.89734	safe
108	**Pulwama**	**Pulwama**	7989.25	7868.84	182.7	150.25	771.26	33.76	1137.97	113.8	1024.17	78.4252	15.12	245.268	338.81	245.27	685.36	33.08142	safe
109	**Pulwama**	**Shadimarg**	3468.78	3346.33	116.54	150.25	327.99	33.76	628.54	62.86	565.68	39.2126	0	156.699	195.92	156.7	369.76	34.63442	safe
110	**Pulwama**	**Tral**	7295.36	4638.89	134.63	150.25	454.68	33.76	773.32	77.33	695.99	44.8144	0	170.325	215.13	170.32	480.87	30.90993	safe
111	**Rajouri**	**Kalakote**	26808.65	12341.2	3643.94	172.84	1131.96	84.26	5033	503.3	4529.7	38.5	0	70	108.5	70	4421.2	2.395302	safe
112	**Rajouri**	**Khawas**	17362.45	1286.43	379.84	172.84	117.99	84.26	754.93	75.5	679.43	45.5	0	80.5	126.01	80.5	553.42	18.54643	safe
113	**Rajouri**	**Lamberi**	7620.44	5739.09	2033.47	172.84	526.4	84.26	2816.97	281.7	2535.27	80.5	0	91	171.51	91	2363.76	6.76496	safe
114	**Rajouri**	**Nowshera**	36577.06	14893.18	3517.97	357	1366.04	165.61	5406.62	540.66	4865.95	119	0	238	357	238	4508.95	7.336697	safe
115	**Rajouri**	**Planger**	7280.4	2347.71	693.2	172.84	215.34	84.26	1165.64	116.56	1049.08	59.5	0	84	143.5	84	905.58	13.67865	safe
116	**Rajouri**	**Rajouri**	12059.29	5526.89	1631.91	357	506.94	165.61	2661.46	266.15	2395.31	84	5.4	154	243.4	154	2151.91	10.16152	safe
117	**Rajouri**	**Seri**	10110.11	3607.15	852.06	172.84	330.86	84.26	1440.02	144	1296.02	77	0	108.5	185.5	108.5	1110.52	14.31305	safe
118	**Rajouri**	**Siot**	8085.54	7101	2359.03	172.84	651.32	84.26	3267.45	163.37	3104.08	59.5	0	87.5	147	87.5	2957.08	4.735703	safe
119	**Rajouri**	**Sunderbani**	26634.53	12704.55	4501.47	357	1165.29	165.61	6189.37	618.94	5570.43	224	0	315	539	315	5031.43	9.676093	safe
120	**Ramban**	**Banihal**	12983.22	504.97	18.12	73.95	101.87	38.85	232.79	23.28	209.51	35	0	42	77	42	132.51	36.75242	safe
121	**Ramban**	**Ramban**	8270.38	448.46	16.09	73.95	90.47	38.85	219.36	21.93	197.43	17.5	5.4	56	78.91	56	118.52	39.9686	safe
122	**Ramban**	**Sangaldan**	6298	600.01	21.53	73.95	121.04	38.85	255.37	25.54	229.83	7	0	49	56	49	173.83	24.36584	safe
123	**Reasi**	**Katra**	12928.28	5093.3	1472.2	2359.21	467.17	1112.67	5411.25	541.13	4870.12	184.8594	0	510.975	695.83	510.98	4174.29	14.28774	safe
124	**Reasi**	**Panthal**	6183.15	3357.83	991.45	2282.4	307.99	1112.67	4694.51	469.45	4225.06	28.009	0	415.593	443.61	415.59	3781.45	10.4995	safe
125	**Reasi**	**Pouni**	28957.06	11908.35	3516.14	2282.4	1092.26	1112.67	8003.47	800.34	7203.13	11.2036	0	545.04	556.25	545.04	6646.88	7.722337	safe
126	**Reasi**	**Reasi**	12493.41	7015.01	2071.3	2359.21	643.43	1112.67	6186.61	618.66	5567.95	140.045	36.491	531.414	707.94	531.41	4860.01	12.71455	safe
127	**Samba**	**Bari Brahmana**	6225.24	6225.24	1429.99	17.84	275.29	47.17	1770.29	177.03	1593.26	22.4072	130.325	218.016	370.76	218.02	1222.5	23.27053	safe
128	**Samba**	**Ghagwal**	8561.85	8561.85	1966.73	17.84	378.62	47.17	2410.36	241.04	2169.32	0	26.065	204.39	230.45	204.39	1938.87	10.62314	safe
129	**Samba**	**Nud**	15762.07	7881.035	1810.34	17.84	348.52	47.17	2223.87	222.39	2001.48	0	0	183.951	183.95	183.95	1817.53	9.190699	safe
130	**Samba**	**Purmandal**	8318.13	6897.06	1320.26	17.84	305	47.17	1690.27	169.03	1521.24	11.2036	0	149.886	161.09	149.89	1360.15	10.58939	safe
131	**Samba**	**Raj Pura**	6180.22	6180.22	1041.08	434.42	273.3	265	2013.8	201.38	1812.42	84.027	0	361.089	445.11	361.09	1367.31	24.55888	safe
132	**Samba**	**Ramgarh**	14019.63	14019.63	2146.95	434.42	619.98	265	3466.35	346.63	3119.72	145.6468	0	272.52	418.18	272.51	2701.56	13.40441	safe
133	**Samba**	**Samba**	13203.58	13203.58	2912.18	434.42	583.89	265	4195.49	364.45	3831.04	128.8414	0	422.406	551.26	422.4	3279.79	14.3893	safe
134	**Samba**	**Sumb**	21266.63	5316.658	1221.28	17.84	235.11	47.17	1521.4	152.14	1369.26	16.8054	0	122.634	139.43	122.63	1229.83	10.18287	safe

135	**Samba**	**Vijaypur**	10884.94	10884.94	2083.64	17.84	481.36	47.17	2630.01	263	2367.01	22.4072	0	204.39	226.8	204.39	2140.21	9.581709	safe
136	**Shopian**	**Chitragam**	3012.76	3012.76	142.43	100.5	512.48	44.14	799.55	79.95	719.6	11.52	0	74.88	86.4	74.88	633.2	12.00667	safe
137	**Shopian**	**Harman**	2101	2101	99.33	100.5	357.38	44.14	601.35	60.13	541.22	17.28	0	97.92	115.2	97.92	426.02	21.28524	safe
138	**Shopian**	**Imamsahib**	3671.65	3671.65	173.58	100.5	624.55	44.14	942.77	94.28	848.49	20.16	0	109.44	129.6	109.44	718.89	15.27419	safe
139	**Shopian**	**Kanji Ullar**	2428.65	2428.65	114.82	100.5	413.12	44.14	672.58	67.26	605.32	11.52	0	83.52	95.04	83.52	510.28	15.70079	safe
140	**Shopian**	**Kaprin**	2043.87	2043.87	96.63	100.5	347.67	44.14	588.94	58.89	530.05	14.4	0	100.8	115.2	100.8	414.85	21.7338	safe
141	**Shopian**	**Keller**	7525.41	6034.57	285.29	100.5	1026.49	44.14	1456.42	145.64	1310.78	11.52	0	103.68	115.2	103.68	1195.58	8.78866	safe
142	**Shopian**	**Ramnagri**	2134.87	2134.87	100.93	100.5	363.15	44.14	608.72	60.87	547.85	8.64	0	109.44	118.08	109.44	429.77	21.55334	safe
143	**Shopian**	**Shopian**	4738.31	4554.3	215.31	100.5	774.69	44.14	1134.64	113.46	1021.18	20.16	27	89.28	136.44	89.28	884.74	13.36101	safe
144	**Shopian**	**Zainpora**	2001.39	2001.39	94.62	100.5	340.44	44.14	579.7	57.97	521.73	14.4	0	100.8	115.2	100.8	406.53	22.08039	safe
145	**Srinagar**	**Srinagar UA**	87500	87500	2539.46	468.27	8576.26	623.46	12207.45	1220.74	10986.71	44.8144	328.419	6574.7	6947.93	6574.7	4038.78	63.2394	safe
146	**Udhampur**	**Khoon**	17487.14	7092.15	2512.89	325	650.51	176.72	3665.12	366.51	3298.61	72.8234	0	395.154	467.97	395.15	2830.64	14.18688	safe
147	**Udhampur**	**Majalta**	14748.89	7202.36	2150.43	325	660.62	176.72	3312.77	165.64	3147.13	95.2306	0	347.463	442.7	347.46	2704.43	14.06678	safe
148	**Udhampur**	**Tikri**	5830.26	3420.07	807.87	336.22	313.7	199.63	1657.42	165.74	1491.68	106.4342	0	258.894	365.33	258.89	1126.35	24.49118	safe
149	**Udhampur**	**Udhampur**	32318.36	16927.15	5997.62	1122.65	1552.6	176.72	8849.59	884.96	7964.63	190.4612	119.899	769.869	1080.22	769.86	6884.42	13.56271	safe

ANNEXURE XIV: UT Level Committee for Assessment of Ground Water Resources in UT of J&K.

GOVERNMENT OF JAMMU AND KASHMIR,
GENERAL ADMINISTRATION DEPARTMENT.
CIVIL SECRETARIAT, J&K.

Subject:- Constitution of a standing Union territory Level Committee for assessment of Ground Water Resources in the Union territory of Jammu and Kashmir.

Ref: **U.O No. JSD-PS04/13/2021-PLG received from Jal Shakti Department.**

Government Order No:1053-JK(GAD) of 2023
Dated:30-08-2023

Sanction is hereby accorded to constitution of a standing Union territory Level Committee, comprising the following, for assessment of Ground Water Resources in the Union territory of Jammu and Kashmir:-

1	Administrative Secretary, Jal Shakti Department	**Chairman**
2	Administrative Secretary, Planning, Development & Monitoring Department	**Member**
3	Director Rural Sanitation, J&K	Member
4	Director Agriculture, Jammu/Kashmir	Member(s)
5	Director Industries, Jammu/Kashmir	Member(s)
6	Chief Engineer, Jal Shakti (PHE), Jammu/Kashmir	Member(s)
7	Chief Engineer, Jal Shakti (I&FC), Jammu/Kashmir	Member(s)
8	Regional Director, Central Ground Water Board, Jammu	Member Secretary
9	General Manager, NABARD, Jammu	Member
10	Representative of Central Water Commission	Member
11	Representative from Rural Development Department & SKUAST Jammu/Kashmir	Member(s)
12	Representative of Geology & Mining Department (not below the rank of Additional Secretary).	Member
13	Representative of Forest, Ecology & Environment Department (not below the rank of Additional Secretary).	Member
14	Any other Officer to be co-opted by the Chairman of the Committee, if required.	Special Invitee

Terms of Reference:-

i) To ensure the assessment of annual ground water recharge of the Union territory.

ii) To work on ground water assessments for water year (June to May) in accordance with the approved latest methodology.

iii) To adopt improved procedures and practices wherever possible for the sake of achieving greater accuracy of assessment.

iv) To supervise the estimation of status of utilization of the annual ex-tractable ground water resource as in specified water year.

The Committee shall be serviced by the Jal Shakti Department.

By order of Government of Jammu and Kashmir.

Sd/-
(Sanjeev Verma) IAS
Commissioner/Secretary to the Government
Dated: 30.08.2023

No. GAD-ADM0IV/23/2022-09-GAD

Copy to the:-

1. All Financial Commissioners (Additional Chief Secretaries).
2. Director General of Police, J&K.
3. All Principal Secretaries to the Government.
4. Principal Secretary to the Hon'ble Lieutenant Governor, J&K.
5. Joint Secretary (J&K) Ministry of Home Affairs, Government of India, New Delhi.
6. All Commissioner/Secretaries to the Government.
7. Chief Electoral Officer, J&K.
8. Divisional Commissioner, Kashmir/Jammu.
9. Director Information, J&K.
10. All Deputy Commissioners.
11. All Heads of Department/Managing Directors/Secretary, Advisory Boards.
12. Registrar General, J&K High Court.
13. Secretary, J&K Public Service Commission/SSB/BoPEE.
14. Director, Archives, Archaeology and Museums, J&K.
15. Director Rural Sanitation, J&K.
16. Director Agriculture, Jammu/Kashmir.
17. Director Industries, Jammu/Kashmir.
18. Chief Engineer, Jal Shakti (PHE), Jammu/Kashmir.
19. Chief Engineer, Jal Shakti (I&FC), Jammu/Kashmir.
20. Regional Director, Central Ground Water Board, Jammu.
21. General Manager, NABARD, Jammu.
22. Private Secretary to the Chief Secretary, J&K.
23. Private Secretary to Advisor (B) to the Lieutenant Governor.
24. Private Secretary to Commissioner/Secretary to the Government, GAD.
25. Government Order/Stock file/Website, GAD. Hindi and Urdu version shall follow.

30.08.23

(Malik Suhail) JKAS
Deputy Secretary to the Government

ANNEXURE XV: Minutes of the Meeting of the UTLC Committee.

सत्यमेव जयते

Government of Jammu and Kashmir
Jal Shakti Department
Civil Secretariat, Jammu/Srinagar
Email: plansectionjsd@gmail.com

Regional Director,
Central Ground Water Board,
Jammu.

No. JSD-PS04/13/2021-PLG-JSD (e-81435) Dated- 03.10.2024

Subject:-Minutes of 1st Meeting of UT Level Committee for Ground Water Resource Estimation for UT of J&K, as on 31st March, 2024 held on 30.04.2024 held under the Chairmanship of Sh. Shaleen Kabra (IAS), Additional Chief Secretary (Jal Shakti Department).

UT Level Committee for Ground Water Resource Estimation as on 31st March, 2024 for UT of J&K was held on 30.04.2024 at 04.30 PM under the chairmanship of Sh. Shaleen Kabra (IAS), Additional Chief Secretary (Jal Shakti Department) at Meeting Hall, 1st Floor, Civil Secretariat, Jammu.

The list of participants is given in ***Annexure-I.***

At the outset of the meeting, Sh. M.L. Angurala, Scientist 'D' & HOO, Central Ground Water Board, Jammu welcomed the Chairman of SLEC, UT of J&K. The meeting was started with introduction of committee members and the agendas to be discussed during meeting. A presentation on GWRE was made by Sh. M.L. Angurala, HOO, NWHR, Jammu.

After elaborate discussion with the committee members, the Chairman (UTLEC) advised:

Agenda 1:- Nomination of State/UT Nodal Ground Water Department and Head of Ground Water Resources (GWAC) Assessment Cell from State/UT Govt. departments.

The Chairman nominated Jal Shakti Department to be Nodal Ground Water Department and Chief Engineer, PHE, Jammu to be the Head of Ground Water Resources (GWAC) Assessment Cell (Working Group).

Agenda 2:- Creation of Ground Water Resources (GWAC) Assessment Cell and deployment of District/State level officers in GWAC from State/UT line departments.

The Chairman advised that Chief Engineer, PHE, Jammu/Kashmir and Regional Director, CGWB will discuss and nominate the District/State level officer for GWAC (Working Group). The GWAC (Working Group) will be constituted in a week time.

Agenda 3 :- Availability of boundaries of all blocks of State/UT, as Ground Water Resource Estimation as on March 2024 is to be carried out considering block as Assessment Unit.

The Chairman advised Director Industries and Commerce & Director Rural Development to arrange & provide the shape files (.shp/.KML) of blocks boundary maps to CGWB at the earliest and asked CGWB to have the block level assessment of ground water done through the latest methodology.

Agenda 4:- Discussion on NAQUIM 2.0 study taken during 2024-25.
The Chairman advised Chief Engineer, PHE Jammu to facilitate the study of CGWB under intimation to Administrative Department. The district level data/ assistance shall be provided by GM, DIC Kathua, Xen PHE (Civil/ Mech.) Kathua and Incharge, KVK Kathua to collaborate with CGWB for carrying out the study.

In addition to the agenda of the meeting, the following points were discussed during the meeting:

1. Administrative Secretary, PD&MD raised the issue of data on water budgeting at district level and suggested to hold district level workshops for data dissemination and training of Ground Water expert for PHE/I&FC. It has been agreed upon by the Chairman and advised to MD JJM to coordinate with CGWB for preparing district level workshop calendar/ Schedule. The training will be arranged by the JJM and faculty will be provided by CGWB.

2. The Chairman has advised to arrange the Minor Irrigation Census 2022 statistics regarding private irrigation tube wells to CGWB from the Revenue Department at the earliest for use in GWR Estimation. Director Planning, JSD to coordinate.

3. Rural Development Department informed that they are monitoring approximately 2200 wells through Jal Dooth Application. The Chairperson advised to provide the data to CGWB at the earliest. The CGWB will validate the data and add the feasible wells to the monitoring network. It was further informed by the RDD that the data is available on departmental website www.mgnrega.nic.in under Jal Dooth tab. CGWB will provide the data on open borewells/ tubewells to the RDD for pre and post monsoon data by Jal Dooths.

4. All the participating departments/ members of the committee were put under the direction to maintain a close liaison with CGWB and data required for GWRE 2024 will be provided by the concerned departments by 12th of May 2024. The data template will be shared by CGWB to all concerned departments.

5. CGWB will come up with the data on annual extractable water block wise as suggested by the Director Planning, Jal Shakti Department to intensify the Jal Shakti Abhiyan and other water conservation/ recharging measures in the classified blocks as per the annual extractable parameter.

Meeting ended with the vote of thanks to the Chair.

3.10.2024
Chanchal Kumar (JKE&S)
Deputy Director
Jal Shakti Department

A. List of Officers:

1. Sh. Mohammad Aijaz(IAS), Administrative Secretary, Planning, Development and Monitoring Development.
2. Er. Hamesh Manchanda, Chief Engineer, Jal Shakti Department (PHE), Jammu.
3. Er. Manoj Gupta, Chief Engineer, Jal Shakti (I&FC), Jammu.
4. Dr. Arun Manhas, Director Industries and Commerce, Jammu.
5. Sh. Vivek Modi, Special Secretary (Tech.), Forest, Jammu.
6. Sh. Rajesh Kumar, CEO, IWMP (RDD), Jammu.
7. Sh. Waseem Raja, Additional Secretary, Rural Development Department, Jammu
8. Sh. Arun Kotwal, Additional Secretary, Mining, Jammu.
9. Er. Bodh Raj, SE, PHE (Mech.), Jammu.
10. SE, PHE (Mechanical) Srinagar.
11. Dr. Vijay Bharti, Professor, SKAUST, Jammu.
12. Dr. R.K Shrivastva , Professor, SKAUST, Jammu
13. Er. Rakesh Bhatti, XeN, Ground Water Department, Jammu.
14. Executive Engineer, Ground Water, Srinagar.
15. Smt. Sachi Jain, Deputy Director, CWC, Jammu.
16. Sh. Vikas Mittal, DGM, NABARD, Jammu.
17. Smt. Anoo Malhotra, DCRS, Jammu.
18. Sh. Sanjeev Kumar Sharma, AGM, NABARD, Jammu.
19. Sh. Chanchal Kumar Sharma, Dy. Director, JSD, Jammu

B. List of Officers from Central Ground Water Board:

1. M.L. Angurala, Scientist 'D' & HOO, CGWB, NWHR, Jammu, J&K.
2. Rayees Ahmad Pir, Scientist 'B', CGWB, NWHR, Jammu, J&K.
3. Naresh Singh Barti, Assistant Hydrogeologist, CGWB, NWHR, Jammu, J&K.
4. Nikhil Kumar, Assistant Hydrogeologist, CGWB, NWHR, Jammu, J&K.

C. Special Invitee

1. Sh. K.C. Naik, Chairperson, JKWARA, Jammu.
2. Sh. Iftikhar Kakroo, Member, JKWRRA, Jammu.