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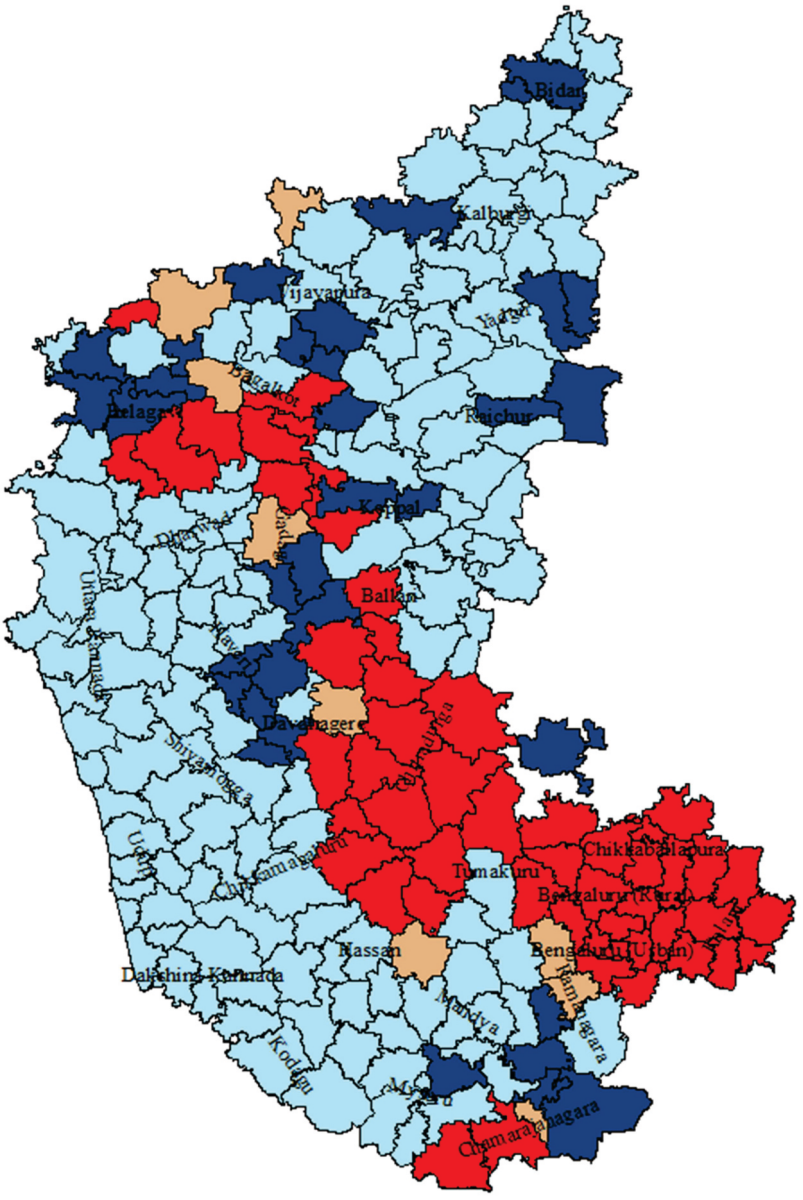
DYNAMIC GROUND WATER RESOURCES OF KARNATAKA, MARCH – 2020



GROUNDWATER DIRECTORATE
MINOR IRRIGATION AND GROUNDWATER DEVELOPMENT DEPARTMENT
GOVERNMENT OF KARNATAKA
&
CENTRAL GROUND WATER BOARD
SOUTH WESTERN REGION
BANGALORE

OCTOBER 2021

ಕರ್ನಾಟಕ ಸರ್ಕಾರ

DYNAMIC GROUNDWATER RESOURCES OF KARNATAKA – MARCH – 2020

Office of the Director

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ಸಂದೇಶ

"ಹರಿಯುವ ನೀರನ್ನು ನಿಲ್ಲಿಸಿ, ನಿಂತ ನೀರನ್ನು ಇಂಗಿಸಿ ಅಂತರ್ಜಲವನ್ನು ಹೆಚ್ಚಿಸಿ,
ರೈತರ ಬದುಕನ್ನು ಹಸನುಗೊಳಿಸಿ"

ರಾಜ್ಯದಲ್ಲಿ ಅಂತರ್ಜಲ ಸಂಪನ್ಮೂಲದ ವಿವೇಚನಾ ರಹಿತ ಬಳಕೆಯಿಂದ ಅಂತರ್ಜಲ ಮಟ್ಟವು ಗಣನೀಯವಾಗಿ ಕುಸಿದು ಅಂತರ್ಜಲ ಮಟ್ಟದಲ್ಲಿ ತೀವ್ರತರದ ಇಳಿಕೆ ಉಂಟಾಗಿದೆ. ನಿರೀಕ್ಷಿತ ವಾಡಿಕೆ ಮಳೆ ಬರುತ್ತಿದ್ದರೂ ಸಹ ರಾಜ್ಯದಲ್ಲಿ ತೀವ್ರ ಅಂತರ್ಜಲದ ಕೊರತೆಯನ್ನು ಎದುರಿಸಲಾಗುತ್ತಿದೆ. ಈ ಬಗ್ಗೆ ಅಂತರ್ಜಲ ನಿರ್ದೇಶನಾಲಯದಿಂದ ಅಂತರ್ಜಲ ಸಂರಕ್ಷಣೆಗಾಗಿ ವೈಜ್ಞಾನಿಕವಾಗಿ ಸಮೀಕ್ಷೆ ನಡೆಸುವುದು, ಅಂತರ್ಜಲ ಅತಿಬಳಕೆ ನಿಯಂತ್ರಿಸುವುದು, ಮರುಪೂರಣ ಮಾಡುವುದರ ಕುರಿತು ಸಾರ್ವಜನಿಕರಲ್ಲಿ ಅರಿವು ಮೂಡಿಸುವ ಕಾರ್ಯಕ್ರಮವನ್ನು ಕೈಗೊಳ್ಳಲಾಗುತ್ತಿದೆ. ಈ ನಿಟ್ಟಿನಲ್ಲಿ ಅಂತರ್ಜಲ ನಿರ್ದೇಶನಾಲಯವು ಕೇಂದ್ರೀಯ ಅಂತರ್ಜಲ ಮಂಡಳಿಯವರ ಸಹಯೋಗದೊಂದಿಗೆ ಕರ್ನಾಟಕ ರಾಜ್ಯದ 'ಅಂತರ್ಜಲ ಸಂಪನ್ಮೂಲ ಮೌಲೀಕರಣ ವರದಿ ಮಾರ್ಚ್-2020' ಎಂಬ ಶೀರ್ಷಿಕೆಯಡಿಯಲ್ಲಿ ಪ್ರಕಟಿಸಲಾಗುತ್ತಿದೆ.

ಸದರಿ ಅಧ್ಯಯನಗಳ ವರದಿಗಳನುಸಾರ ರಾಜ್ಯದಲ್ಲಿ ಅಂತರ್ಜಲ ಅಧಿನಿಯಮವನ್ನು ಜಾರಿಗೊಳಿಸಲು ಅತಿಬಳಕೆ ತಾಲ್ಲೂಕುಗಳನ್ನು ಅಧಿಸೂಚಿಸಿ, ಅನುಷ್ಠಾನಗೊಳಿಸಲಾಗುತ್ತಿದೆ. ಅಧ್ಯಯನದ ವರದಿಯನ್ವಯ 41 ಅಂತರ್ಜಲ ಶೋಷಿತ ತಾಲ್ಲುಕುಗಳಲ್ಲಿ ಕೇಂದ್ರ ವಲಯ ಯೋಜನೆಯಡಿ ಅಂತರ್ಜಲ ನೀರಿನ ಸುಸ್ಥಿರ ನಿರ್ವಹಣೆಯಲ್ಲಿ ಬೇಡಿಕೆ ಹಾಗೂ ಸರಬರಾಜು ನಿರ್ವಹಣೆಗೆ ಸಮುದಾಯ ಸಹಭಾಗಿತ್ವದಲ್ಲಿ ಒತ್ತು ನೀಡುವ ಅಟಲ್ ಭೂಜಲ್ ಯೋಜನೆಯ ಕಾರ್ಯಕ್ರಮವನ್ನು ಕರ್ನಾಟಕ ರಾಜ್ಯದಲ್ಲಿ ಜಾರಿಗೊಳಿಸಲಾಗುತ್ತಿರುವುದು ಹೆಮ್ಮೆಯ ಸಂಗತಿ.

2...

ಅಂತರ್ಜಲ ನೈಸರ್ಗಿಕ ಸಂಪನ್ಮೂಲವಾಗಿದ್ದು, ವಿವೇಚನಾರಹಿತವಾಗಿ ಬಳಸುತ್ತಾ ಬಂದಿರುವ ಕಾರಣ ಮಾರ್ಚ್-2017ರ ಅಂತರ್ಜಲ ಮೌಲೀಕರಣ ವರದಿಯಲ್ಲಿ ಅಂತರ್ಜಲ ಬಳಕೆ ಹಂತ ಶೇ.70ರಷ್ಟಿದ್ದು, ಪ್ರಸ್ತುತ ಮಾರ್ಚ್-2020ರ ಮೌಲೀಕರಣದಲ್ಲಿ ಅಂತರ್ಜಲ ಬಳಕೆ ಹಂತ ಶೇ.66 ಕ್ಕೆ ತಲುಪಿರುತ್ತದೆ. ಇದಕ್ಕೆ ರಾಜ್ಯ ಸರ್ಕಾರದಿಂದ ಕೈಗೊಂಡಿರುವ ಕೃತಕ ಅಂತರ್ಜಲ ಮರುಪೂರೈಕೆ ರಚನೆಗಳ ನಿರ್ಮಾಣ, ಕೆರೆ ತುಂಬಿಸುವ ಯೋಜನೆಗಳಿಂದ ಹಾಗು ಕೃಷಿಯಲ್ಲಿ ಅಧುನಿಕ ಪದ್ದತಿಗಳನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳುವಲ್ಲಿ ಹೆಚ್ಚಿನ ಪ್ರಗತಿ ಸಾಧಿಸಿರುವುದರಿಂದ ಅಂತರ್ಜಲ ಸಂಪನ್ಮೂಲದ ಲಭ್ಯತೆ ಪ್ರಮಾಣದಲ್ಲಿ ಸುಧಾರಣೆಯಾಗಿರುವುದನ್ನು ಗಮನಿಸಬಹುದಾಗಿದೆ.

ಅಂತರ್ಜಲ ನಿರ್ದೇಶನಾಲಯವು ಕೇಂದ್ರೀಯ ಅಂತರ್ಜಲ ಮಂಡಳಿಯವರ ಸಹಯೋಗದೊಂದಿಗೆ ಕರ್ನಾಟಕ ರಾಜ್ಯದ **'ಅಂತರ್ಜಲ ಸಂಪನ್ಮೂಲ ಮೌಲೀಕರಣ ವರದಿ ಮಾರ್ಚ್-2020'** ಎಂಬ ಶೀರ್ಷಿಕೆಯಡಿಯಲ್ಲಿ ಪ್ರಕಟಿಸುತ್ತಿದ್ದು, ಸದರಿ ವರದಿಯು ಸಾರ್ವಜನಿಕರಿಗೆ ಮತ್ತು ಸರ್ಕಾರಕ್ಕೆ ಹೆಚ್ಚಿನ ಉಪಯುಕ್ತತೆವುಳ್ಳ ಮಾಹಿತಿಯನ್ನು ಹೊಂದಿರುತ್ತದೆ ಎಂದು ತಿಳಿಸಲು ಹರ್ಷಿಸುತ್ತೇನೆ. ಮುಂದಿನ ದಿನಗಳಲ್ಲಿ ಆಧುನಿಕ ತಂತ್ರಜ್ಞಾನಗಳನ್ನು ಬಳಸಿ, ಅಂತರ್ಜಲ ಸಂಪನ್ಮೂಲದ ಸ್ಥಿತಿಗತಿಯನ್ನು ಸಾರ್ವಜನಿಕರಿಗೆ ಪರಿಣಾಮಕಾರಿಯಾಗಿ ತಲುಪಿಸಲು ಕಾರ್ಯಕ್ರಮಗಳನ್ನು ಹಮ್ಮಿಕೊಳ್ಳಲು ಹಾಗೂ ವರದಿಗಳನ್ನು ಪ್ರಕಟಿಸಲು ಕ್ರಮಕೈಗೊಳ್ಳಲೆಂದು ಆಶಿಸುತ್ತೇನೆ. ಅಂತರ್ಜಲ ಪ್ರಕೃತಿಯ ಅತ್ಯಾಮೂಲ್ಯವಾದ ಕೊಡುಗೆಯಾಗಿದ್ದು ಇದನ್ನು ಸಂರಕ್ಷಿಸಿ, ಮಿತವಾಗಿ ಬಳಸಿ, ಮುಂದಿನ ಪೀಳಿಗೆಗಾಗಿ ಉಳಿಸಿ, ಅಂತರ್ಜಲ ಹಾಹಾಕಾರವನ್ನು ತಪ್ಪಿಸುವ ಜವಾಬ್ದಾರಿ ನಮ್ಮೆಲ್ಲರ ಹೊಣೆಯಾಗಿರುತ್ತದೆ ಎಂದು ಈ ಮೂಲಕ ತಿಳಿಸಲು ಇಚ್ಚಿಸುತ್ತೇನೆ.

(ಜೆ.ಸಿ.ಮಾಧುಸ್ವಾಮಿ)

C. MRUTHYUNJAYASWAMY, K.E.S.,
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FOREWORD

It is gratifying to note that Dynamic Ground Water Resources of Karnataka as on March 2020 is being published with the coordination of the Groundwater Directorate, Minor Irrigation and Ground Water Development Department, Government of Karnataka and Central Ground Water Board, South Western Region.

The report mainly provides Taluk wise information on ground water resources available and status of utilization as on March 2020 with 2019-20 as base year. The methodology is improved as the estimations are carried out on watershed basis for both command and non-command areas separately and further apportioned to the respective Taluk. The report is very resourceful for Planning, Decision Making, implementation of Minor Irrigation Schemes, Financing Well Schemes etc. The report is hopeful of concentrate on such of areas where immediate protective measures are to be adopted for conjunctive and conservation irrigation, and drinking water supply in order to sustain and preserve the available ground resource.

The Present estimation reveals 52 taluks are over-exploited, 10 taluks are Critical, 35 taluks are semi-critical and 135 taluks are safe. The situation in 2017 was, 45 taluks were over exploited, 26 taluks were semi-critical and 08 taluks were critical, 97 taluks were safe.

Based on this categorization of taluk, the taluks are notified under Karnataka Groundwater Authority for regulation, control and management of overuse of groundwater.

There is an increase in groundwater utilization of the state from 70% to 65% of resources which is apparent. Additional Over exploited taluks Guledagudda in Bagalkote District, Yelahanka in Bengaluru Urban District, Kagawada and Bailahongala Taluk in Belagavi District, Kotturu Taluk in Bellary District, Chamarajanagar Taluk in Chamarajanagara District, Kukannooru Taluk in Koppal District & Sira Taluk in Tumkuru Districts respectively have been identified. In these districts construction of water conservation Structures should be taken up on top priority.

Comparison of ground water assessment of 2017 & 2020 reveals that more number of taluk needs appropriate attention as the aquifer system in these areas are affected by steep decline of ground water resources. This calls for a focused and co-ordinated effort from all the water related sectors to mitigate, conserve and develop groundwater resources in the State for the future generation.

KC Valley tank filling program has played a vital role in improvement of groundwater condition in taluks of Kolar and Chikkaballapura Districts.

I hope that this data will be utilized by the public and State agencies to conserve ground water, which is a precious natural resources.

Date:04/10/2021
Place: Bengaluru

(C. MRUTHYUNJAYA SWAMY)
Secretary to Government
Minor Irrigation and Ground
Water Development Department

Central Ground Water Board
South Western Region
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सत्यमेव जयते
भारत सरकार
GOVERNMENT OF INDIA

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दक्षिण पश्चिम क्षेत्र
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एच.एस.आर. लेआउट, सेक्टर १,
बेंगलूरु - ५६० १०२

PREFACE

Periodic assessment on the availability and utilization of Groundwater resource is vital for planning, its Sustainable development and judicious management. This is extremely important in the case of Karnataka State wherein ground water resources is under increasing stress owing to its extraction for various uses. Periodic assessment of Groundwater resources is done once in three years and the last was in March 2017. The assessment of Dynamic Groundwater Resources of Karnataka as on March 2020 has been carried out jointly by CGWB and Karnataka State Groundwater Directorate under the supervision of Ground Water Resource re-estimation Committee based on Groundwater Estimation Methodology, 2015 (GEC–2015), which takes into account all the relevant parameters contributing to ground water recharge and extraction.

For the first time, all computations for the assessment of ground water resources have been automated and done in a GIS environment through a web based application namely "INDIA GROUNDWATER RESOURCE ESTIMATION SYSTEM (IN-GRES)" developed in collaboration with IIT, Hyderabad. This application provides a common and standardized platform for the assessment of Dynamic Ground Water Resource for the entire country. This application helps the State to visualize the results of assessment and take proper management decisions. The database thus generated will have a significant role in planning and scientific management of groundwater. The report briefly describes salient features of previous assessments, ground water estimation methodology, rainfall distribution, hydrogeology, aquifer systems of Karnataka and ground water level scenario of the state in the first five chapters before describing various components of the ground water resource assessment, 2020 in some detail. This is followed by details of District-wise assessment of resources and conclusions drawn from the assessment. The report also has 12 Annexure having district-wise information related to various components of the assessment and comparisons with the previous assessment. I express my profound appreciation of the untiring efforts of team of Officers of Ground Water Cell comprising of Officers lead by Nodal Officer Miss.D. Dhayamalar, Scientist D from CGWB and Officers from State Groundwater Directorate for completing the challenging task of compiling this informative report.
The guidance of Shri C.Mruthyunjaya Swamy, K.E.S, Secretary (MI & GWDD), Government of Karnataka & Chairman of State Level Committee for Re-estimation of Groundwater resources has helped in improving the quality of the report as well as fast-track assessment and is gratefully acknowledged. I truly believe that stakeholders at various levels will find this report informative and helpful for managing our precious ground water resources judiciously and for ensuring their sustainability for years to come.

Date: 15-09-2021

(V.KUNHAMBU)
REGIONAL DIRECTOR

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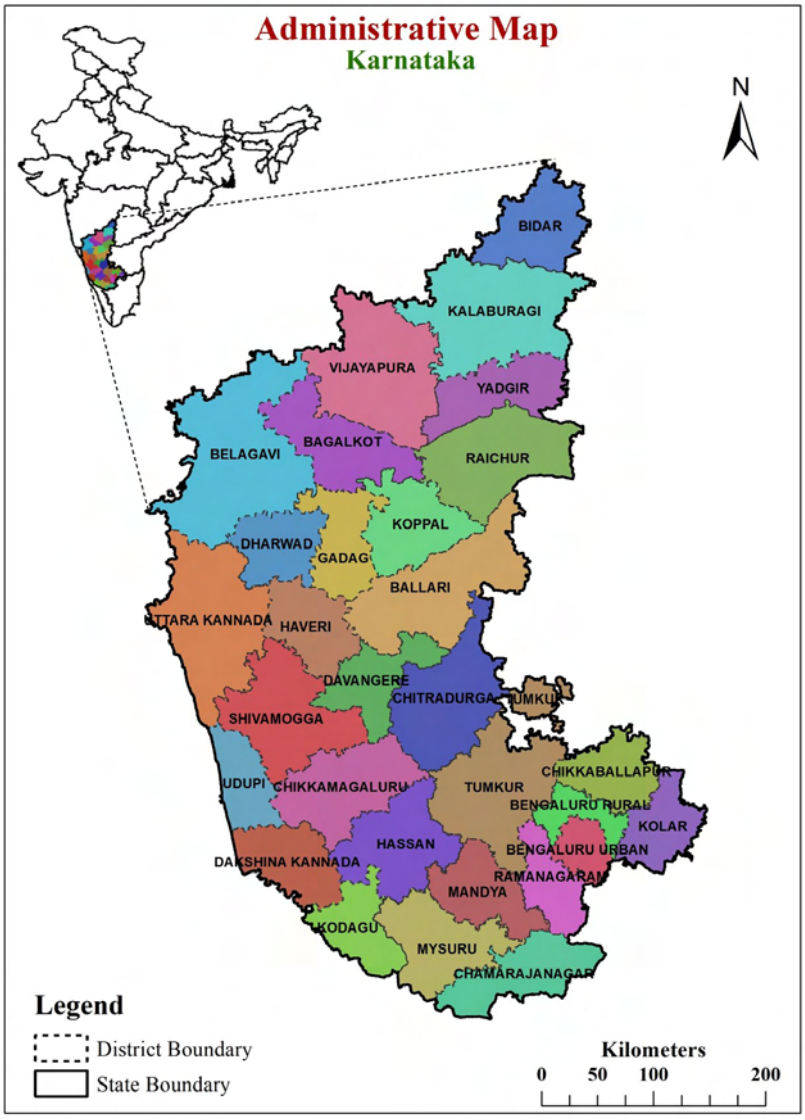
DYNAMIC GROUNDWATER RESOURCES OF KARNATAKA, 2020

1. INTRODUCTION.

Groundwater resources of Karnataka state has been assessed based on Groundwater Estimation Methodology (GEC-2015) as in March 2020 on a watershed basis using the database available upto 2019. The resources so assessed were apportioned and presented on an administrative unit i.e. Taluk wise to facilitate at planning of developmental activities (Plate-1). The Methodology envisages that groundwater assessments may be made once in three year. The groundwater resources were last estimated for the state of Karnataka as on March-2017. Now groundwater resources are estimated for the state of Karnataka as on March-2020 using the Minor irrigation data on well census and the data collected by the district level officers of Groundwater Directorate, Government of Karnataka and various state agencies as the base data on watershed basis.

Plate-1



For the re-estimation of groundwater potential in the state of Karnataka the following committee was constituted vide GO No.MID 22 AAJAA 2020 (E) Bangalore dated 20.08.2020 by the Minor Irrigation and Groundwater Development Department Government of Karnataka (Table-1 & Annexure IX).

Table-1 Constitution of Committee for Groundwater Re-estimation

1.	Secretary to Government, Minor Irrigation and Groundwater development department	Chairman
2.	Chief Engineer, Minor Irrigation & Groundwater Development Department, South Zone, Bangalore	Member
3.	Chief Engineer, Minor Irrigation & Groundwater Development Department, North Zone, Vijayapura	Member
4.	Director, Groundwater Directorate	Member
5.	Chief Engineer, Karnataka Urban Water Supply & Drainage Board	Member
6.	Director, Department of Agriculture	Member
7.	Chief Engineer, Water Resources Development Organization	Member
8.	Chief Engineer, Rural Water Supply & Sanitation Department	Member
9.	Commissioner/Director for department of Industries	Member
10.	General Manager, NABARD	Member
11.	Chief Engineer, Advanced center for Integrated Water Resources Management Center, Bangalore	Member
12.	Regional Director, Central Groundwater Board, Government of India, Bangalore	Member Secretary

The members of the committee had several informal meeting for data sharing and discussion of the progress of their source evaluation. A working committee comprising of the officers of the Central Ground Water Board (CGWB) and Groundwater Directorate (GWD) was formed for resource assessment. They had meeting at frequent intervals to monitor the progress and address the constraints in resource evaluation. The resources re-assessed on a watershed basis and several meetings were held. Based on the suggestion in these meetings, the finalized resources were presented in the State Level meeting held on 04.05.2021 and was approved by the State Level Committee.

1.1. 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 will provide common and standardized platform for Ground Water Resource Estimation for the entire country and its pan-India operationalization (Central and State Governments). The system will take '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. The INGRESS Platform is used in computation of results of Groundwater Resource Assessment of Karnataka State as on March 2020. URL of IN-GRES http://ingres.iith.ac.in

2. HYDROGEOLOGICAL CONDITIONS OF KARNATAKA

2.1 CLIMATE AND RAINFALL

In Karnataka typical monsoon is experienced. Bulk of the annual rainfall is received during the south-west (June to September) and north-east (October-December) monsoons. Pre-monsoon thunder storms also contribute significant to considerable rainfall. Humid to semi arid climatic conditions prevail in the state. In general rainfall varies from around 400 mm in the eastern fringe of the state to more than 4000 mm in the west (plate 2). The state can be broadly classified into four distinct climatic zones. These are:

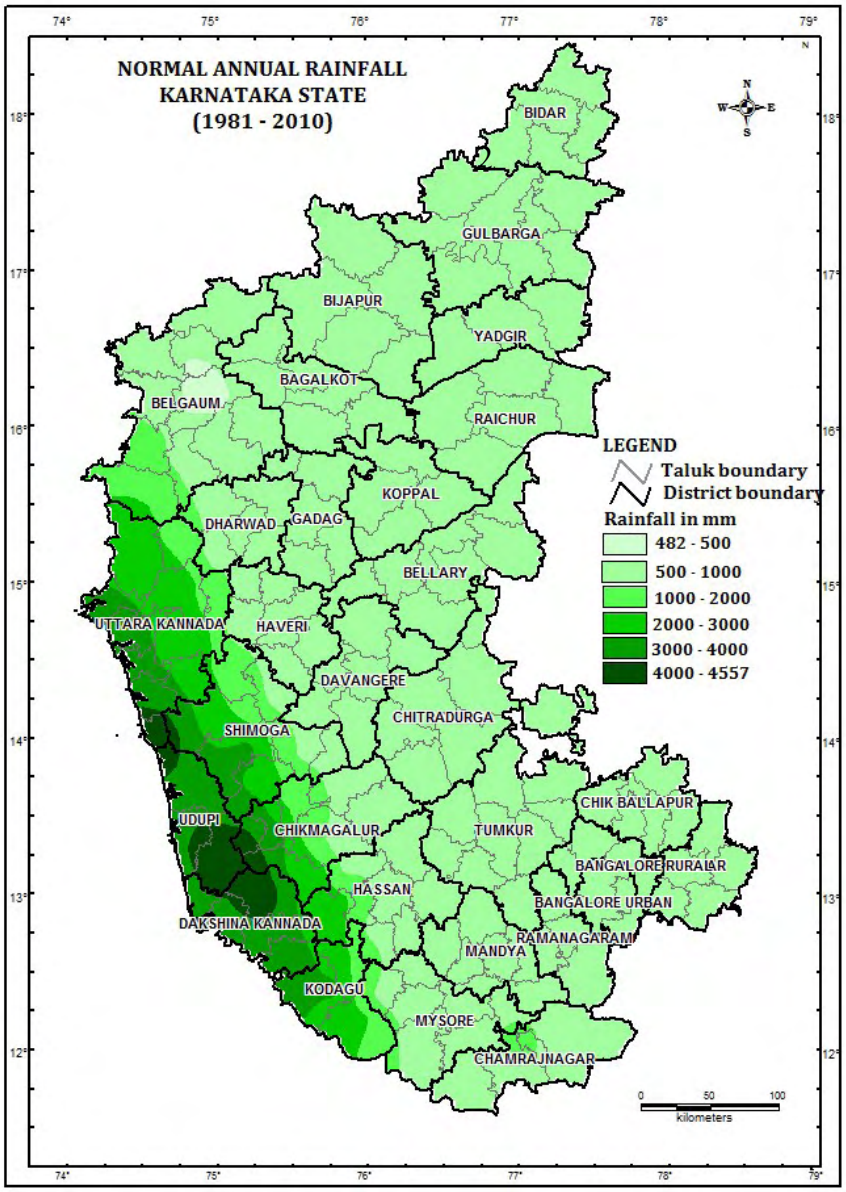
I. Narrow Coastal Zone along the West Coast: The whole of Dakshina Kannada, Udupi and western parts of Uttara Kannada district come under this zone. The rainfall generally increases from the coast towards the mountains on the east and from north to south. Average rainfall is around 4000 mm and bulk of this rainfall occurs during the south west monsoon period lasting from June to September. July is the wettest month.

II. The Mountain (Malnad) Zone: Parts of Belagavi, Uttara Kannada, Shimoga, Chikamagalur, Hassan, Kodagu and Mysuru districts fall under this zone. The area is composed of series of mountain and dense tropical forests. Rainfall is over 5000 mm on hill tops and around 2000mm in the adjoining forest areas. However, Agumbe in Shimoga district records a rainfall over 7000mm annually on an average. The south west monsoon yields the bulk of the rainfall and July is the wettest month. The rainfall decreases from west to east.

III. The Northern Plains: Eastern part of Belagavi and whole of Bidar, Vijayapura, Bagalkote, Bellary, Kalaburagi, Dharwad, Gadag, Haveri, Raichur and Koppal fall in this zone. Bulk of the rainfall occurs in the winter months. The rain fall decreases from the west to east. On an average about 700mm rainfall is received annually. September is usually the month of peak rainfall.

IV. The Southern Plains: Parts of Shimoga, Chikamagalur, Hassan, Mysuru and whole of Mandya, Tumkur, Bangalore and Kolar districts fall in this zone. In these parts, rainfall ranges from 1000mm to around 400mm. Considerable rainfall occurs during the pre-monsoon months due to thunder storms. Both the monsoons are active giving copious amounts of rainfall. The peak rainfall is found to occur in September/October with a secondary peak occurring in May. The average rain fall in these parts is around 700 mm.

Plate-2



2.2 GEOLOGY

Karnataka State comprises rock types of age from Archaean to Recent (Plate-3). Major portion of the State is covered by Peninsular Gneisses, Granites and Dharwad Schists of Archaean age. Substantial area in the northern part of Karnataka is underlain by basalts, which form a continuation of the Deccan Traps occurring in Maharashtra. The sedimentary rocks comprising Bhima and Kaladgis occupy a small area in the northern districts. The recent alluvium is restricted to a narrow belt in the coastal area and along stream courses. The geological succession in the state is presented as below (Table.2).

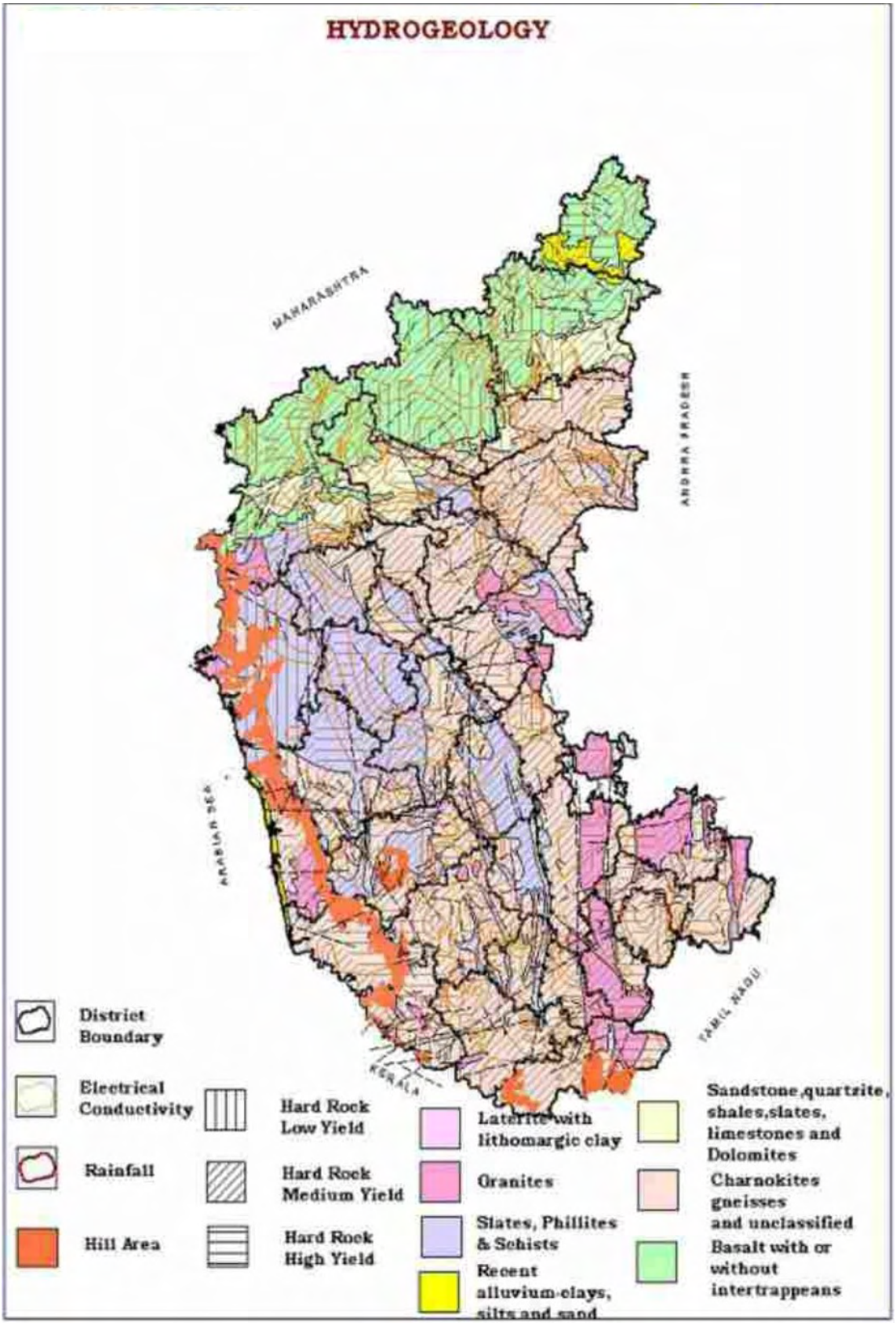
Table.2 Geological Succession in Karnataka State

Age	Series/System	Formation
Recent	Soil & Alluvium	Sand and Clay
Pliestocene	Laterite	Laterite
Tertiary to Mesozoic	Deccan Trap Basalt	Hard massive & vesicular Basalts
~~**Unconformity**~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
Lower Palaeozoic to upper Precambrian	Bhima Series	Quartzites, Sandstones, Limestone, Shale and Conglomerates
~~**Unconformity**~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
Upper Precambrian	Kaladgi Series	Quartzites, Sandstones, Limestones, Shale and Conglomerates.
~~**Unconformity**~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
Lower Precambrian	Dharwad system Volcanic, meta sediments, Greenstone	Dharwad Schist's meta sediments, Green Stone Formations
~~**Unconformity**~~~~~~~~~~~~~~~~~~~~~~~~~~~~		
Archaean	Peninsular Gneissic complex	Gneisses, Granites, Charnockites, Khondalites

The Archaean crystalline rocks occupy nearly 79% of the total geographical area of the state. Excepting Bidar district and northern parts of Belagavi, Bagalkote, Vijayapura and Kalaburagi district, archaean crystalline rocks occur in the remaining parts of state. The gneissic complex is composed of composite gneisses, migmatites, granites and quartz veins. Charnockites are exposed over a limited extent in the southernmost parts of the state in kodagu and Mysuru districts. The weathered zone in these crystalline extends from less than a meter to about 20m the thickness in general and at places it is as deep as 60-90m. In parts of Belguam, Bengaluru and kolar districts the weathered material is more of clayey in nature.

The Dharwad mainly composed of slates, phyllites and schists form the second major group of rocks occurring in about 40000sq. km of the state. These are sub divided in to three main types namely Chitradurga group, Dharwad sub group and Sargur group. They are wide spread in parts of Uttara Kannada, Dharwad, Shimoga, Chitradurga and Chikamagalur districts where as in other districts their occurrence is limited in extent as small strips distributed throughout gneissic terrain.

Plate-3


HYDROGEOLOGY
MAHARASHTRA
ANDHRA PRADESH
ARABIAN SEA
KERALA
TAMIL NADU
District Boundary
Electrical Conductivity
Rainfall
Hill Area
Hard Rock Low Yield
Hard Rock Medium Yield
Hard Rock High Yield
Laterite with lithomargic clay
Granites
Slates, Phillites & Schists
Recent alluvium-clays, silts and sand
Sandstone,quartzite, shales,slates, limestones and Dolomites
Charnokites gneisses and unclassified
Basalt with or without intertrappeans

This group consists of volcanic rocks such as rhyolites, felsites etc., limestone, conglomerates, quartzite (ferruginous), and Meta sediments as amphibolites sands chists. The schists and related argillites form the valley portions, but in general, the Dharwad form high grounds. The weathered zone extends down to about 20m in the valleys. The Dharwad rocks have regional strike of NNW-SSE, which tends to N-S in the southern part of Mysuru and even to NE-SW direction near the southern border.

Meta-Sedimentary formations of Bhimas, Kaladgis and Badamis are exposed over an area of 9640sqkm in the state. The major litho units in the group are sandstone, quartzite, shale, slate, limestone and dolomite. The Kaladgi formations are exposed over length of 160km between Krishna and Malaprabha rivers in Belagavi and Vijayapura districts. The formation comprises of conglomerates, quartzite, limestone and shale's, which are divided into lower and upper series. The uppermost and stone formations exposed at Badami and further east which are thick bedded and gritty are designated as Badamis and stone. This horizon is considered as younger and equivalent to Bhima/Vindyas. This formation however, occupies higher altitudes occupying ridge sand hence is of less importance from groundwater point of view. In the central part of the basin the Kaladgis are well developed with the presence of all litho units while towards west only the lower series consisting mainly they are nacreous members are exposed. The Kaladgis are partly overlain by Deccan trap. The formations are folded giving rise to a series of ridge sand valleys. The valleys are mainly occupied by limestone and shale. The limestone formation occupies a wide area in between Lokapur and Bagalkote. Generally the lime stones are horizontally bedded and have very low permeability. At places it is karstified and cavernous. A narrow band of dolomite overlies the limestone. In the southern and northern valleys, i.e. South of Bilgi and at Kulgeri respectively, the shale's are purple in colour.

The regional trend of the formations and the axial planes of the folds are WNW-ESE. A major fault zone runs in limestone formation marking the contact between an anticline and syncline along Kaladgis-Kardigud In the Lokapur valley. Another major fault zone runs along Gaddanakeri in Bagalkote valley. A number of minor faults and major fracture zones are identified in the basin cutting the quartzite and the drainage in this area seems to be controlled by structure. The basin in the central part i.e. along Bilgi-Gaddankeri-Kulgeri is severely disturbed while towards east and west of zone, the tectonic intensity is not displayed. Exploratory drilling in this area revealed the presence of major fracture/shear zones down to a depth of 200m.

The Bhima basin lies east of the Kaladgis stretching in NE-SW direction. The major part of the basinlies in Kalaburagi district, except for a small strip in the Vijayapura district between Muddebihal and Talikot. The Bhimas are represented by conglomerates, sandstones, shales and lime stones, which could be sub divided in to three series lower, middle and upper. The lower and

middle series consist of the sequence of these three lithological units, while the upper series is represented mainly in purple shale. Among the lower series the lime stones are well developed over a wide area and are popularly known as 'Shahabad' stones. The middle series forms a narrow strip and are of little significance from groundwater point of view. The shales are purple colored and laminated and the lime stones are variegated but predominantly grey colored and thick bed deed. The formations do not show any metamorphism. They are in general horizontally bedded or dip at less than 5° towards west. However, this trend is not maintained in the distributed zones.

A number of faults of relatively lesser magnitude are identified in the basin at different places. The displaced block is also gently folded on the western side. Thrust faults and the gravity faults are also identified at a few places. The formations are highly fractured in these distributed zones. Certification marks fault zones in the limestone formations. The drainage in the Bhima basin is considered to be of tectonic origin. The curvilinear trend of Bhima river course seems to be controlled by the two axes of superposed folds and also faults. Similarly, the streams of lower orders are also influenced by the fracture system in granitic terrain and folding pattern in the Bhima formations.

Deccan trap forms the northern part of the State. Both massive basalts wells vesicular basalt is encountered in the area. The maximum thickness of about 600to 800m trap is reported around Kolhapur in Maharashtra but becomes thinner to about 70 m or less towards the fringe as observed in parts of Kalaburagi, Bagalkote and Belguam districts of Karnataka. The inter-trappean beds are of small extent and appear have been formed in local depressions only or near to the south western edge of the trap area. In Vijayapura district, three flows of zeolitic trap are observed between 506m and 610m contour each with a thickness of about 6m. In the southern part of Kalaburagi district only zeolitic trap unit is identified which is exposed at higher elevation in the southern most part and at the ground surface around Kalaburagi. The weathered zone in traps varies from traces about 15mbgl. Traps are considered to be not involved in any tectonic disturbances. It is also difficult to recognize any structural deformities in them as they are generally fine grained and massive. However some faults identified in Bhima basin are considered to be extending into the traps also. At some places in Kaladgis the traps are reported to enclose fragment of quartzite.

Laterite perhaps of different genetic histories such as residual and transported are found overlying different formations in different parts of the state. It occurs along the coast in Dakshina Kannada, Udupi and Uttara Kannada districts overlying schists and granites with a maximum thickness of about 40m. In Kaladgis, Laterite also occurs as isolated patches in the valleys capping shales and basalt. The thickness in this part is 2 to10m. The Laterite capping on Deccan trap is extensive in parts of Bidar and Kalaburagi districts. However Laterite as an aquifer is having limited real extent of about 1300 sq. km. Its occurrence is also reported in the Belguam district.

Generally it is confined to the highest ridge sand peaks. The Laterite formed in the vesicular traps are deep yellow is brown in color. Localized patches of laterites are encountered in other parts of the state also, overlying the granites and Dharwads.

The alluvium of recent age is limited to only certain river courses in the west coast. Alluvial patches are located along Tungabhadhra, Suvarnamukhi and Chitravathi river courses. The thickness of alluvium is variable generally and a maximum thickness of 15m is reported in the Chitravathi basin. The alluvium consists of unconsolidated sediments such as pebbles, gravel, sand, silt and clays. In the coastal area the thickness ranges from negligible to about 30m.

2.3 SOILS

Soils of the state can be grouped into 9 classes. They follow mainly the rock types but vary widely due to the effects of climate and topography.

2.3.1. Shallow Black Soils

These occur in the trap region and to some extent are also developed in schist, shale and limestone in parts of Belagavi, Vijayapura, Kalaburagi and Bidar districts. These are dark grayish brown, dark brown to dark reddish brown, usually calcareous sand are clayey loam to clay in texture. They have moderate to poor infiltration characteristics. An area of about 2350sq.km is covered under shallow black soil in the state.

2.3.2. Medium Black Soils

They are derived from Deccan traps and occupy large tracts of Belagavi, Vijayapura, Kalaburagi and Bidar districts. They are comparatively light in colour on high lands than in valleys. Their texture varies from loam to clay. Their infiltration characteristics are poor to moderate. In filtration rate of 2.5cm/hr has been recorded in Kalaburagi district. An area of about 36150sq.km is covered under medium black soil in the state.

2.3.3. Deep Black Soils

They occupy large tracts in Raichur district and in parts of Belagavi, Vijayapura, Chitradurga, Bellary and Kalaburagi districts. They are dark black in colour and have high clay content. They are derived from a variety of parent rocks like traps, schists, gneiss sand sedimentary rocks. They are mostly transported, occurring in the basins of major river valley sand depressions. In texture, they are generally clay loam to clay. Accumulations of lime, gypsum and soluble salts at varying depths in the profile of ten pose problems. They have poor infiltration characteristics. Infiltration rates of 0.5 to1.2 cm/hr in Bellary, 0.6 to 3.6 in Raichur and 0.8 to 2.8cm/hr in Dharwad have been recorded. An area of about 21770sq. km is covered under deep black soil in the state.

2.3.4. Red Sandy Soils

They are derived from the acidic type of rocks like granite and gneisses and occupy large tracts in Kolar, Bangalore, Tumkur, Mandya and Mysuru districts. These are light textured, varying from sand or gravely to loamy and are highly leached. They have good infiltration characteristics.

Infiltration rate of 4.5cm/hr in Bellary, 6.5to11 cm/hr in Raichur,1 to 5cm/hr in Dakshina Kannada and 5cm/hr in Chikamagalur and Mysuru districts have been recorded. An area of about 57100 sq. km is covered under red sandy soil in the state.

2.3.5 Mixed Red and Black Soils:

Red and black soils occur together and are found in parts of Belagavi, Vijayapura, Dharwad, Raichur, Bellary and Chitradurga districts. They are derived from gneisses, schist sand sedimentary rocks. The highly permeable red soils are confined to the upland area while in the low lands and valleys, black soils of poor to medium infiltration characteristics occur. An area of about 19100 sq. km is covered under mixed red and black soils in the state.

2.3.6 Red Loamy Soils

They occur in small trips in Shimoga, Chikamagalur, Hassan and Mysuru district sand in the valley portions adjacent to hill sand Western Ghats. They are transported in origin and are loamy to silty in texture. They have moderate to good infiltration characteristics. Infiltration rate of 1.8 to 6.9cm/hr is recorded in these soils in Dharwad district. An area of about 26700sq.km is covered under red loamy soil in the state.

2.3.7 Lateritic Soils

These soils occur mostly in the malnad and coastal districts of Uttara Kannada and Dakshina Kannada and parts of Belagavi, Shimoga, Chikamagalur, Hassan, Udupi and Kodagu. In Bangalore, Kolar and Bidar districts also, patches of lateritic soils are seen. They occur under two modes: a) High level, insitu and b) Low-level, transported. In malnad and coastal districts, these are derived from the Dharwad schist's sand peninsular gneisses. They have moderate to good infiltration characteristics. In Dakshina Kannada district, infiltration rate of 0.6 to 3cm/hr has been recorded. An area of about 14200sq.km is covered under lateritic soil in the state.

2.3.8 Lateritic Gravely Soils

They occur in patches in the southern parts of Dakshina Kannada district, Northern parts of Shimoga and north-eastern part of Bangalore district. They are similar to lateritic soils in the properties. An area of about 3700sq. km is covered under lateritic gravelly soil in the state.

2.3.9 Alluvial Soils

These are developed over the alluvium deposited by west flowing rivers, which occur as a narrow patch along the coast in the districts of Dakshina Kannada and Uttara Kannada. These are coarse textured sands, sandy loams or loam sand has good infiltration characteristics. In sandy soil infiltration rate of 17 cm/hr is recorded in Kodagu district and 28cm/hr in Chikamagalur district. In coastal alluvium, rates of 90 to114 cm/hr are recorded in sand. An area of about 800sq. km is covered under alluvial soil in the state.

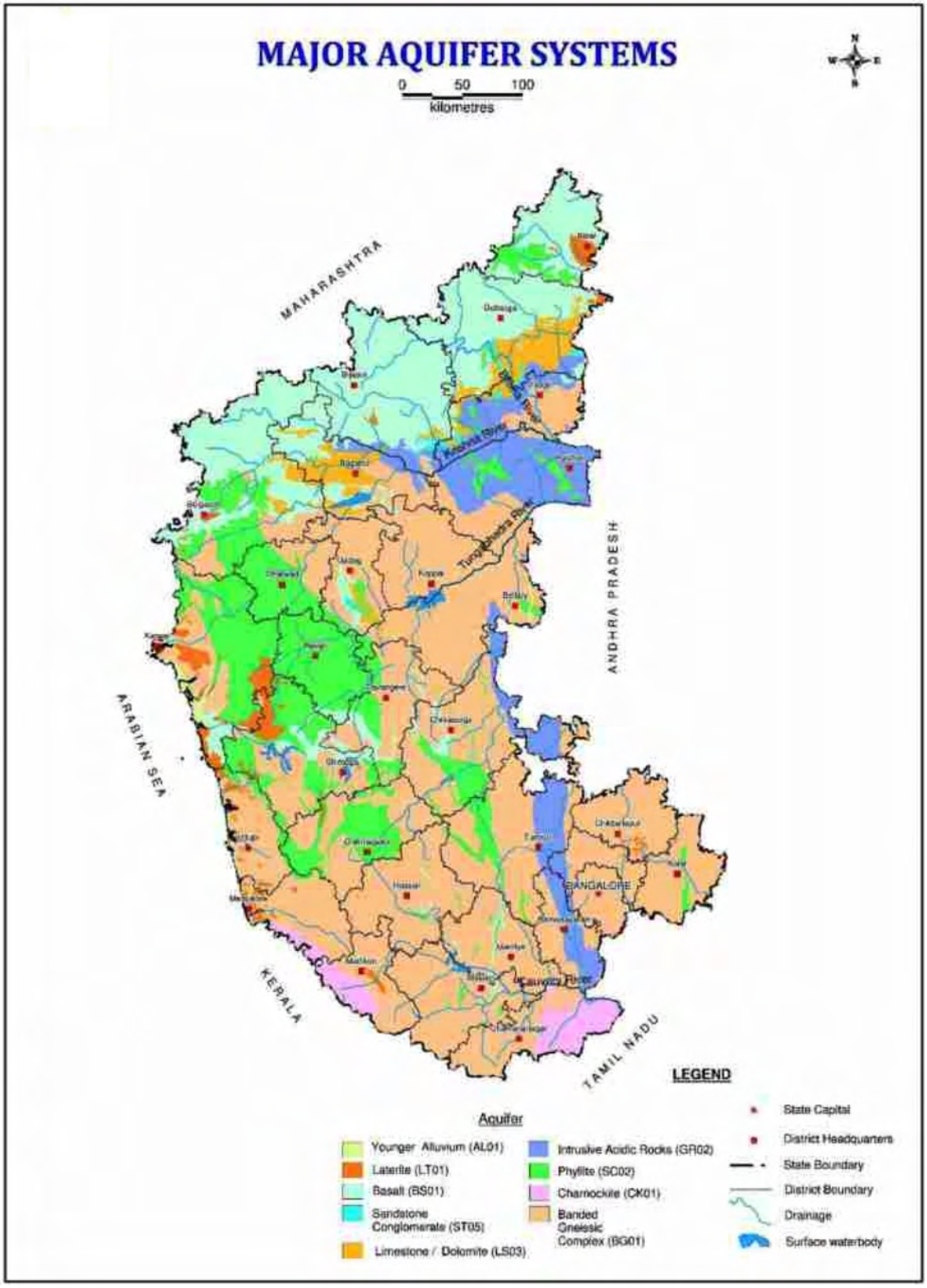
3.0 GROUNDWATER CONDITION

Karnataka State can be considered as having three major hydrogeological provinces. They are the Hard Rock province, Deccan Trap province and Metamorphosed sedimentary province as described below. Groundwater occurs in these provinces under unconfined to semi-confined conditions and under confined conditions in depth. The rock units of provinces do not have the primary porosity, therefore the occurrence and movement of groundwater is through secondary porosity developed through weathering, fracturing and tectonic formation under gone by the rocks. The main source recharge to the aquifers is by precipitation and also by applied irrigation. In addition to these along the coast a thin band of alluvium is encountered (Plate 4).

The Archaean Crystalline Hard Rock Province: Archaean crystalline hard rocks are represented by the gneisses, schists, granites and khondalites, which occupy up to 79% of the area of the state. The availability of groundwater in the phreatic zones in these formations is controlled by the degree of weathering and lithological unit of the area. The schists and khondalites are more susceptible to weathering and hence are having better yield in the phreatic zones compared to Granites. Generally the depth of weathering goes down to 30 min this formation sand they sustain dug wells. In contrast, the yield of bore wells is controlled by the tectonic history of the area and the lithology encountered. Thus equi-granular rocks when subjected to differential stress tend to develop open(tensile) joints in the direction of stress sand shear joints at about 23° to the direction of stress, whereas rocks having linear mineral stand to absorb the stress and the linear minerals reorient along the stress direction. Thus Granites, Pegmatite sand Charnockites yield better compared to Schists, Phyllites and Gneisses.

Further, the analysis of the results of groundwater exploration in the state indicated that the tectonic story has an important bearing on the yield of bore wells. Thus all the lineaments are not equally potential. The NE-SW lineaments are the most potential followed by E-W, NNW-SSE and NW-SE in the order of preference even though the NW- SE lineament is the most commonly occurring one. The yield of bore well in the province is as high as 30lps with a transmissivity of upto 2000 m^2/day in ideal conditions tapping tensile joints in granites/ pegmatite's and other equi-granular rocks.

Plate-4


MAJOR AQUIFER SYSTEMS
0 50 100
kilometres
MAHARASHTRA
ANDHRA PRADESH
KERALA
TAMIL NADU
ARABIAN SEA
BANGALORE
LEGEND
Aquifer
Younger Alluvium (AL01)
Laterite (LT01)
Basalt (BS01)
Sandstone Conglomerate (ST05)
Limestone / Dolomite (LS03)
Intrusive Acidic Rocks (GR02)
Phyllite (SC02)
Charnockite (CK01)
Banded Gneissic Complex (BG01)
State Capital
District Headquarters
State Boundary
District Boundary
Drainage
Surface waterbody

Deccan Traps: The Deccan trap constitutes about 15% area of the state occupying Bidar, Vijayapura, major parts of Kalaburagi, Belagavi and northern parts of Bagalkote districts. The vesicles and amygdales are the porous media for the traps. Generally these porous media are filled with the secondary materials like Quartz, Zeolites, and Bauxite sand Clays. The Deccan traps also act like acrystalline formation. Zeolitic traps and Amygdales and vesicular properties of the trap facilitate occurrence and movement of groundwater in traps. Further at the trap crystalline fringe area in Karnataka part, the traps have minor dip, which carry the water through contact zone of the flows. The intra trappean red bole beds act as an aquiclude. The weathered zone occurs up to a depth of 20mbgl and semi confined conditions occur below 20 to 40m in the Deccan trap. The jointed and fractured Deccan traps carry the groundwater to deeper depths. Depth of bore wells drilled in traps ranges from 40 to175m.The general yields of wells in traps is low and draw downs are high. The specific capacity of the wells in Deccan traps ranges from 0.05 to 34l/min/m draw down. The yield of bore wells ranges from 4 to1440m^3/day. The transmissivity of the traps ranges from 1 to369 m^2/day.

The Sedimentary Provinces: The sedimentary rocks province is represented by the Kaladgis, Bhima sand Badamis, also known as consolidated sedimentary sand it constitutes about 5% of the area of the state spread over parts of Kalaburagi, Bagalkote, Belagavi and Vijayapura districts. The primary porosity that usually exists in these formations has been lost due to the process of consolidation and compaction. Amongst these formations, lime stones form very poor aquifers as they are mostly horizontally bedded and devoid of solution activity except along the contact zones. Except in Ramdurg, Soundatti, Badami and Hungund areas the sand stones do not form aquifers because it occupies the higher altitudes as ridges. The shales are very rarely seen as aquifers but act as collector ponds than as an aquifer. Wherever sandstone occur as an aquifer it has a specific yield of 0.03. The limestone of the Bhima series has specific yield of 0.005 to 0.04. Discharge of the bore wells drilled in limestone ranges from 100 to 300m ^{3}/day. Depth of the bore wells drilled varies from 94 to 120 m.

Alluvium: Alluvial deposits occur as an aquifer comprised of fluvial materials like fine to coarse sand, gravels and pebbles. It constitutes little over 1% area of the state. The river banks show the presence of alluvial deposits to a depth of 2m to 20m and the coastal tract accounts up to 40. The river that records alluvial/colluvial deposits are the Pennar, Kumudavati, the Tungabhadra, Suvarnavati, Chitravati and lower Hagari river. The yield of these river alluvial deposits ranges from 10 to 500m^3/hour. The coastal alluvial deposits yield from 2400 to 4800m^3/day. The transmissivity ranges from 2 to 4348 m^2/d.

Laterite: Laterite is seen as a capping, scattered over the country rock in all the three Groundwater provinces. The demarcation of the area under Laterite is difficult as it forms potential aquifer only if it is having considerable thickness. In other places especially on the eastern parts of the state, it is absent or occurs as a thin capping over the country rock. However these are more predominant in the western parts of the state, where it forms potential phreatic aquifer. These are highly porous and permeable; as a result gets fully recharged after monsoon. The aquifer drains out due to subsurface out flow in the post-monsoon period. The dug wells tapping these aquifers located in slopping ground gets dried up during summer months, even if the groundwater utilization in the area is on a low key.

3.1 GROUNDWATER LEVELS

Pre-monsoon

The depth to water level recorded in the State during May 2019 ranged from 0.43 m bgl to 30.70 m bgl. A total of 1442 stations are monitored during this monitoring season. Out of this 1442 wells are analyzed, 5 % of wells have water level less than 2mbgl, 19% of wells have water level in the range of 2 to 5mbgl and 43 % of wells have water level in the range of 5 to 10mbgl. Thus, about 67 % of the analyzed wells have water level within 10mbgl. Moderately deep water levels of 10 to 20mbgl are seen in 31% of wells and deep water levels of > 20m is found in about 2% of the analyzed wells. A map showing the depth to water level in the ranges of <2, 2 to 5, 5 to10, 10 to 20 and >20mbgl was prepared and is enclosed as Depth to Water Level Map of Karnataka, May 2019 (Plate-5). The map shows that the depth to water levels in the range <2mbgl is observed in isolated patches in parts Bangalore Urban, Belgaum, Chikmagalur, Dakshin Kannada, Davanagere, Gadag, Hassan, Haveri, Kodagu, Kolar, Mandya, Mysore, Raichur, Shimoga, Tumkur and Uttara Kannada districts. The depth to water levels in the range of 2 to 5 m bgl and 5 to 10 m bgl is recorded in all districts of Karnataka State. The depth to water levels in the range of 10 to 20 m bgl in pockets in all districts of Karnataka State. The depth to water levels in the range more than 20 m bgl in observed as isolated pockets in Bagalkot, Bangalore Rural, Belgaum, Bidar, Bijapur, Dharwad, Gadag, Gulbarga, Hassan, Mysore, Shimoga and Tumkur districts of Karnataka State.

Post-monsoon

The depth to water level recorded in the State during November 2019 ranged from 0.01 m bgl to 30.7 m bgl. It is seen that out of 1432 stations' data analyzed for the month, 32.5% of wells have water level less than 2mbgl, 35% of wells have water level in the range of 2 to 5mbgl and 26 % of wells have water level in the range of 5 to 10mbgl. Thus, about 93.5% of the analyzed wells have water level within 10mbgl. Moderately deep water levels of 10 to 20mbgl are seen in 1% of wells and deep water levels of more than 20 m is found in about 0.5% of the analyzed wells.

A map showing the depth to water level in the ranges of less than 2, 2 to 5, 5 to10, 10 to 20 and more than 20 mbgl was prepared and is enclosed as Depth to Water Level Map of Karnataka, November 2019 (Plate-6). Water levels in the range of less than 2mbgl is recorded in all the districts of Karnataka State. The map shows that the water levels in the range of 2 to5 and 5 to 10 m bgl are the general water levels prevalent in the State. Depth to water level between 10 to 20 mbgl is observed in Bagalkot, Bangalore Rural, Bangalore Urban, Bellary, Bidar, Bijapur, Chamarajanagar, Chikmagalur, Chitradurga, Davanagere, Dharwad, Gadag, Gulbarga, Hassan, Kodagu, Koppal, Mandya, Mysore, Raichur, Shimoga, Tumkur and Uttara Kannada districts and water level more than 20 mbgl occur as a small isolated patches in Bagalkot, Bijapur, Dharwad, Gadag, Mysore and Raichur districts of Karnataka State.

Seasonal Fluctuation – May to November 2019

Water levels data from 1342 stations were analyzed to know the seasonal change in groundwater level in May 2019 with that of November 2019. Out of 1342 stations 1333 stations were compared and the remaining stations could not be compared due to the non-availability of data for a particular station in current season. On the whole, 1290 wells accounting for 97% of the analyzed wells have recorded a rise in water level during November 2019 as compared with the water level of May 2019. The remaining 43 wells accounting for 3% have recorded a fall in water level.

In the rise category, the water level in the range 0 to 2 m is observed in 232 wells accounting for 17% of the analyzed wells. Rise in water level in the range of 2 to 4 m and more than 4 m is recorded in 329 wells (25%) and 729 wells (55%) respectively. In the fall category, the fall of water level in the range of 0 to 2 m is observed in 27 of wells accounting for 2% of analyzed wells. Fall in water level in the range of 2 to 4 m and more than 4 m are seen in 6 wells (0.3%) and 10 wells (0.7%) respectively.

The analysis shows that rise in groundwater level in the range of 0 to 2 m is observed in all districts of Karnataka State. Rise of water level in the range of 2 to 4 m is observed in almost all districts of Karnataka State. Rise of more than 4 m is noticed in all districts of Karnataka State. Water level fall of less than 2 m is recorded as isolated pockets in parts Bangalore Rural, Bangalore Urban, Chikmagalur, Gadag, Gulbarga, Kodagu, Kolar, Mandya, Mysore, Raichur, Shimoga, Tumkur and Uttara Kannada districts. Water level fall in the range of 2 to 4 m is noticed as isolated pockets in parts of Bangalore Urban, Bellary, Chamarajanagar, Chikmagalur, Dharwad, Gadag, Hassan, Kodagu, Kolar, Mandya, Mysore, Raichur and Shimoga districts. Fall in water level of more than 4 m is observed

as isolated pockets in parts of Bangalore Urban, Chamrajnagar, Dharwad, Gadag, Hassan, Mysore, Raichur and Shimoga districts of Karnataka State.

Annual Fluctuation - May 2018 to May 2019

Water levels from 1309 stations were analyzed to know the annual change in groundwater level in May 2019 with that of May 2018. Out of 1309 stations 1196 stations were compared and the remaining stations could not be compared due to the non-availability of data for a particular station in current season. On the whole 262 wells accounting for 22 % of the analyzed wells have recorded a rise in water level during May 2019 as compared with the water level of May 2018. The remaining 934 wells accounting for 78% have recorded a fall in water level.

In the rise category, the rise of water level in the range of 0 to 2 m is observed in 200 wells accounting for 35 % of analyzed wells. Rise of water level in the range of 2 to 4 m is observed in 45 wells (3 %) and > 4 m are seen in 27 wells (2%) respectively.

In the fall category, the fall of water level in the range 0 to 2 m is observed in 566 wells accounting for 47 % of the analyzed wells. Fall in water level in the range of 2 to 4 m is observed in 211 wells (18%) and >4 m is recorded in 157 wells (13 %) respectively.

Rise in water level in the range of 0 to 2 m is observed in Bagalkot, Bangalore Rural, Bangalore Urban, Belgaum, Bellary, Bidar, Bijapur, Chikmagalur, Chitradurga, Dakshin Kannada, Davanagere, Gadag, Gulbarga, Hassan, Haveri, Kodagu, Kolar, Koppal, Mandya, Mysore, Raichur, Shimoga, Tumkur, Udupi and Uttara Kannada of Karnataka State. Rise in water level of 2 to 4 m is also noticed in Bagalkot, Bangalore Rural, Bangalore Urban, Belgaum, Bellary, Bidar, Chikmagalur, Dakshin Kannada, Davanagere, Hassan, Haveri, Kodagu, Koppal, Mandya, Mysore, Shimoga, Udupi and Uttara Kannada districts of the State. Localized patches of >4 m rise in water level is noticed in parts of Bagalkot, Bangalore Urban, Bijapur, Chamarajanagar, Chikmagalur, Dakshin Kannada, Dharwad, Gulbarga, Hassan, Kodagu, Kolar, Mandya, Mysore, Raichur and Shimoga districts. Fall in water level in the range of 0 to 2 m and 2 to 4 m is observed in almost all parts of the State. Fall in water level of > 4 m is noticed in all the districts of Karnataka State.

Annual Fluctuation - November 2018 to November 2019

Water levels from 1328 stations were analyzed and 1328 stations were compared to know the annual change in groundwater level in November 2019 with that of November 2018. On the whole, 1039 wells accounting for 78% of the analyzed wells have recorded a rise in water level during November 2019 as compared with the water level of November 2018. The remaining 289 wells accounting for 22 % have recorded a fall in water level.

In the rise category, the rise of water level in the range of 0 to 2 m is observed in 615 wells accounting for 46% of analyzed wells. Rise of water level in the range of 2 to 4 m and more than 4 m are seen in 244 wells (18 %) and 180 wells (14%) respectively. In the fall category, the fall of water level in the range 0 to 2 m is observed in 216 wells accounting for 16% of the analyzed wells. Fall in water level in the range of 2 to 4 m and more than 4 m is recorded in 50 wells (4%) and 23 wells (2%) respectively.

Rise in water level in the range of 0 to 2 m is observed in all district of Karnataka State. Rise in water level of 2 to 4 m is also noticed in except Chamrajnagar district of the State. Localized patches of >4 m rise in water level is noticed in all parts Karnataka State except Bangalur and Mysore districts. Fall in water level in the range of 0 to 2 m is observed in all districts of State as isolated pockets. 2 to 4 m fall is observed as isolated patches Bagalkot, Bangalore Rural, Bangalore Urban, Bellary, Bidar, Bijapur, Chikmagalur, Dakshin Kannada, Davanagere, Gadag, Gulbarga, Hassan, Kodagu, Kolar, Koppal, Mandya, Mysore, Raichur, Tumkur and Udupi districts of the State. Fall in water level of > 4 m is noticed as isolated pockets in Bangalore Rural, Bijapur, Chikmagalur, Dharwad, Gadag, Gulbarga, Hassan, Kodagu, Mandya, Mysore, Raichur and Tumkur districts of Karnataka State.

Change in Water Level, Mean (May 2009 to May 2018) – May 2019

Mean groundwater level for the period May 2009 to May 2018 was compared with the groundwater level in May 2019. It is seen that, out of the 1347 stations analyzed, 416 stations accounting for 31% have shown a rise in water level during May 2019 as compared to preceding decadal mean and the remaining 931 stations accounting for 69% have shown a fall in water level.

In the water level rise category; a rise of 0 to 2 m range is recorded in 340 stations accounting to 25% of analyzed wells. A rise of 2 to 4 m and >4 m is seen in 48 stations (4 %) and 28 stations (2%) respectively. In the fall category, a fall in water level of 0 to 2 m range is prominent and recorded in 600 wells accounting for 45 % of analyzed wells. Fall in water level of 2 to 4 m and >4 m range is seen in 191 wells (14 %) and 140 wells (10%) respectively.

A map in respect of the change in water levels showing rise/fall in the ranges of 0 to 2 m, 2 to 4 m and >4 m has been prepared and enclosed as Water Level Fluctuation Map of Karnataka, Decadal Mean (May 2009 to May 2018) – May 2019 (Plate-7).

Rise in water level in the range of 0 to 2 m is observed in all districts of the Karnataka State. A rise in water level of 2 to 4 m is noticed as isolated patches in Bagalkot, Bangalore Rural, Bangalore Urban, Belgaum, Bellary, Bidar, Bijapur, Chamarajanagar, Dakshin Kannada, Davanagere, Gadag, Gulbarga, Hassan, Kodagu, Kolar, Koppal, Mandya, Mysore, Raichur,

Shimoga, Udupi and Uttara Kannada districts of the State. Rise in water level of >4m is noticed as small patches in Bangalore Urban, Belgaum, Bellary, Bidar, Chamarajanagar, Chikmagalur, Dakshin Kannada, Dharwad, Gadag, Gulbarga, Hassan, Haveri, Kodagu, Kolar, Mandya, Mysore, Raichur, Shimoga and Udupi districts of the State. Fall in water level of <2 m and 2 to 4 m is noticed in almost all districts of the State. Fall in water level of >4 m is noticed in all districts of the State except except in Bangalore Urban district.

Change in Water Level, Mean (Nov 2009 to Nov 2018) – Nov 2019

Mean groundwater level for the period November 2009 to November 2018 is analyzed and compared with the groundwater level in November 2019 for 1273 stations. It is seen that, out of the 1273 **s**tations compared, 1212 stations accounting for 95% have shown a rise in water level during November 2019 as compared to the preceding decadal mean and the remaining 61 stations accounting for 5 % have showed a fall in water level**.**

In the water level rise category, a rise of 0 to 2 m range is recorded in 283 stations accounting to 22% of analyzed wells. A rise of 2 to 4 m and more than 4 m is seen in 332 stations (26%) and 597 stations (46%) respectively. In the fall category, fall in water level in the range of 0 to 2 m is recorded in 44 wells accounting for 4% of analyzed wells. Fall in water level of 2 to 4 m and more than 4 m range is seen in 10 wells (1%) and 7 wells (1%) respectively.

A map for the change in water levels showing rise/fall in the ranges of 0-2 m, 2-4 m and more than 4 m was prepared and enclosed as "Water Level Fluctuation Decadal Mean of (Nov 2009 to Nov 2018) – Nov 2019'' of Karnataka (Plate-8).

Major part of the State is showing rise in water level as compared to decadal mean water level of November 2009 - November 2018 with respect to November 2019 water level. In the rise category, water level showing less than 2 m, 2 to 4 m and more than 4 m is observed in all districts of Karnataka State. Fall in water level less than 2 m is observed as isolated patches in Bangalore Rural, Bangalore Urban, Chikmagalur, Dakshin Kannada, Davanagere, Gadag, Gulbarga, Hassan, Kolar, Koppal, Mandya, Mysore, Raichur, Shimoga, Tumkur and Uttara Kannada districts. The fall of 2 to 4 m is noticed as isolated patches in parts of Bangalore Rural, Bellary, Chikmagalur, Gadag, Hassan, Koppal, Mandya and Raichur districts. Fall of water level of more than 4 m is observed as small isolated patches in Bangalore Urban, Chamarajanagar Dharwad, Mysore, Raichur and Shimoga districts of Karnataka State.

Plate-5

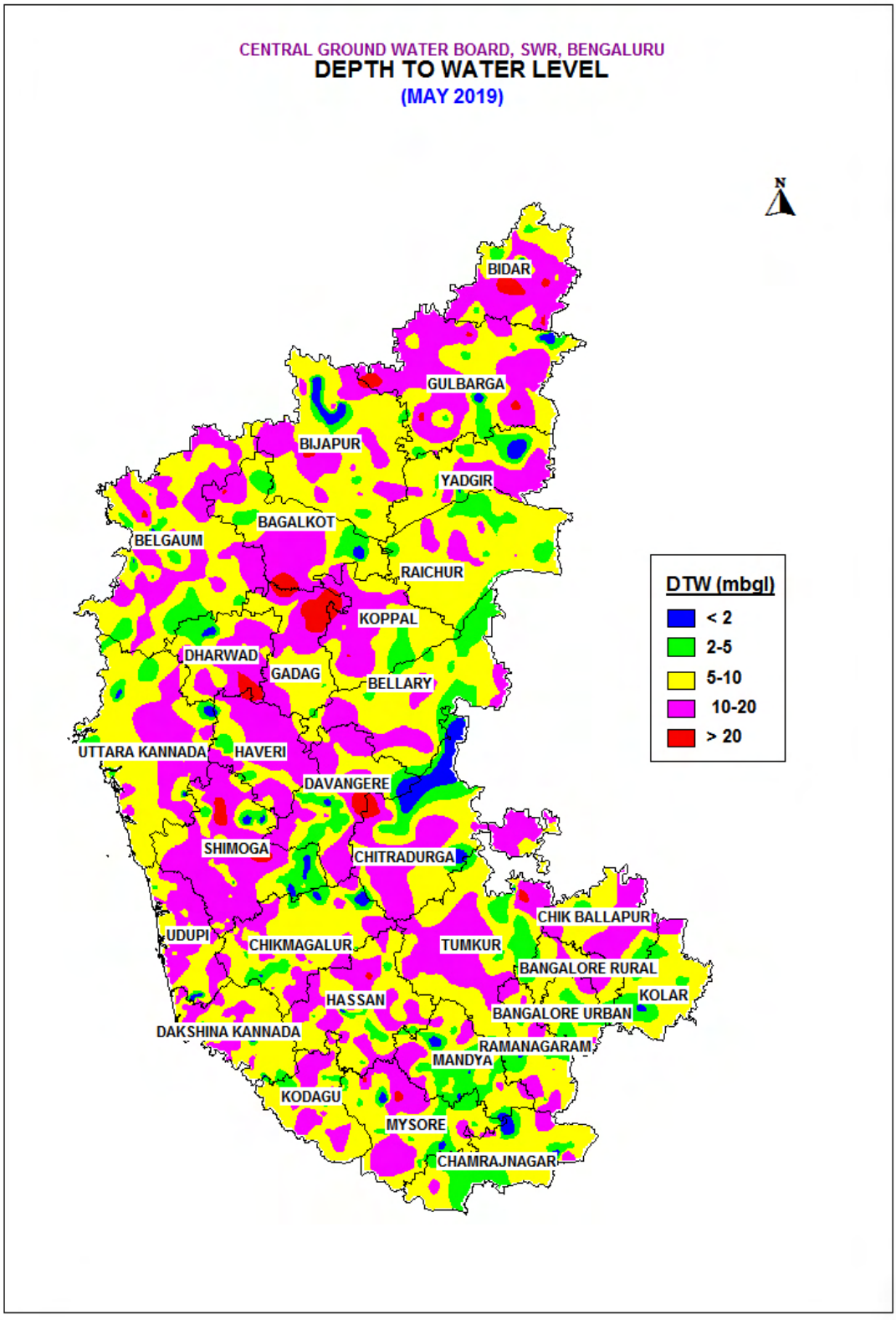

CENTRAL GROUND WATER BOARD, SWR, BENGALURU
DEPTH TO WATER LEVEL
(MAY 2019)
N
BIDAR
GULBARGA
BIJAPUR
YADGIR
BAGALKOT
BELGAUM
RAICHUR
KOPPAL
DHARWAD
GADAG
BELLARY
UTTARA KANNADA
HAVERI
DAVANGERE
SHIMOGA
CHITRADURGA
CHIK BALLAPUR
UDUPI
CHIKMAGALUR
TUMKUR
BANGALORE RURAL
KOLAR
HASSAN
BANGALORE URBAN
DAKSHINA KANNADA
RAMANAGARAM
MANDYA
KODAGU
MYSORE
CHAMRAJNAGAR
DTW (mbgl)
< 2
2-5
5-10
10-20
> 20

Plate-6

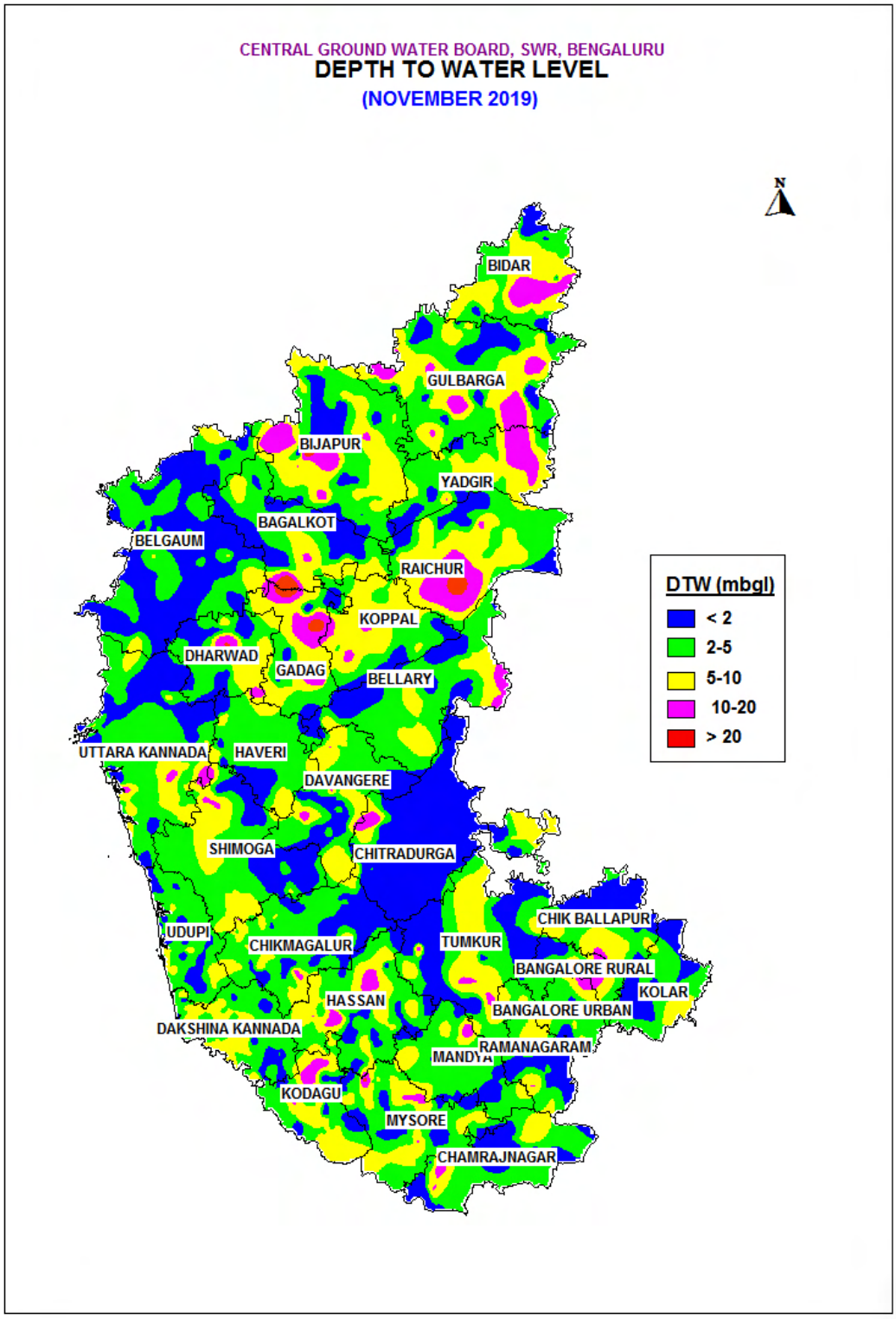

CENTRAL GROUND WATER BOARD, SWR, BENGALURU
DEPTH TO WATER LEVEL
(NOVEMBER 2019)
N
BIDAR
GULBARGA
BIJAPUR
YADGIR
BAGALKOT
BELGAUM
RAICHUR
KOPPAL
DHARWAD
GADAG
BELLARY
UTTARA KANNADA
HAVERI
DAVANGERE
SHIMOGA
CHITRADURGA
CHIK BALLAPUR
UDUPI
CHIKMAGALUR
TUMKUR
BANGALORE RURAL
KOLAR
HASSAN
BANGALORE URBAN
DAKSHINA KANNADA
RAMANAGARAM
MANDYA
KODAGU
MYSORE
CHAMRAJNAGAR
DTW (mbgl)
< 2
2-5
5-10
10-20
> 20

Plate-7

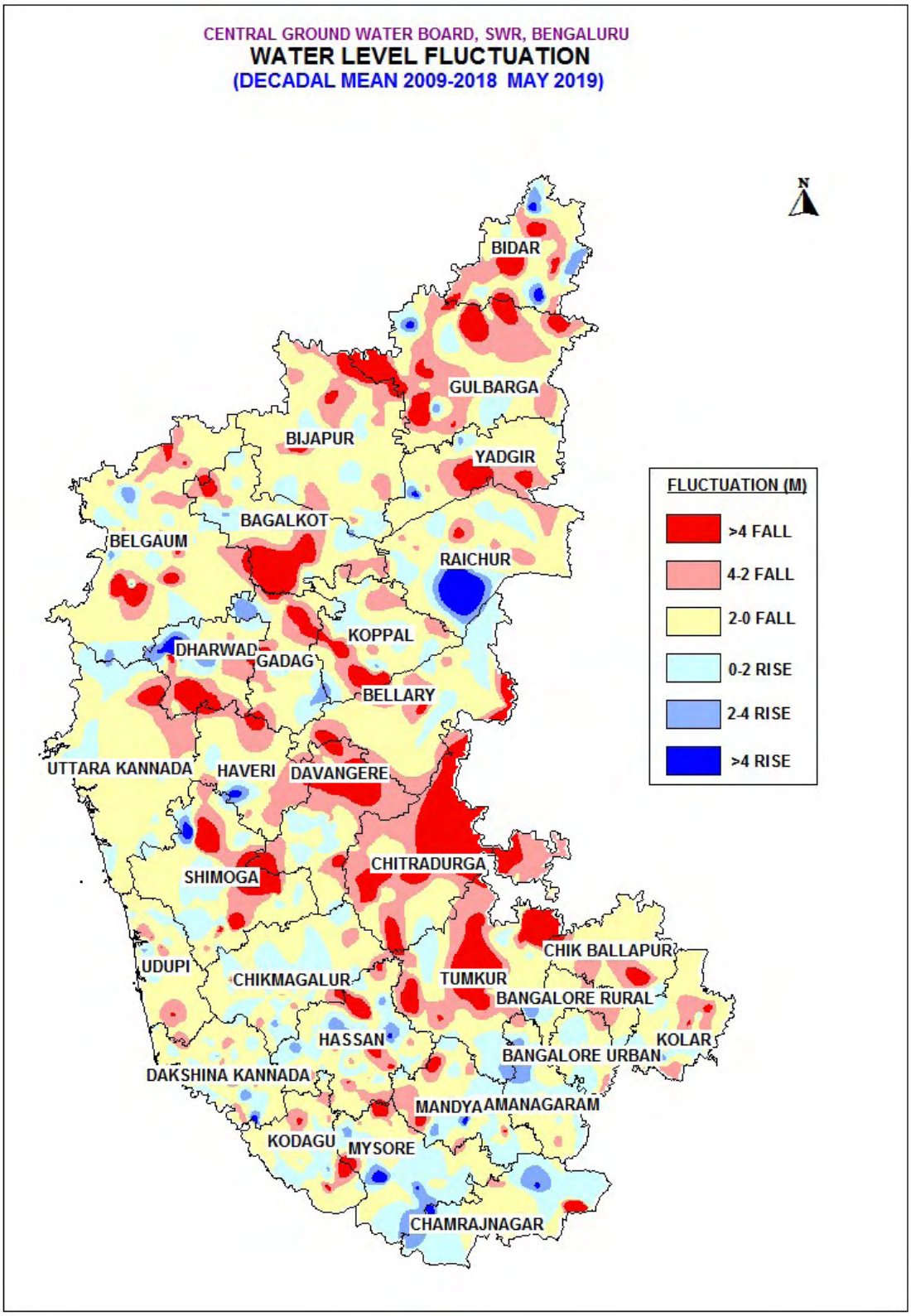
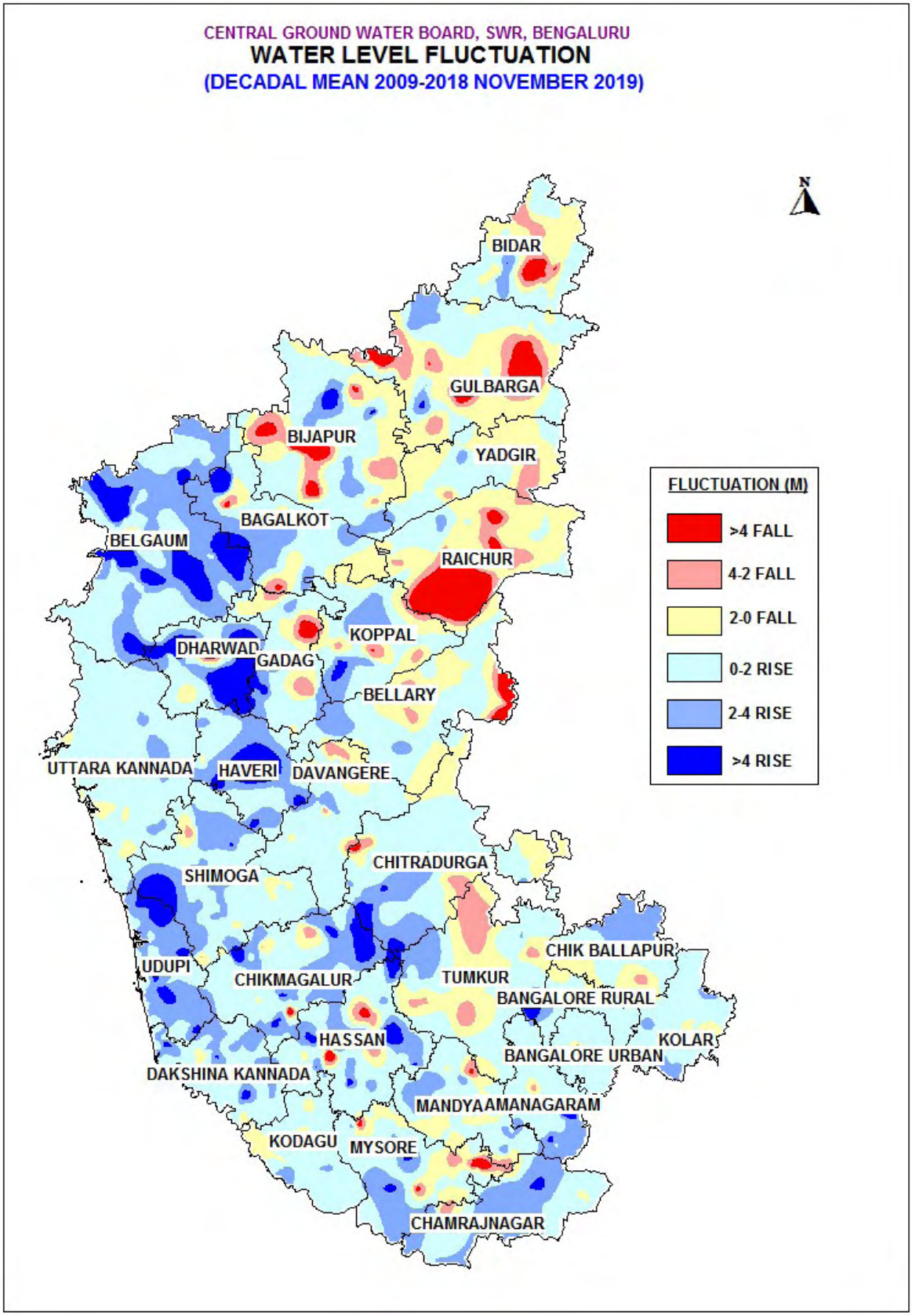

CENTRAL GROUND WATER BOARD, SWR, BENGALURU
WATER LEVEL FLUCTUATION
(DECADAL MEAN 2009-2018 MAY 2019)
N
BIDAR
GULBARGA
BIJAPUR
YADGIR
BAGALKOT
BELGAUM
RAICHUR
KOPPAL
DHARWAD
GADAG
BELLARY
UTTARA KANNADA
HAVERI
DAVANGERE
CHITRADURGA
SHIMOGA
CHIK BALLAPUR
UDUPI
CHIKMAGALUR
TUMKUR
BANGALORE RURAL
HASSAN
KOLAR
BANGALORE URBAN
DAKSHINA KANNADA
MANDYA
RAMANAGARAM
KODAGU
MYSORE
CHAMRAJNAGAR
FLUCTUATION (M)
>4 FALL
4-2 FALL
2-0 FALL
0-2 RISE
2-4 RISE
>4 RISE

Plate-8


CENTRAL GROUND WATER BOARD, SWR, BENGALURU
WATER LEVEL FLUCTUATION
(DECADAL MEAN 2009-2018 NOVEMBER 2019)
N
BIDAR
GULBARGA
BIJAPUR
YADGIR
BAGALKOT
BELGAUM
RAICHUR
KOPPAL
DHARWAD
GADAG
BELLARY
UTTARA KANNADA
HAVERI
DAVANGERE
CHITRADURGA
SHIMOGA
CHIK BALLAPUR
UDUPI
CHIKMAGALUR
TUMKUR
BANGALORE RURAL
HASSAN
KOLAR
BANGALORE URBAN
DAKSHINA KANNADA
MANDYAAMANAGARAM
KODAGU
MYSORE
CHAMRAJNAGAR
FLUCTUATION (M)
>4 FALL
4-2 FALL
2-0 FALL
0-2 RISE
2-4 RISE
>4 RISE

4.0 HYDROCHEMISTRY

The quality of shallow groundwater in Karnataka state has been evaluated by sampling and analysis of water sample collected from Groundwater Monitoring wells. About 1066 Groundwater Monitoring wells were monitored for water quality during May 2018 representing pre-monsoon water quality. The summarized results of groundwater quality ranges are given in Table-3.

Table 3: Groundwater quality of SWR, during May-2018

SI.No	Parameters		Range	No. of sample	Percentage
1	Electrical Conductivity µs/cm at 25°c	Fresh	< 750	401	38.0
		Moderate	751- 2250	548	51.0
		Slightly mineralized	2251-3000	53	05.0
		Highly mineralized	> 3000	64	06.0
2	Chloride mg/l	Desirable limit	< 250	887	83.0
		Permissible limit	251-1000	164	15.0
		Beyond permissible limit	> 1000	15	02.0
3	Fluoride mg/l	Desirable limit	< 1.0	858	81.0
		Permissible limit	1.1- 1.5	129	12.0
		Beyond permissible limit	>1.5	79	07.0
4	Nitrate mg/l	Permissible limit	<45	720	68.0
		Beyond permissible limit	> 45	346	32.0

Electrical Conductivity

In general the groundwater quality in the state is fresh in about 38 % of the Groundwater Monitoring wells as indicated by the EC value less than 750 µs/cm at 25°C. In about 51 % of the Groundwater Monitoring wells, the EC varies between 751 -2250µs/cm at 25° C and 5 % of Groundwater Monitoring wells are between 2251-3000 µs/cm at 25° C indicating that the groundwater is slightly mineralized and about 6 % of Groundwater Monitoring wells the EC is more than 3000 µs/cm at 25°C indicating that the Groundwater is highly mineralized. The highest value 13280 µs/cm at 25° C was observed in Ullal Beach, Dakshina Kannada district.

Chloride

The chloride content is less than 250 mg/l in about 83 % of the sample analyzed and 15 % of the sample are between 251 – 1000 mg/l and 2 % shows more than 1000mg/l which are from the districts of Belagavi, Bijapur, Davanagere, Dharwad, Gadag, Raichu, Udupi and Yadgir.

Fluoride

The Fluoride content is less than 1.5 mg/l in about 93 % of the sample analyzed and about 7 % of the sample shows more than 1.5 mg/l, which are from the districts of Bagalkot, Belagavi, Bellary, Chikballapur, Davanagere, Gadag, Gulbarga, Koppal, Mysore, Raichur, Tumkur and Yadgir.

Nitrate

The Nitrate content is less than 45mg/l in about 68 % of the sample analyzed and 32 % of sample shows more than 45 mg/l which are from the district of Bagalkot, Bangalore Rural, Belgaum, Bellary, Bidar, Bijapur,Chamarajanagar, Chickmagalur, Chitradurga, Dakshina kannada, Dharwad, Gadag, Gulbarga, Hassan, Haveri, Kolar, Koppal, Mandya ,Mysore, Raichur, Ramnagara, Shimoga, Tumkur and Yadgir.

5.0 AREAS HAVING GROUNDWATER DEVELOPMENT PROSPECTS

Crystalline rocks underlie about 99% of the area of the state, of which about 15% along the northern parts is occupied by Deccan Basalts (Plate 6). In this area Groundwater occurs under phreatic condition in the top weathered zones wherever the thickness of weathering is considerable to sustain the dugwells. In the western parts of the Western Ghats generally there is a thick capping of Laterites making it ideal zones for dug wells. However due to the high porosity of the formation and the steep gradient of the terrain these dug wells dry up in summer months due to subsurface out flow. About 15% of the area of the state, just south of the Basalts, falling in parts of Belguam, Bagalkote, Vijayapura and Kalaburagi is underlain by meta- sediments of the Kaladgis, Bhimas and Badamis. These formations also act like crystalline as far as their Groundwater potential is concerned. The general depth of phreatic aquifer in these rocks is in the range of 5-30 mbgl. About 1% of the area along the west coast falling in the districts of Uttara Kannada, Udupi and Daskshina Kannada are occupied by coastal alluvium. They are seen close to the sea and at places are quite wide extending 3-5Km from the coastline. They form shallow potential aquifers wherever the thickness is more than 5m. Ground water occurs under semi-confined to confined aquifers in the fractured crystalline.

6.0 RE-ASSESSMENT OF GROUND WATER RESOURCES, 2020

The assessment of Ground water resources is carried out to determine the prevailing status of ground water resources in the State. It also helps assess the impact of the on-going ground water management practices on the groundwater resources. In 2020, Department of Water Resources, River Development & Ganga Rejuvenation, Ministry of Jal Shakti constituted a Central Level Expert Group (CLEG) for over-all supervision of the re-assessment of ground water resources in the entire country as in 2020. The terms of reference of the committee include supervision of assessment of annual replenishable ground water resources and the status of utilization for reference year 2020. A copy of the Government Resolution is in Annexure viii. Ground water resources assessment for reference year 2020 at the State/U.T Levels have been carried out jointly by State Ground Water Departments and Central Ground Water Board under the supervision of State Level Committees (Annexure ix), with technical guidance from Central Level Expert Group. The assessment carried out was approved by the respective State Level Committee.

GROUND WATER RESOURCES ESTIMATION METHODOLOGY

Ground water resource as in 2020 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 is given below: The methodology recommends aquifer wise ground water resource assessment of the Groundwater resources components, i.e., Replenishable ground water resources or Dynamic Ground Water Resources.

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.

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 –

Inflow – Outflow = Change in Storage (of an aquifer) …… (1)

Equation (1) can be further elaborated as –

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

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

It is preferred that all the components of water balance equation should be estimated in an assessment unit. Due to lack of data for all the components in most of the assessment units, it is proposed that at present the water budget may be restricted to the major components only, taking into consideration certain reasonable assumptions. The estimation is to be 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.

Rainfall Recharge

It is recommended that ground water recharge should be estimated on ground water level fluctuation and specific yield approach since this method takes into account the response of ground water levels to ground water input and output components. This, however, requires adequately spaced representative water level measurement for a sufficiently long period. It is proposed that there should be at least three spatially well distributed observation wells in the assessment unit, or one observation well per 100 sq. Km. Water level data should also be available for a minimum period of 5 years (preferably 10years), along with corresponding rainfall data. Regarding frequency of water level data, two water level readings, during pre and post monsoon seasons, are the minimum requirement. It would be ideal to have monthly water level measurements to record the peak rise and maximum fall in the ground water levels. In units or subareas where adequate data on ground water level fluctuations are not available as specified above, ground water recharge may be estimated using rainfall infiltration factor method only. The rainfall recharge during non-monsoon season may be estimated using rainfall infiltration factor method only.

Ground Water Level Fluctuation Method

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

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

Where,

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

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

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

A couple of important observations in the context of water level measurement must be followed. It is important to bear in mind that while estimating the quantum of ground water extraction, the depth from which ground water is being extracted should be considered. One should consider only the draft from the same aquifer for which the resource is being estimated. The change in storage can be estimated using the following equation

$$\Delta S = \Delta h \times A \times S_Y \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

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 subunits,

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

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

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 is to be normalized for the normal monsoon season rainfall as per the procedure indicated below.

Normalization of Rainfall Recharge

Let Ri be the rainfall recharge and ri 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, Ri 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 Ri and ri have been obtained as described above, a normalisation procedure is to be 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

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

Where,

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

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

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

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,

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

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 to be followed in the second method is as given below:

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

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

Where,

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

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, it is recommended to compare the rainfall recharge obtained from water level fluctuation approach 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 to be 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. It is suggested that 10% of Normal annual rainfall may be taken as minimum rainfall threshold and 3000 mm as maximum rainfall limit. While computing the rainfall recharge, 10% of the normal annual rainfall is to be deducted from the monsoon rainfall and balance rainfall would be considered for computation of rainfall recharge. The same recharge factor may be used for both monsoon and non-monsoon rainfall, with the condition that the recharge due to non-monsoon rainfall may be 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 may be estimated for normal rainfall, based on recent 30 to 50 years of data.

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 have to be 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.

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 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

Sl. No.	Source	Estimation Formula	Parameters
4	Recharge due to Tanks & Ponds	$R_{TP} = AWSA \times N \times RF$	R_{TP} = Recharge due to Tanks & Ponds AWSA = Average Water Spread Area N = Number of days Water is available in the Tank/Pond RF = Recharge Factor
5	Recharge due to Water Conservation Structures	$R_{WCS} = GS \times RF$	RWCS = Recharge due to Water Conservation Structures GS = Gross Storage = Storage Capacity multiplied by number of fillings. RF = Recharge Factor

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.

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. Dynamic Ground Water Resources Assessment of India - 2020

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 to be computed for all the sub units available in the assessment unit.

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. The ground water base flow contribution limited to the ecological flow of the river should be determined which will be deducted from Annual Ground Water Recharge to determine Annual Extractable Ground Water Resources (EGR). The ecological flows of the rivers are to be determined in consultation with Central Water Commission and other concerned river basin agencies. In case base flow contribution to the ecological flow of rivers is not determined then following assumption is to be followed. 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, present practice (GEC 1997) of allocation of unaccountable natural discharges to 5% or 10% of annual recharge may be retained. If the rainfall recharge is assessed using water level fluctuation method this will be 5% of the annual recharge and if it is assessed using rainfall infiltration factor method, it will be 10% of the annual recharge. The balance will account for Annual Extractable Ground Water Resources (EGR).

Estimation of Ground Water Extraction

Ground water draft or extraction is to be assessed as follows.

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

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

Ground Water Extraction for Irrigation (GEIRR)

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.

Ground Water Extraction for Domestic Use

There are several methods for estimation of extraction for domestic use. 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.

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

Where, Lg = 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.

Ground Water Extraction for Industrial Use

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.

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

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 Dynamic Ground Water Resources Assessment of India - 2020 14 considered. The storage depletion during a season, where other recharges are negligible can be taken as ground water extraction during that particular period.

GROUNDWATER RECHARGE

The Groundwater recharge is estimated by considering wataer table fluctuation method. The key parameter in this method is specific yield.The specific values considered in Estimation are the valuve derived from field. Non-monsoon recharge from rainfall was computed based on RIF method.

Table 6: Recommended and adopted values of Specific Yield

Formation	GEC 15 Recommendations	Values Adopted
Alluvium	6-16	5-8
Laterites	2-3	1-2
Basalts	1-3	1-2
Lime Stone	1-3	1-1.5
Granite/Schist/Gneiss	1-2	1-3

NATURAL DISCHARGE

GEC-2015 methodology accounts for natural discharge like base flow and evapo-transpiration from Groundwatersource as 5% & 10% of annual recharge incase of recharge calculated by WTF and RIF respectively. The same is followed during the 2020 assessment.

7.0 ESTIMATION OF GROUNDWATER RESOURCES

The dynamic groundwater resources of Karnataka is computed based on GEC 2015 methodology as in 2020 on watershed basis taking in to consideration of various hydrological units is command, non-command and hilly area (having slope above 20%). Mappable poor quality area in each of the assessment units has been demarcated and there source from this area is assessed separately. There is no groundwater draft in this area. The watershed wise results of groundwater resource assessment are later apportioned to administrative unit such as taluk.

DATA COLLECTION AND COMPILATION

The data collected during the minor irrigation census wise. Area under irrigation, well census, details pertaining to tanks, canals and cropping pattern, etc, as provided by the district level geologists of the Groundwater Directorate, forms the basic data for the resource evaluation. Various input data like rainfall, data on crop-water requirement, command and non-command area, population growth etc, were collected from various State Govt. Departments.

Available computer software's are used in processing the data thus collected. Watershed, geology, soil, hilly area, command and non-command area, location of observation wells, rain gauge stations and Taluk boundaries were digitized as separate layers using ArcGIS. Area of each of 234 watersheds and percent of watershed area falling in different Taluks, command/non-commands & hilly area were also estimated. Similarly area of each of the 227 taluks and percentage area of the taluk falling in different watersheds, command/ non- commands & hilly area were also estimated. The water level data collected from observation wells of CGWB and Groundwater Directorate, Govt. of Karnataka were processed and watershed wise mean water level fluctuation and trends were estimated. An effective rainfall value for each watershed was estimated by Theisson polygon method using GIS. The details of different parameters and variables used in the computation are explained in the following paragraphs. The results of 2020 are computed through INGRES platform.

REFINEMENT IN 2020 ASSESSMENT

- The number of taluks during 2017 assessment in Karnataka State was 176. During the current assessment the numbers of taluks are refined from 176 to 227 taluks. Hence, as per the committee recommendation the watershed wise final results of 2020 assessments are apportioned to newly reformed 227 taluks.
- As per committee recommendation due to time constraints in completion of the 2020 assessment, it was decided to use the projected figures suitable for 2019-2020 assessment.For Groundwater abstruction structures, conservation structures, it is fixed as 2% increment per year for three consequtive years (Annexure- X).
- In the current assessment the Natural discharge of 5% to 10% is used as per the norms given in GEC 2015 methodology.

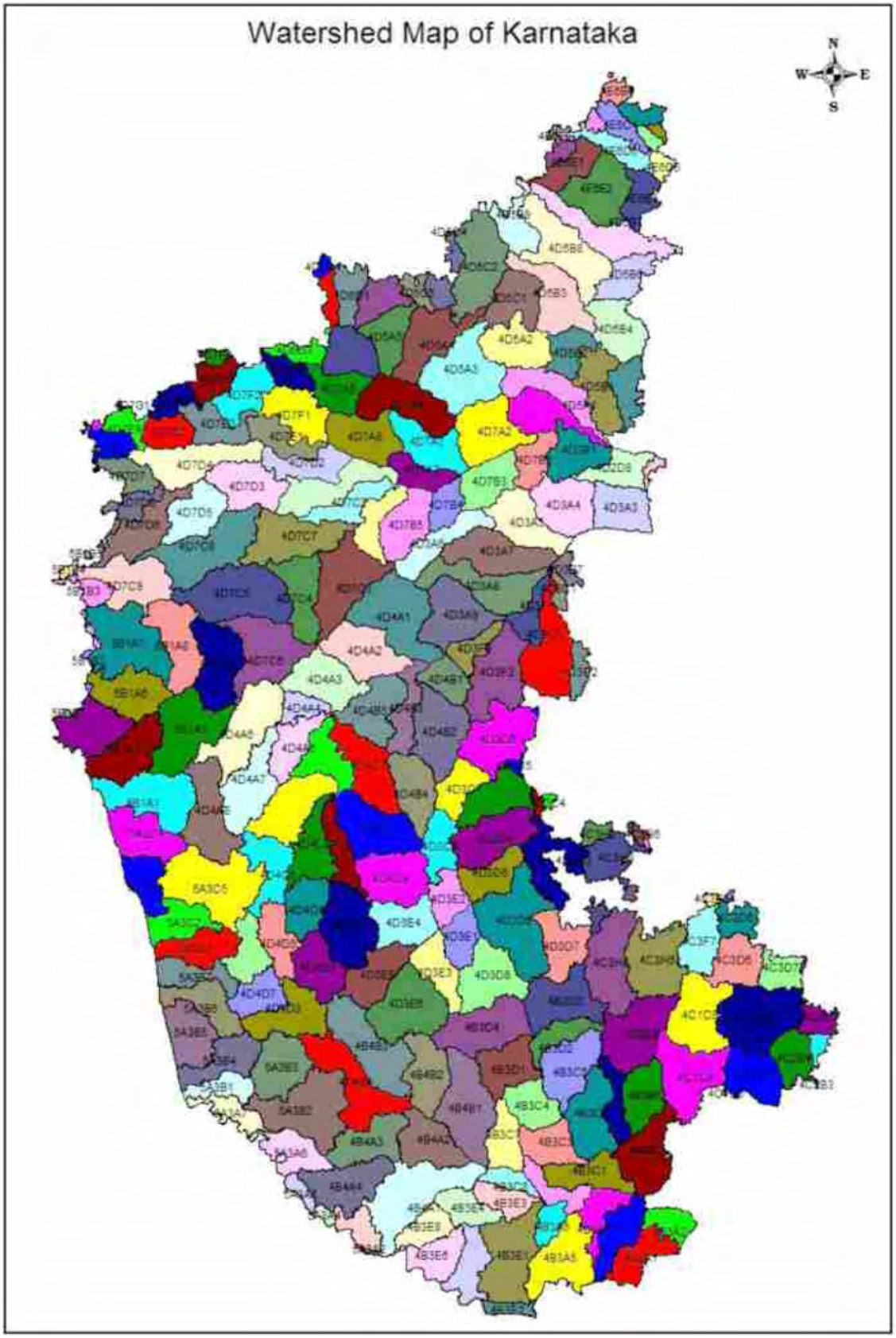
GROUND WATER ASSESSMENT UNIT

Groundwater resources are estimated with watershed as unit of assessment. The watersheds as per Watershed Atlas of India (1990) has been digitized & used for the purpose. Karnataka State has been divided into 234 watersheds spread (Plate-9). The details of catchments, sub catchments and watersheds are presented as alpha numeral and are tabulated below (Table-4)

Table-4. Classification of assessment unit

Region (Code)	Basin (Code)	Catchment (Code)
East Flowing Rivers (4)	Cauvery Basin (4B)	Lower Cauvery (4B3)
		Upper Cauvery (4B4)
	Between Krishna and Cauvery (4C)	Palar (4C1)
		Ponnaiyar (4C2)
		Pennar (4C3)
	Krishna (4D)	Lower Tungabhadra (4D3)
		Upper Tungabhadra (4D4)
		Lower Bhima (4D5)
		Upper Bhima (4D6)
		Krishna (4D7 & 4D2)(Main Krishna, Mallaprabha 4D7C &Ghattaprabha 4D7D)
	Godavari (4E)	Karanja (4E6)
West Flowing Rivers (5)	Upto Sharavathi	Sharavathi (5A3)
	Upto Tapti (5B)	Savitri (5B1)

Plate-9



Delineation and codification of watersheds

The delineation of watersheds has been done in five stages starting with Water Resources Region (WRR) and their sub sequent division and sub-division into Basins, Catchments, Sub-Catchments and Watersheds. Alpha-numeric codes consisting of a combination of alternating Arabic numbers and English capital alphabet letters have been used to designate different stages of delineation. In a watershed code 4A5D1, 4 indicates Water Resource Region code, A indicates basin code, 5 indicates catchment code, D indicates sub-catchment code and 1 indicates watershed code.

Command area: The data on command area map as provided by Groundwater Directorate, Government of Karnataka was digitized and command/non-command area in each of the water sheds/ taluks were calculated by super imposing the respective layers. The resources were calculated separately for command as well as non-command area in taluk as also in the assessment unit viz. Watersheds.

Poor Quality Area: The poor quality is mainly due to high fluoride (above 1.5ppm), high nitrate (above45 ppm) and high total dissolved solids (EC above 3000µS/cm) are observed as isolated patches in some of the taluks. The mappable area having poor quality of groundwater in each of the assessment units have been demarcated and the recharge in this area has been worked out separately.

Hilly areas: Areas having slope of above 20% is supposed to have very quick run off and little recharge to groundwater. Similarly the areas having massive rock exposures are also not suitable for augmenting recharge to Groundwater. Hence such areas are excluded from recharge calculations.

GROUNDWATER DRAFT

The Groundwater draft figures were assessed based on unit draft method. The figures obtained on unit draft method were adopted as it was observed from the studies that the farmers are not adopting the irrigation practice as per the crop water requirement but based on the availability of power and yield of borewell. Thus in one of the severely over exploited districts like Kolar, the water used is almost double the recommended value. (Najeeb K.Md.etal 2006). The unit draft values used during 2017 assessment were used based on sample surveys and feedback from filed units. Accordingly the following values were adopted (Table-5).

Table-5 Adopted unit draft values for various structures

Structure	Unit Draft 2017 (Ham/Annum)
Dug Well	0. 27 - 0.6
Bore Well	0. 90 – 1.1
Dug Cum Bore Well	0. 90 – 1.1

As per committee recommendation due to time constraints in completion of the 2020 assessment, it was decided to use the projected figures suitable for 2019-2020 assessment.For Groundwater abstruction structures, conservation structures, it is fixed as 2% increment per year for three consequtive years. The growth in number of irrigation wells between 2001 to 2020 is given in Table-6.

Table-6: Growth in number of irrigation structures between 2001 and 2020

Type of Structure/ Year	2001	2004	2009	2011	2013	2017	2020
Dug wells	276171	317596	302199	185108	188810	127812	135481
Bore wells	612900	704835	767204	785557	801268	893835	947465
Dug cum Bore wells	NA	0	668	680	694	745	790
Total Structures	889071	1022431	1070071	971345	990772	1024409	1083736

8.0 COMPUTATION OF GROUNDWATER RESOURCES

Dynamic Groundwater resources of the state of Karnataka were assessed taking watershed as a unit. The base year for the data collection is 2019-20. There are 234 watersheds in the state as explained in chapter 4.

WATERSHED WISE CATERGORISATION

Based on the Groundwater resources estimated for the year 2020 the watersheds are classified are as follows (Table-7).

Table-7 CATEGORISATION OF WATERSHEDS AS ON MARCH- 2020

Watersheds wise Category	Watersheds as on 2020
Over Exploited Watersheds	61
Critical Watersheds	13
Semi critical Watersheds	36
Safe Watersheds	124
Total	234

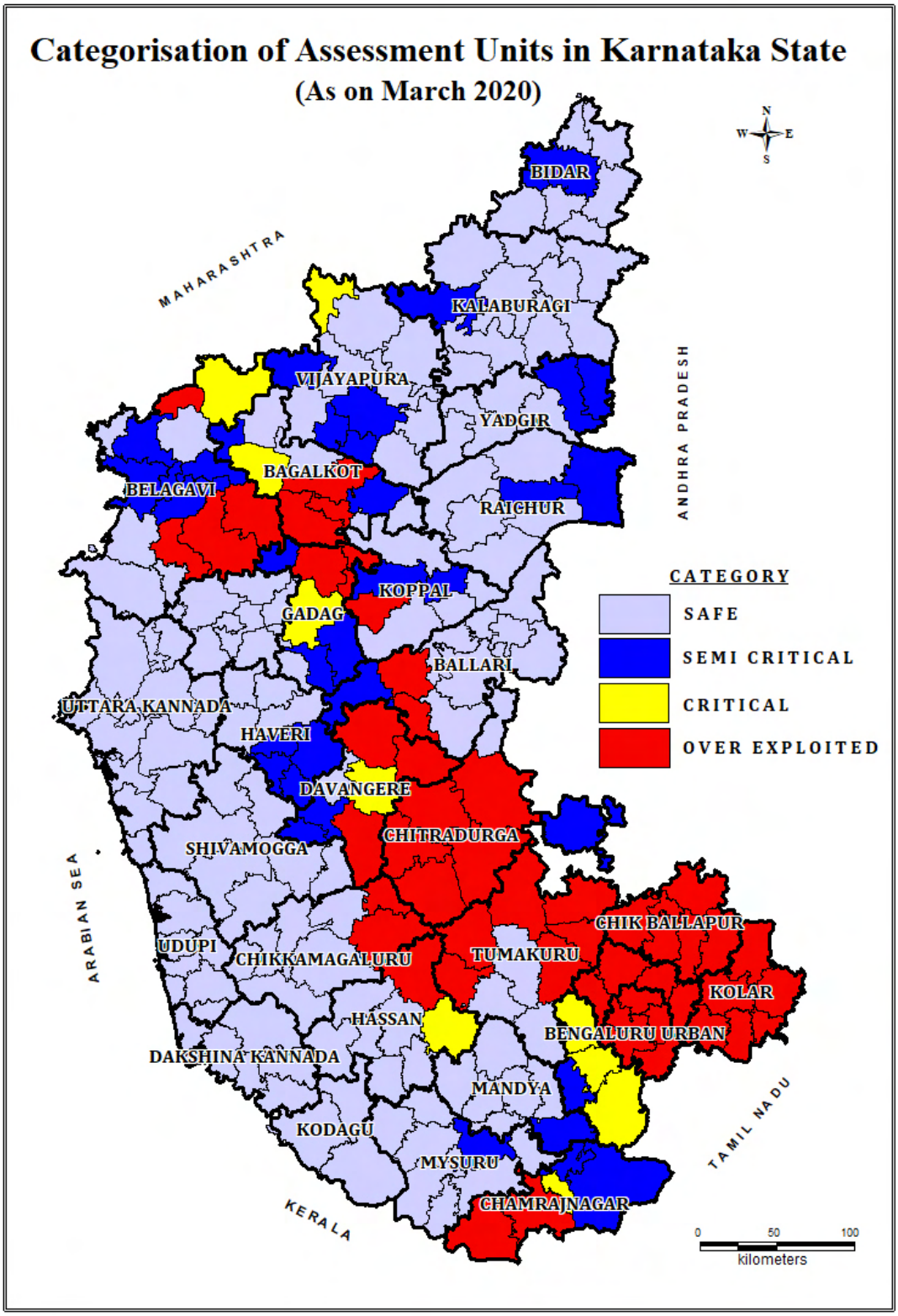
Out of the 234 assessment units, 124 watersheds are safe, 36 watersheds are semi-critical, 13 watersheds are critical and 61 watersheds are Over exploited.

TALUK WISE CATEGORISATION

The Groundwater resource assessed were apportioned to administrative unit viz. Taluk for the convenience of planners and administrators and also to have uniformity with the assessment on national level. The stage of Groundwater extraction and categorization for the entire command parts of the taluk was assessed as a single category, irrespective of the fact that different parts of the command area within taluk fall under different watershed having varying categorization. The taluk wise command area categorization was done by considering the net annual Groundwater availability and gross annual draft and the water level trend of the area, thus getting the average stage of development. Similar exercise was done separately for non- command portion of the taluk also. As far as the government of Karnataka is concerned within Taluk the parts of watershed falling indifferent categories wise. Safe, semi critical, critical and over exploited were required for planning future development strategy.

The categorization is made under one of the four category as suggested by GEC-2015 i.e., Over Exploited, Critical, Semi critical or Safe and the number of assessment units (Taluks) after apportioning was done to 227. As per this, out of the 227 taluks, 130 taluks are safe, 35 taluks are semi critical, 10 taluks are critical, 52 taluks are overexploited Category (Plate-10). The details of these categories are presented in Table-8.

Plate-10


Categorisation of Assessment Units in Karnataka State
(As on March 2020)
N
W
E
S
BIDAR
KALABURAGI
VIJAYAPURA
YADGIR
BAGALKOT
BELAGAVI
RAICHUR
KOPPAL
GADAG
BALLARI
UTTARA KANNADA
HAVERI
DAVANGERE
CHITRADURGA
SHIVAMOGGA
CHIK BALLAPUR
UDUPI
CHIKKAMAGALURU
TUMAKURU
KOLAR
HASSAN
BENGALURU URBAN
DAKSHINA KANNADA
MANDYA
KODAGU
MYSURU
CHAMRAJNAGAR
MAHARASHTRA
ANDHRA PRADESH
TAMIL NADU
KERALA
ARABIAN SEA
CATEGORY
SAFE
SEMI CRITICAL
CRITICAL
OVER EXPLOITED
0
50
100
kilometers

The annual extractable groundwater resources as on March 2020 for the state of Karnataka is 16.40 BCM, while the gross annual draft is 10.63 BCM and the net available for future development is 7.08 BCM. The stage of groundwater extraction in the state is 65%.The State, District and taluk wise ground water resources and categorization is given in Annexures I to V. The district wise maps showing categorisation of taluks is presented from plate 11 to 40

Table-8 CATEGORISATION OF TALUKS AS ON MARCH- 2020

Taluk wise Category	Apportioned from water shed map As on March-2020
Over ExploitedTaluks	52
CriticalTaluks	10
Semi criticalTaluks	35
SafeTaluks	130
Total	227

COMPARISON OF 2020 RESOURCES WITH 2017 RESOURCES

The salient features of the groundwater resources of the state as compared to that in 2017 is presented in Table-9.

Table 9. Groundwater Resources of Karnataka as on 2020 in comparison with 2017

Particulars	As on 2017	As on 2020
Annual Extractable Ground Water Resource (HAM)	1479318	1639584
Ground Water Extraction for Irrigation Use (HAM)	938674	960249
Ground Water Extraction for domestic and Industrial Use (HAM)	94978	102950
Ground water Extraction fo r all uses (HAM)	1033652	1063198
Annual GW Allocation for for Domestic Use as on 2025 (HAM)	113738	115977
Net Ground Water Availability for future use (HAM)	590260	708071
Stage of Ground Water Extraction (%)	70	65

The annual extractable Groundwater resources in the state show increase from 1479318 Ham in 2017 to 1639584 Ham in 2020. There is an increase in total Groundwater extraction in 2020 by about 3% compared to 2017.

The categorization of assessment units was compared with that of 2017 and 2020 is presented in table-10

Table-10. Categorization of assessment unit as on March 2017 and 2020

Taluk wise Category	Apportioned from water shed map As on March-2017	Apportioned from water shed map As on March-2020
Over ExploitedTaluks	45	52
CriticalTaluks	08	10
Semi criticalTaluks	26	35
SafeTaluks	97	130
Total	176	227

During 2020 assessment 97 taluks categorized under OCS (Over Exploted-Critical-Semi Critical) category(Annexure VI). In comparision to the previous assessment seven taluks are improved in category and three are deteorated in category during 2020.The list is given in Annexure-VII.

CATEGORIZATION MAPS

Plate-11

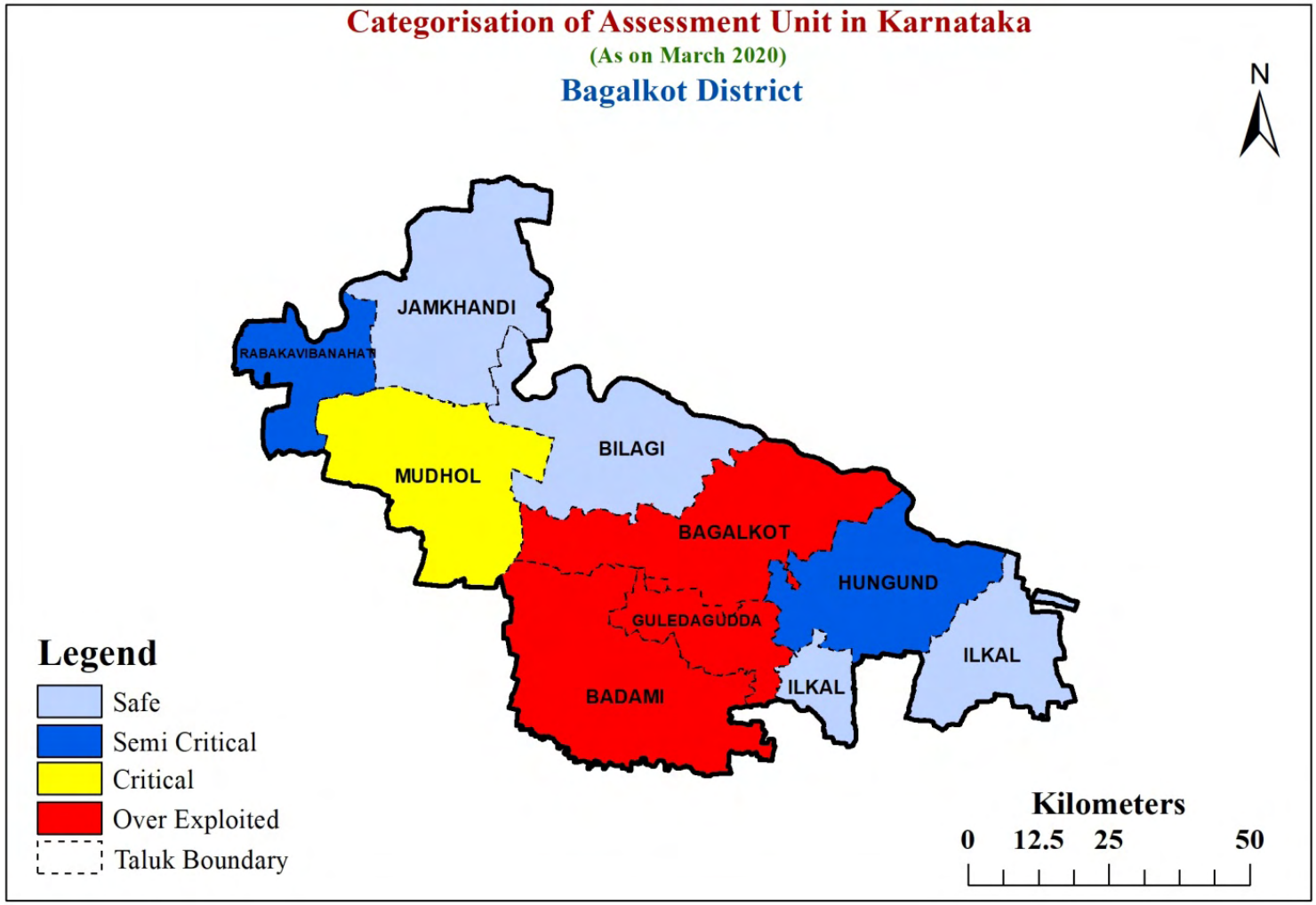

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Bagalkot District
N
JAMKHANDI
RABAKAVIBANAHATTI
MUDHOL
BILAGI
BAGALKOT
HUNGUND
GULEDAGUDDA
ILKAL
ILKAL
BADAMI
Legend
Safe
Semi Critical
Critical
Over Exploited
Taluk Boundary
Kilometers
0 12.5 25 50

Plate-12

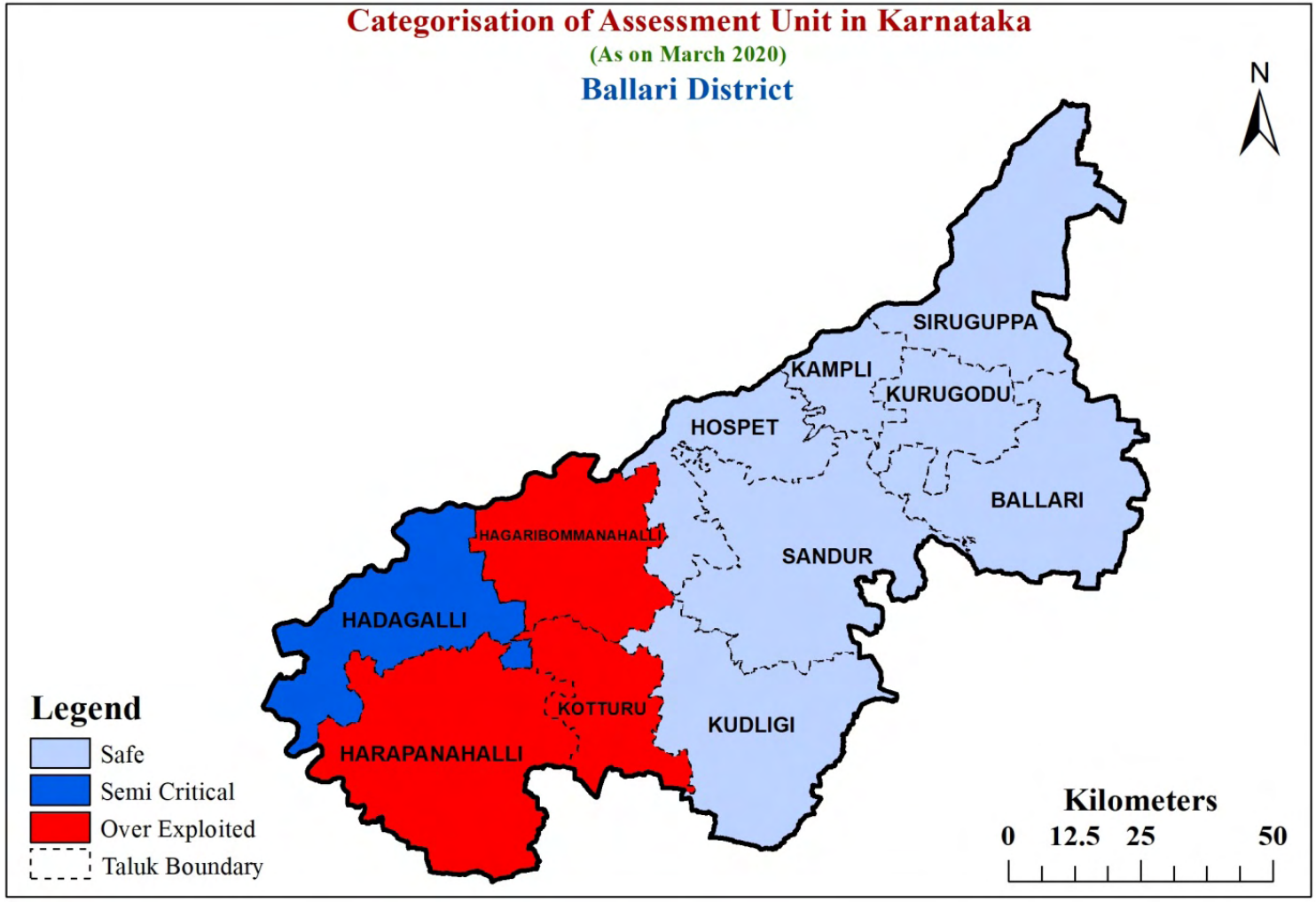

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Ballari District
N
SIRUGUPPA
KAMPLI
KURUGODU
HOSPET
BALLARI
HAGARIBOMMANAHALLI
SANDUR
HADAGALLI
KOTTURU
KUDLIGI
HARAPANAHALLI
Legend
Safe
Semi Critical
Over Exploited
Taluk Boundary
Kilometers
0 12.5 25 50

Plate-13

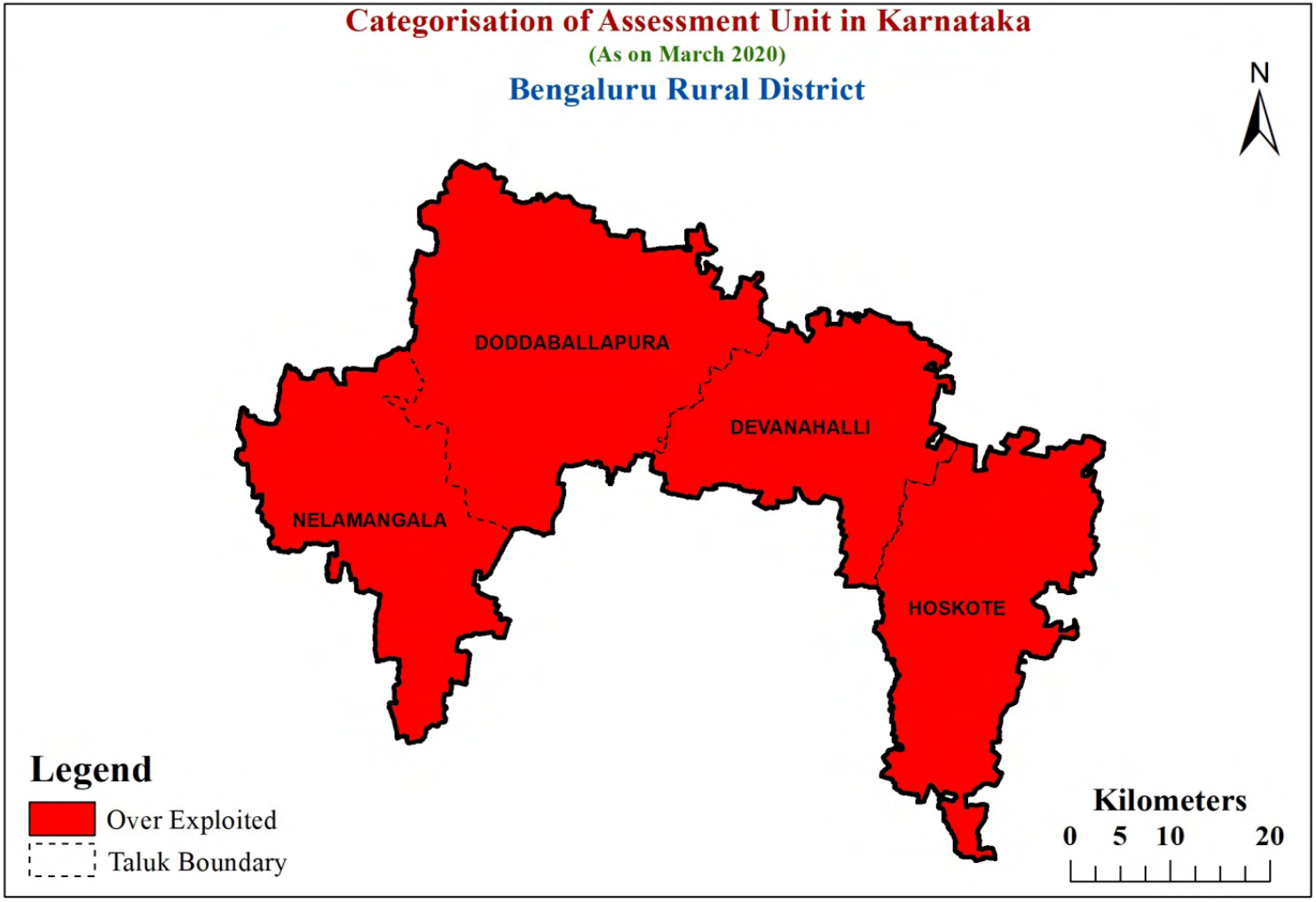

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Bengaluru Rural District
N
DODDABALLAPURA
DEVANAHALLI
NELAMANGALA
HOSKOTE
Legend
Over Exploited
Taluk Boundary
Kilometers
0 5 10 20

Plate-14

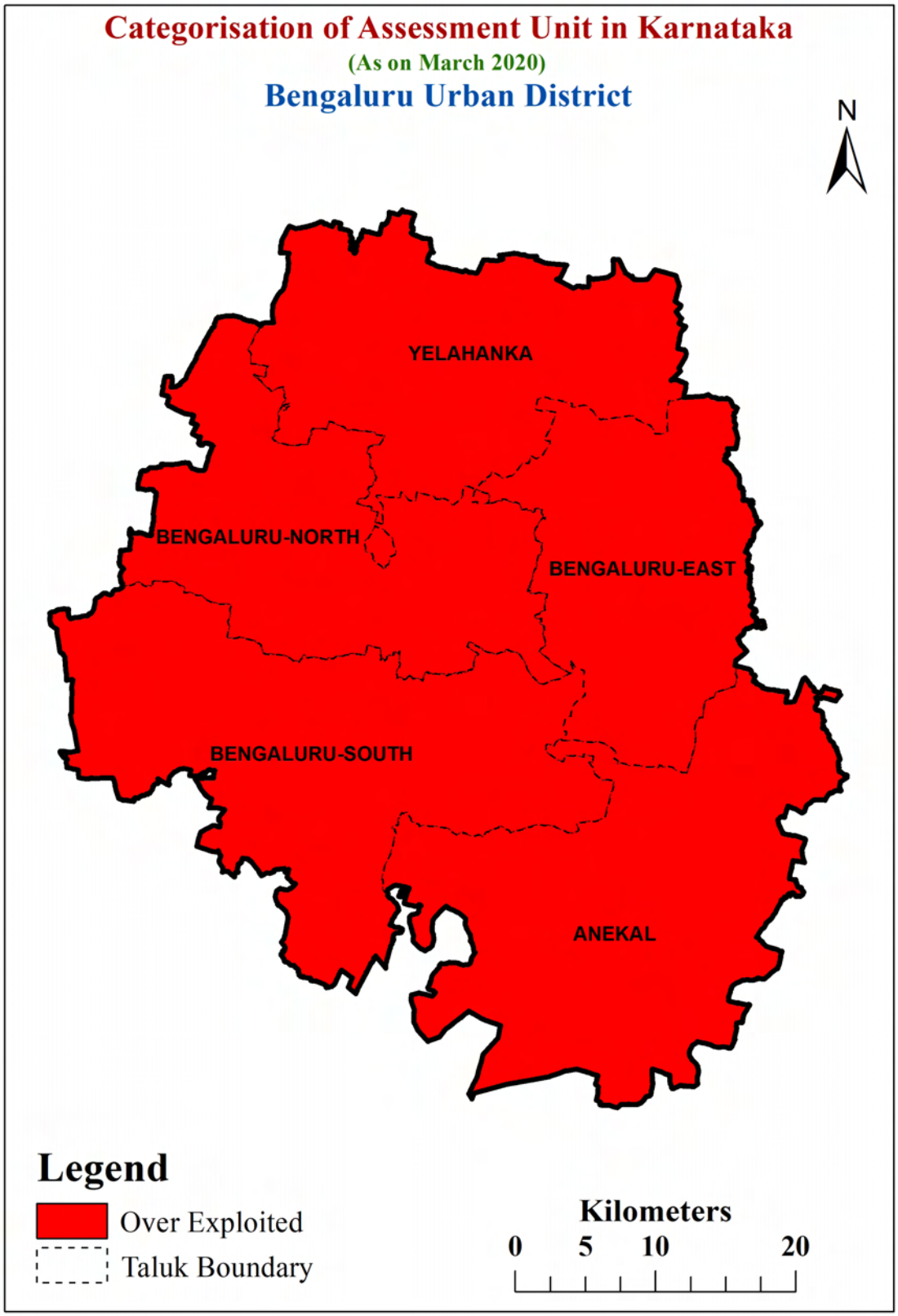

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Bengaluru Urban District
N
YELAHANKA
BENGALURU-NORTH
BENGALURU-EAST
BENGALURU-SOUTH
ANEKAL
Legend
Over Exploited
Taluk Boundary
Kilometers
0 5 10 20

Plate-15

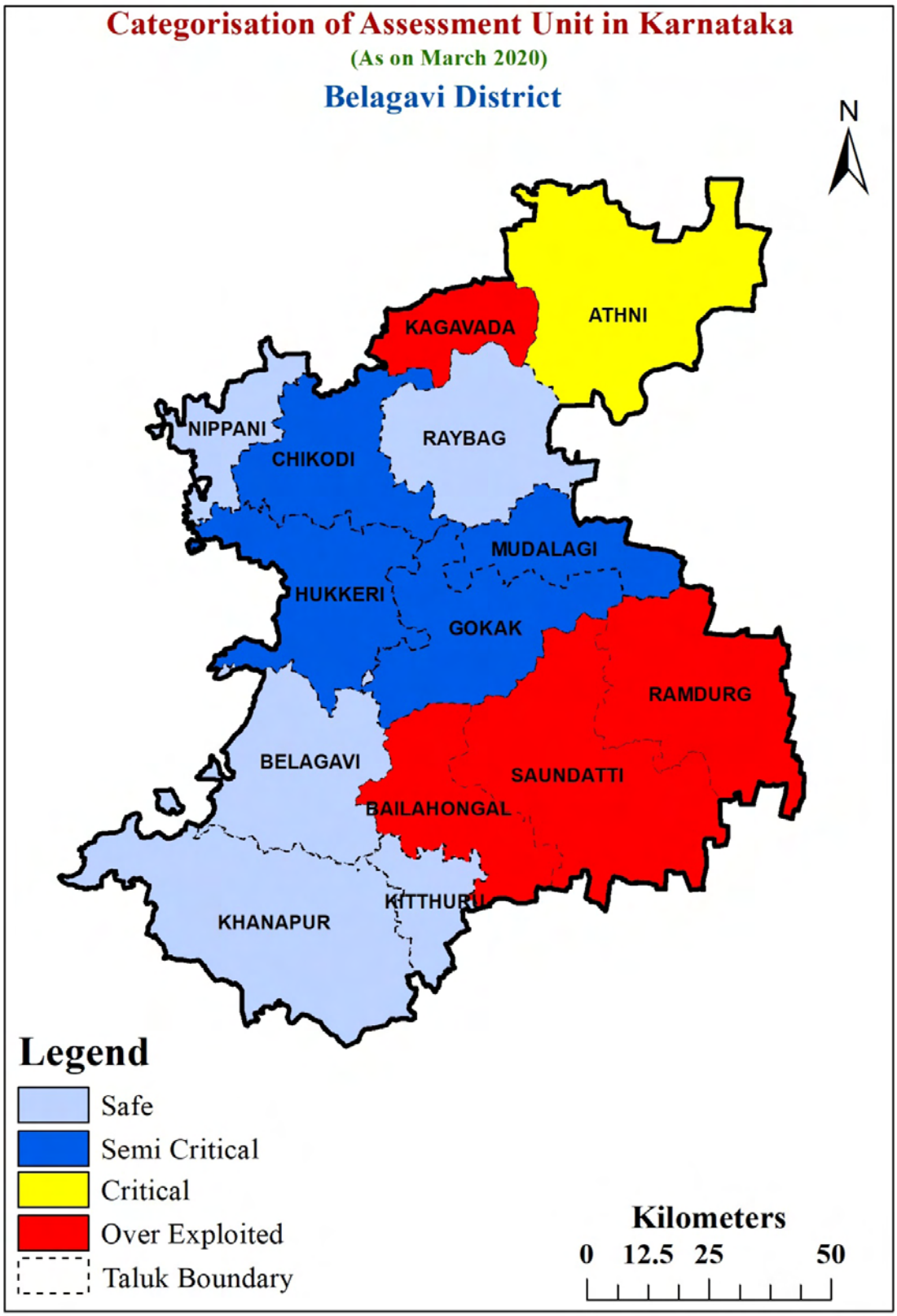

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Belagavi District
N
ATHNI
KAGAVADA
NIPPANI
CHIKODI
RAYBAG
MUDALAGI
HUKKERI
GOKAK
RAMDURG
BELAGAVI
SAUNDATTI
BAILAHONGAL
KITTHURU
KHANAPUR
Legend
Safe
Semi Critical
Critical
Over Exploited
Taluk Boundary
Kilometers
0 12.5 25 50

Plate-16

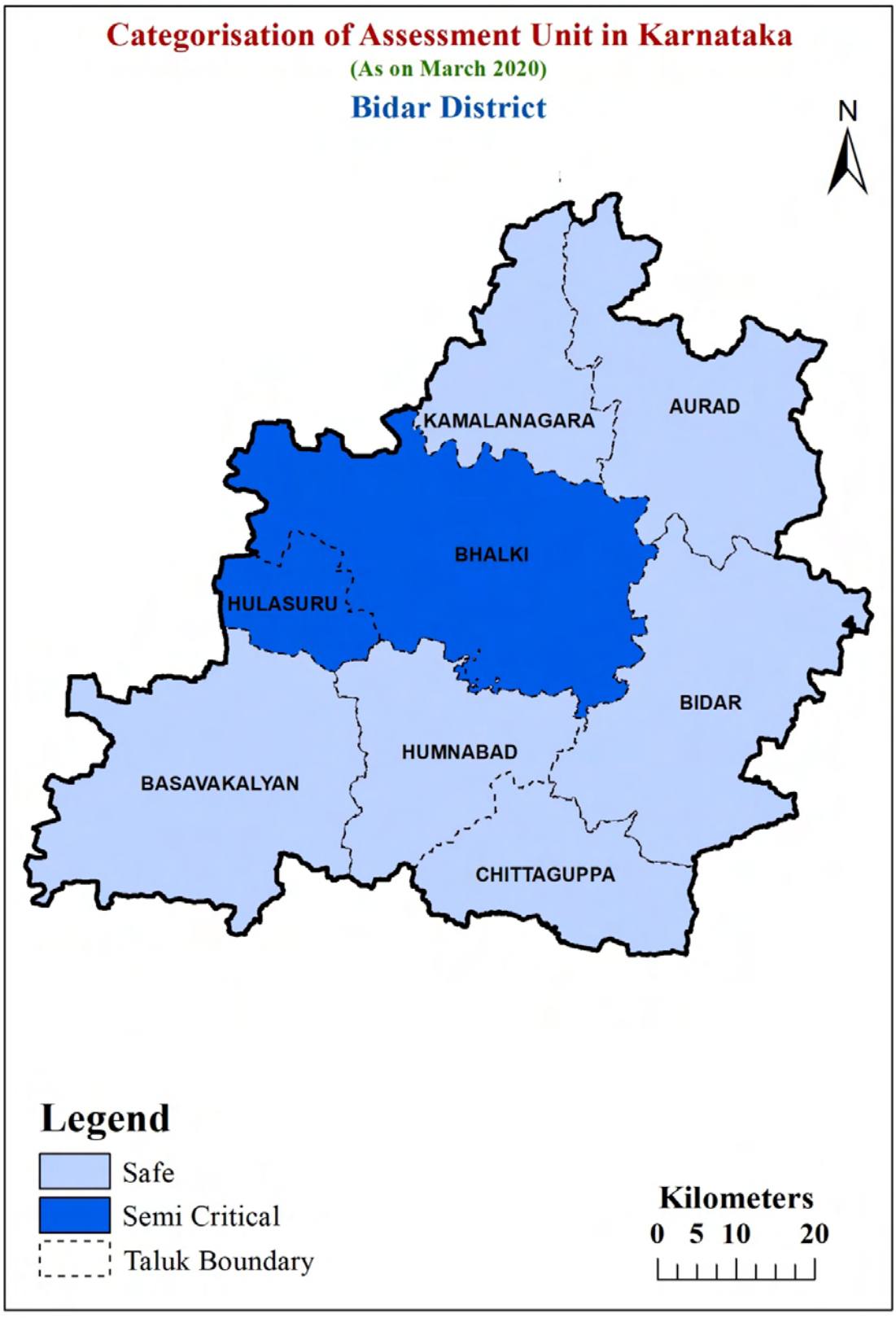

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Bidar District
N
KAMALANAGARA
AURAD
BHALKI
HULASURU
BIDAR
HUMNABAD
BASAVAKALYAN
CHITTAGUPPA
Legend
Safe
Semi Critical
Taluk Boundary
Kilometers
0 5 10 20

Plate-17

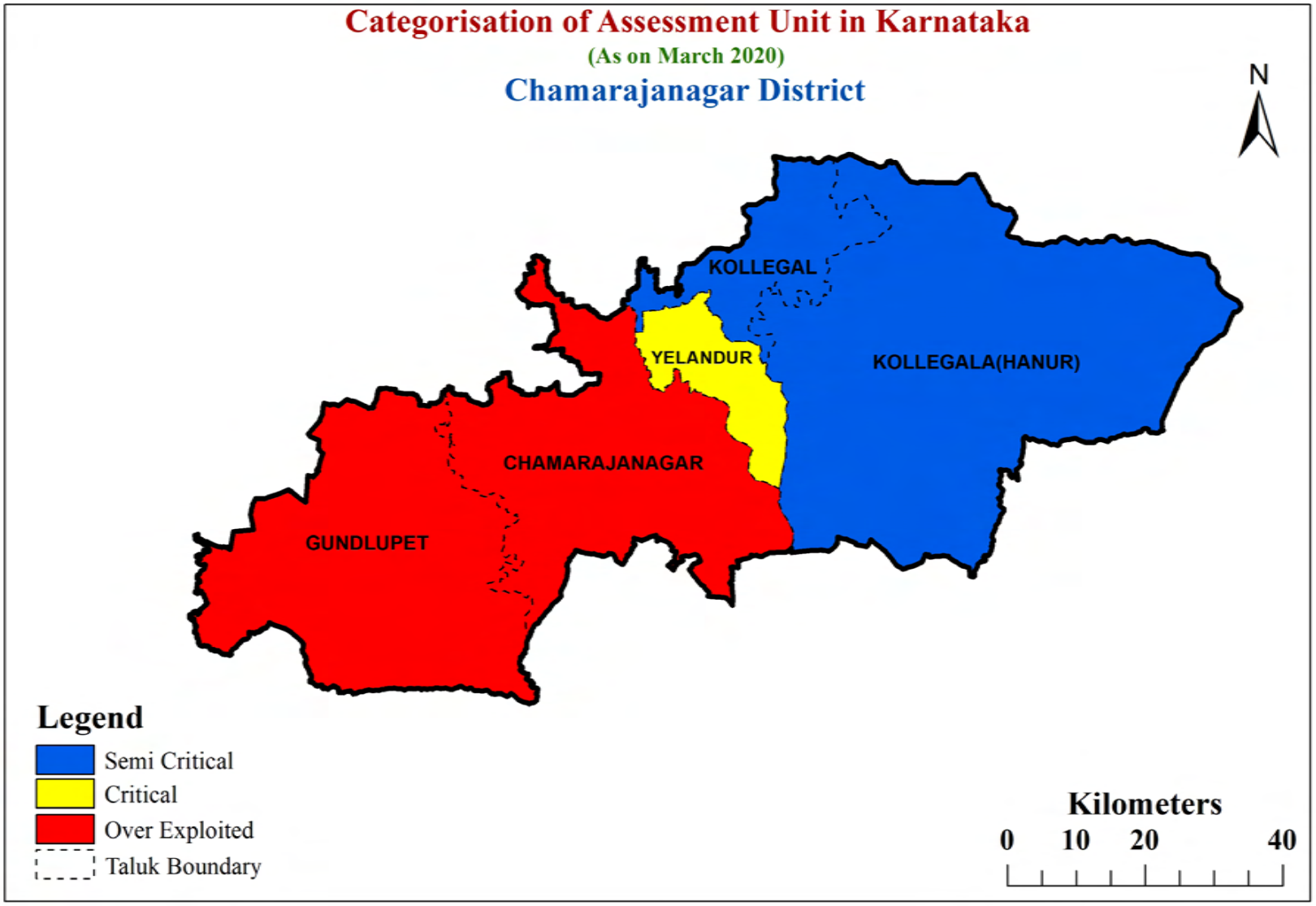

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Chamarajanagar District
N
KOLLEGAL
YELANDUR
KOLLEGALA(HANUR)
CHAMARAJANAGAR
GUNDLUPET
Legend
Semi Critical
Critical
Over Exploited
Taluk Boundary
Kilometers
0 10 20 40

Plate-18

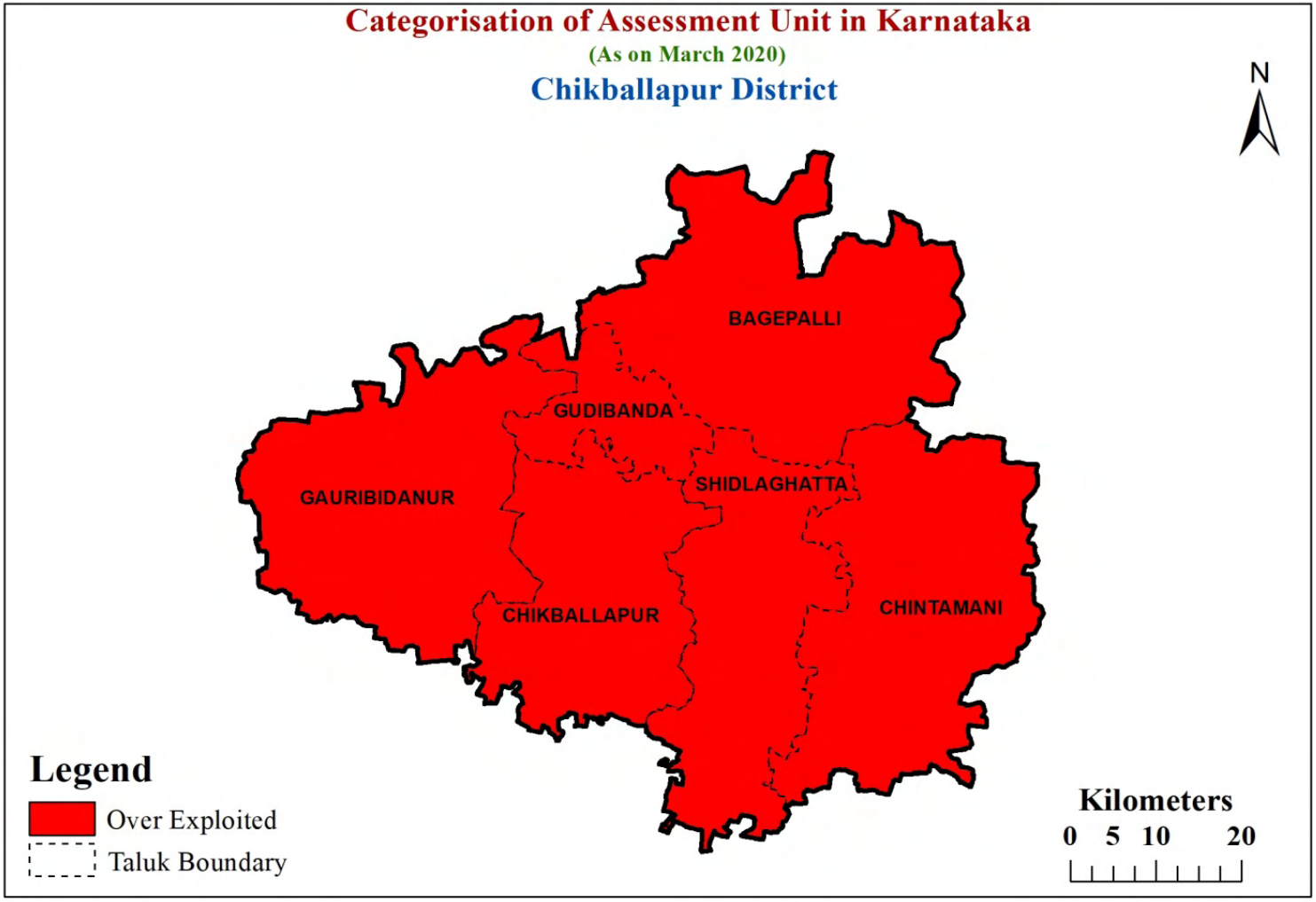

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Chikballapur District
N
BAGEPALLI
GUDIBANDA
SHIDLAGHATTA
GAURIBIDANUR
CHIKBALLAPUR
CHINTAMANI
Legend
Over Exploited
Taluk Boundary
Kilometers
0 5 10 20

Plate-19

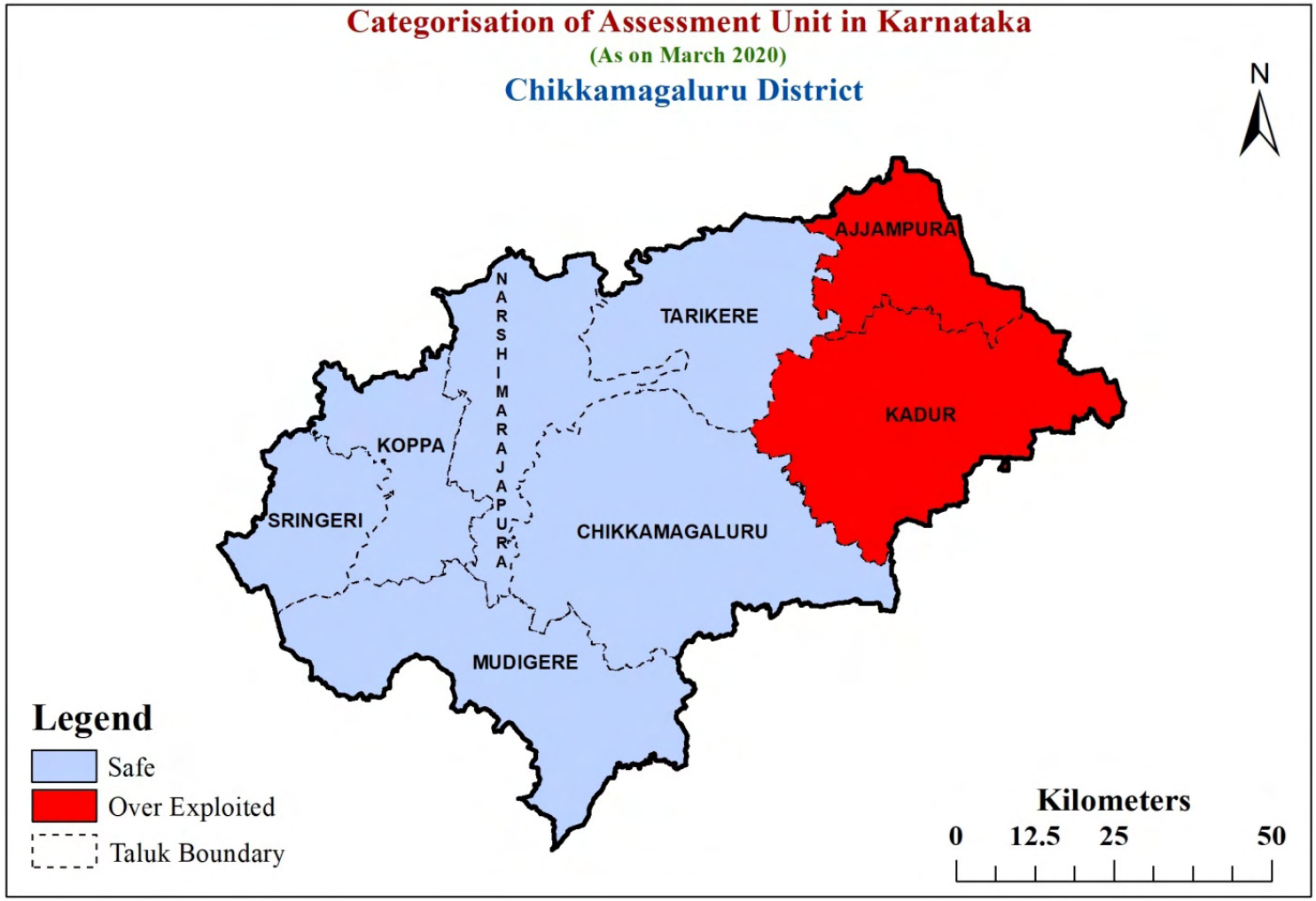

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Chikkamagaluru District
N
AJJAMPURA
TARIKERE
KADUR
NARSHIMARAJAPURA
KOPPA
SRINGERI
CHIKKAMAGALURU
MUDIGERE
Legend
Safe
Over Exploited
Taluk Boundary
Kilometers
0 12.5 25 50

Plate-20

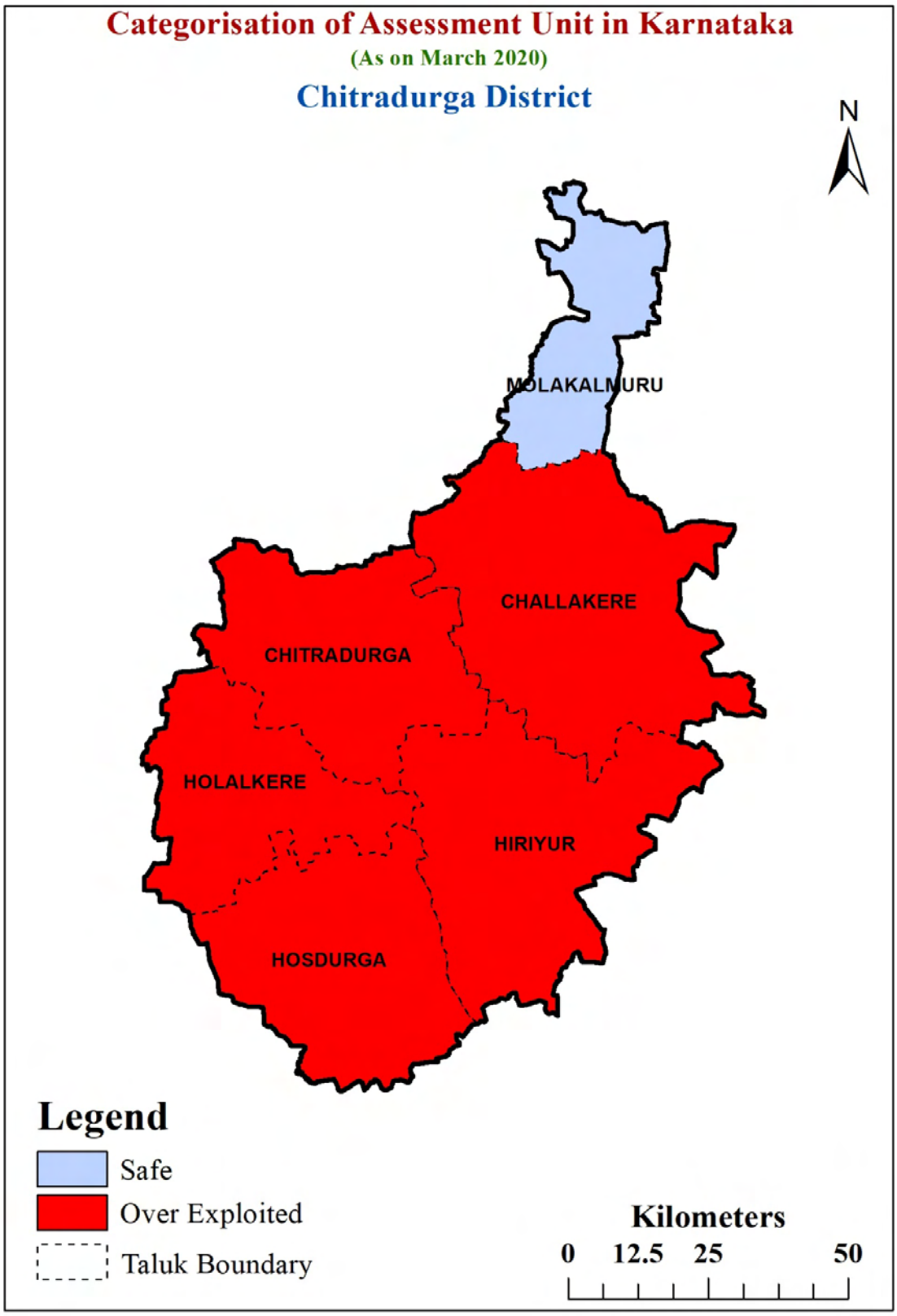

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Chitradurga District
N
MOLAKALMURU
CHALLAKERE
CHITRADURGA
HOLALKERE
HIRIYUR
HOSDURGA
Legend
Safe
Over Exploited
Taluk Boundary
Kilometers
0 12.5 25 50

Plate-21

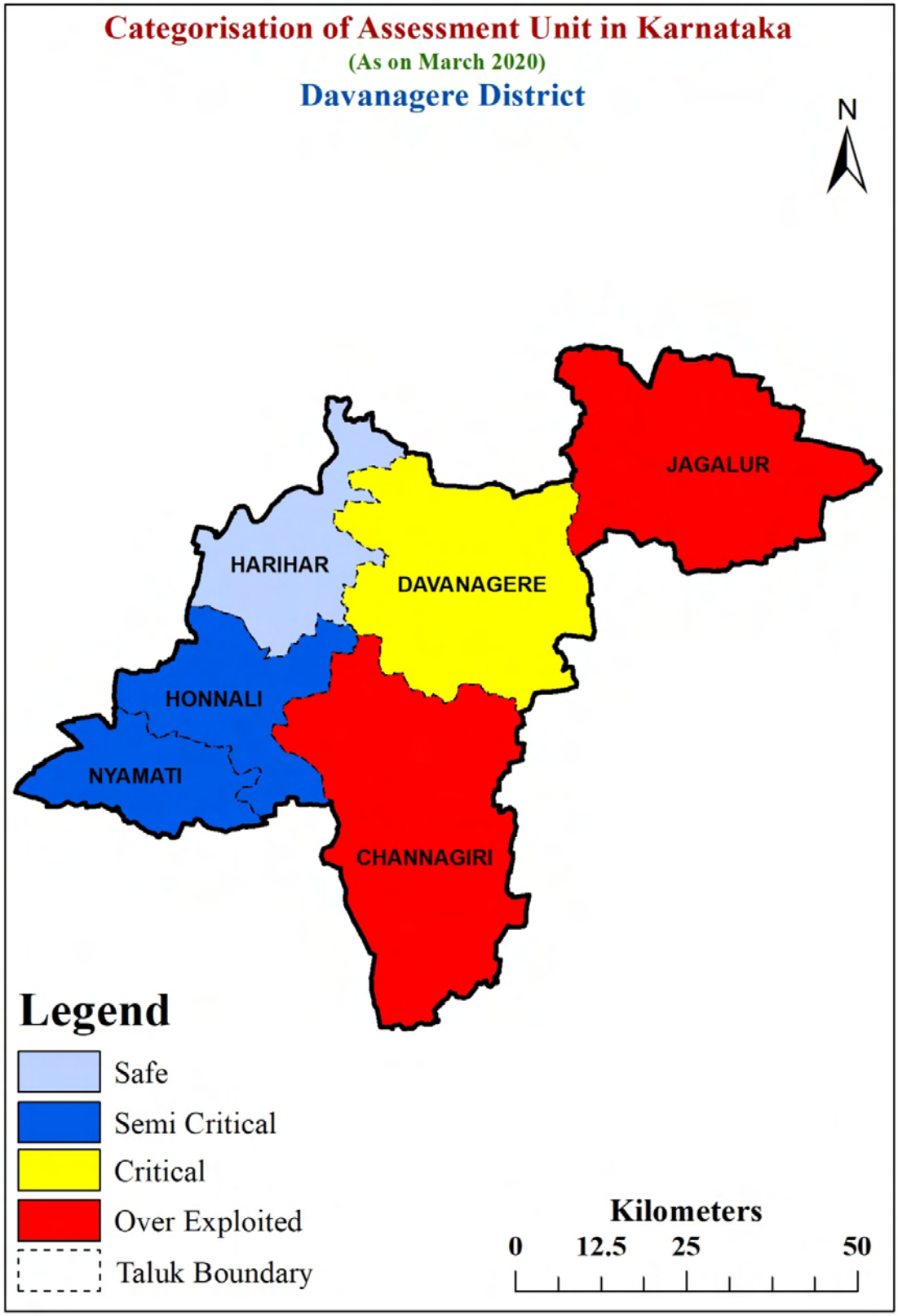

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Davanagere District
N
JAGALUR
HARIHAR
DAVANAGERE
HONNALI
NYAMATI
CHANNAGIRI
Legend
Safe
Semi Critical
Critical
Over Exploited
Taluk Boundary
Kilometers
0
12.5
25
50

Plate-22

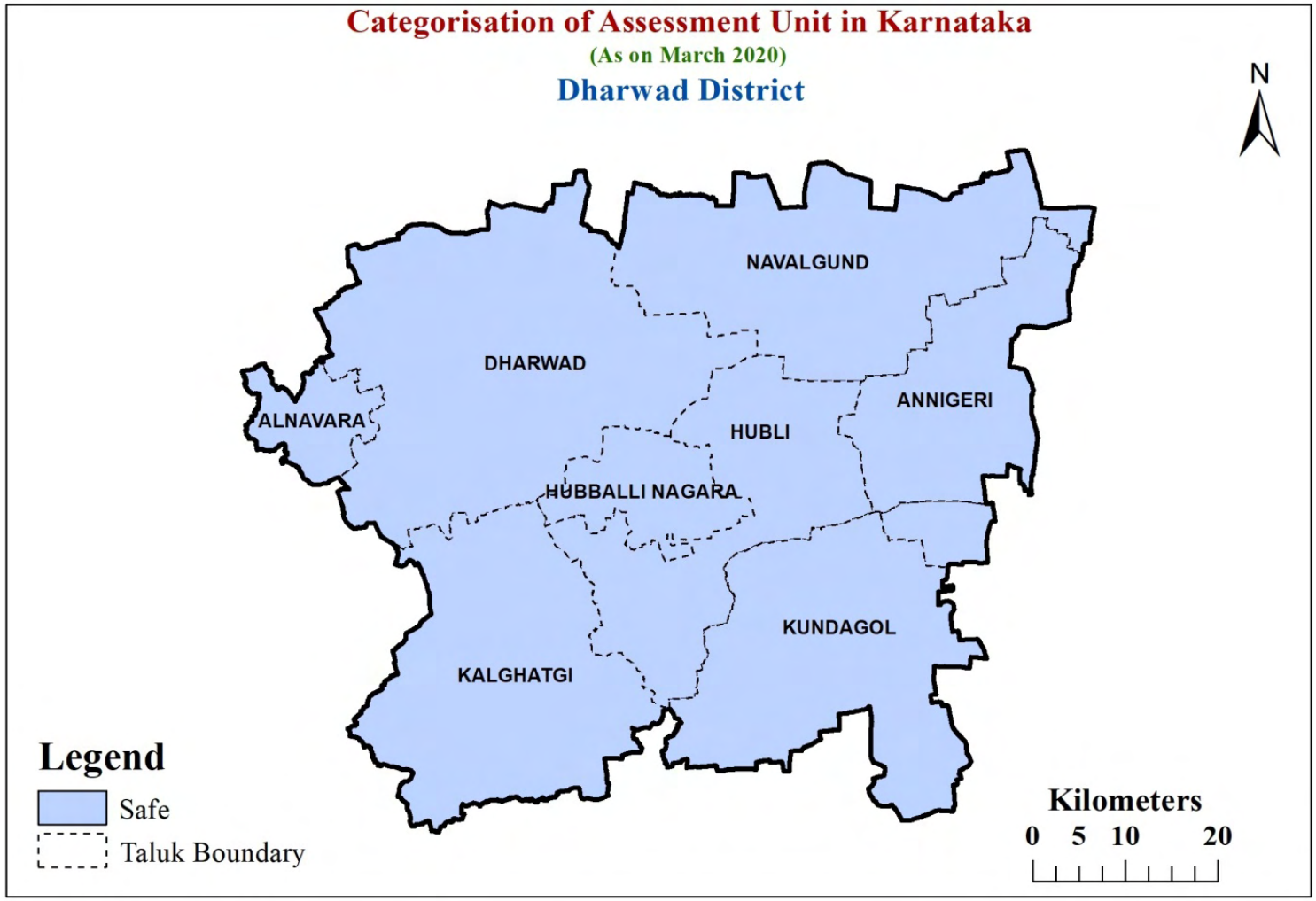

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Dharwad District
N
NAVALGUND
DHARWAD
ALNAVARA
HUBLI
ANNIGERI
HUBBALLI NAGARA
KUNDAGOL
KALGHATGI
Legend
Safe
Taluk Boundary
Kilometers
0 5 10 20

Plate-23-

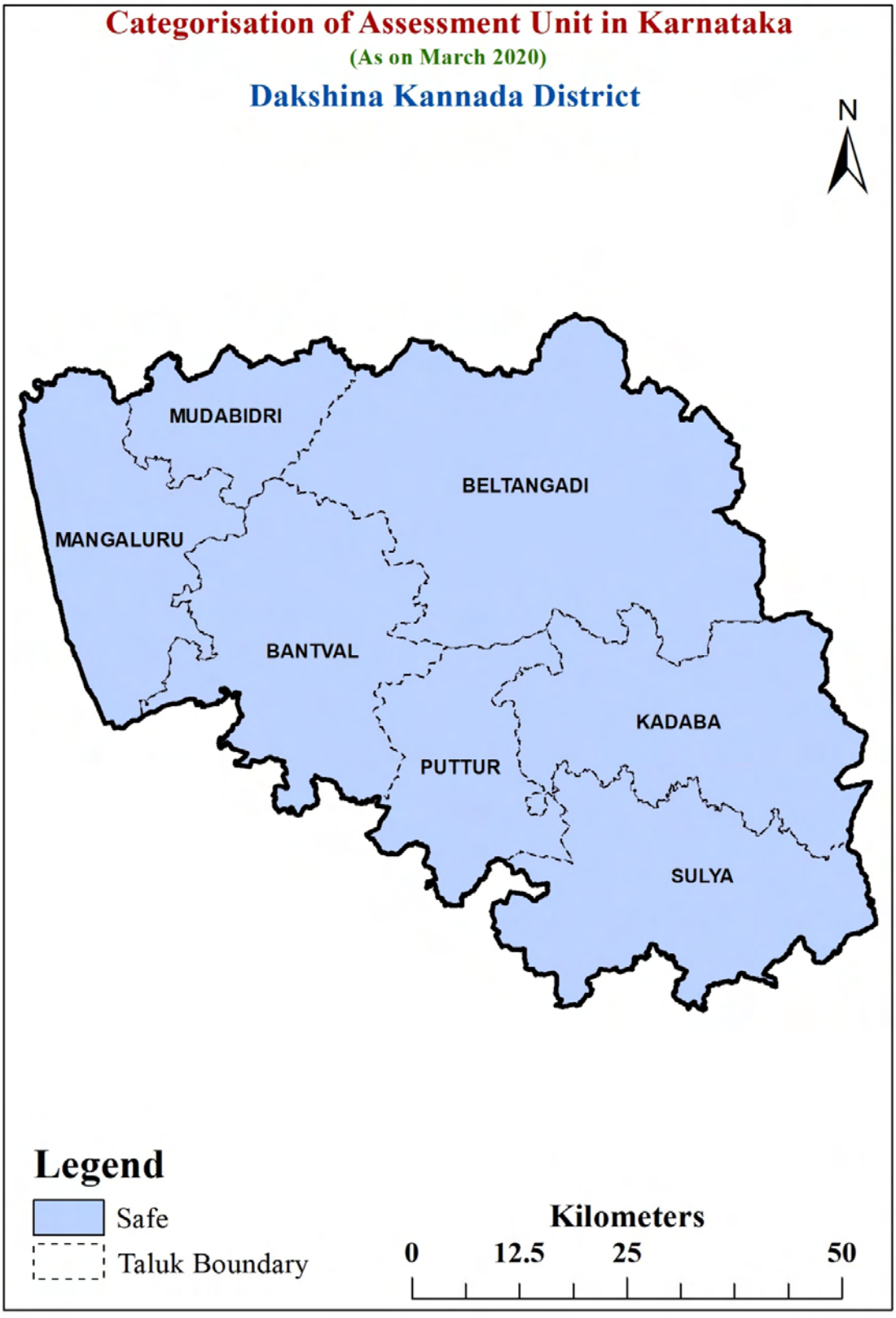

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Dakshina Kannada District
N
MUDABIDRI
BELTANGADI
MANGALURU
BANTVAL
KADABA
PUTTUR
SULYA
Legend
Safe
Taluk Boundary
Kilometers
0
12.5
25
50

Plate-24

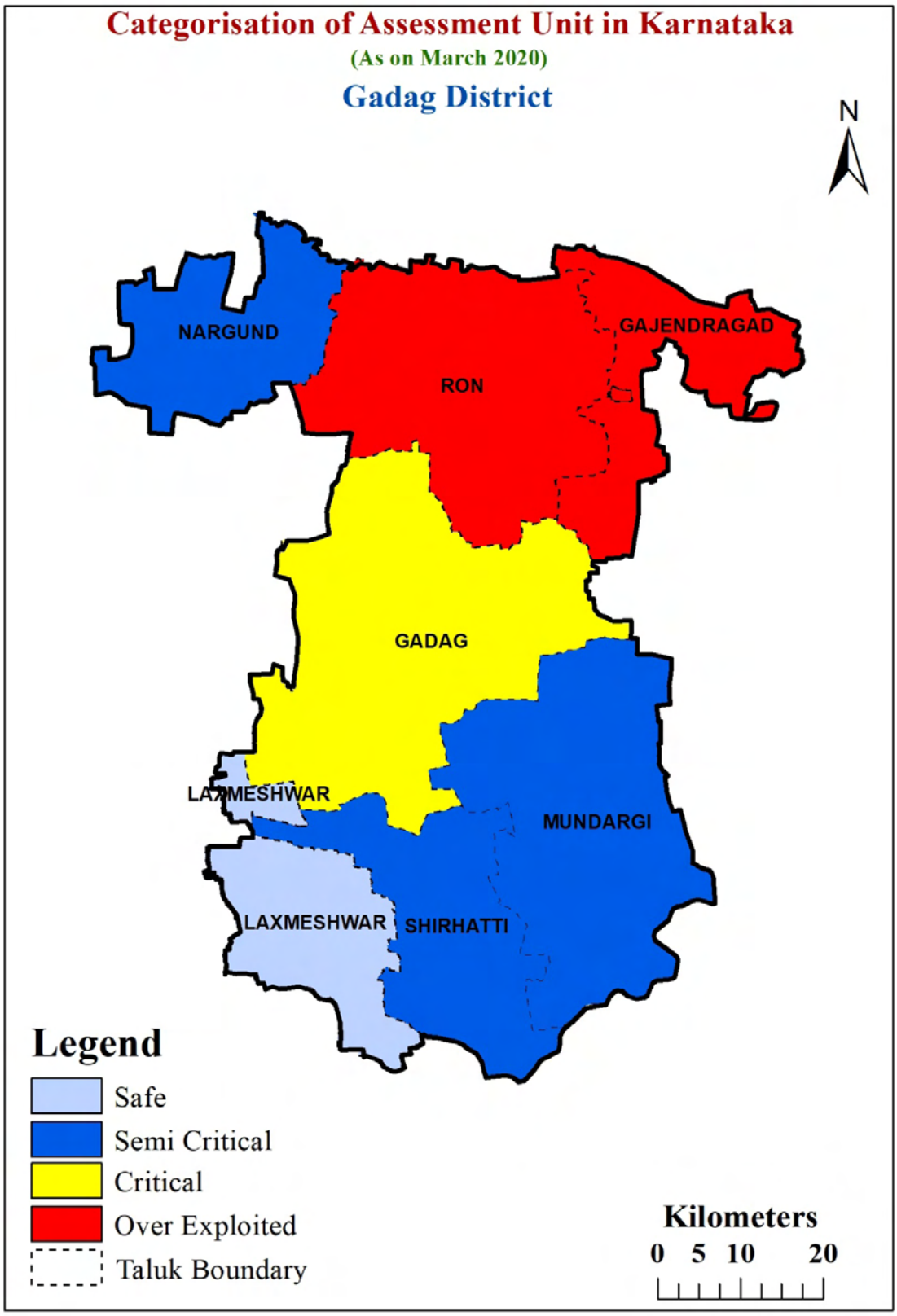

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Gadag District
N
NARGUND
RON
GAJENDRAGAD
GADAG
LAXMESHWAR
MUNDARGI
LAXMESHWAR
SHIRHATTI
Legend
Safe
Semi Critical
Critical
Over Exploited
Taluk Boundary
Kilometers
0 5 10 20

Plate-25

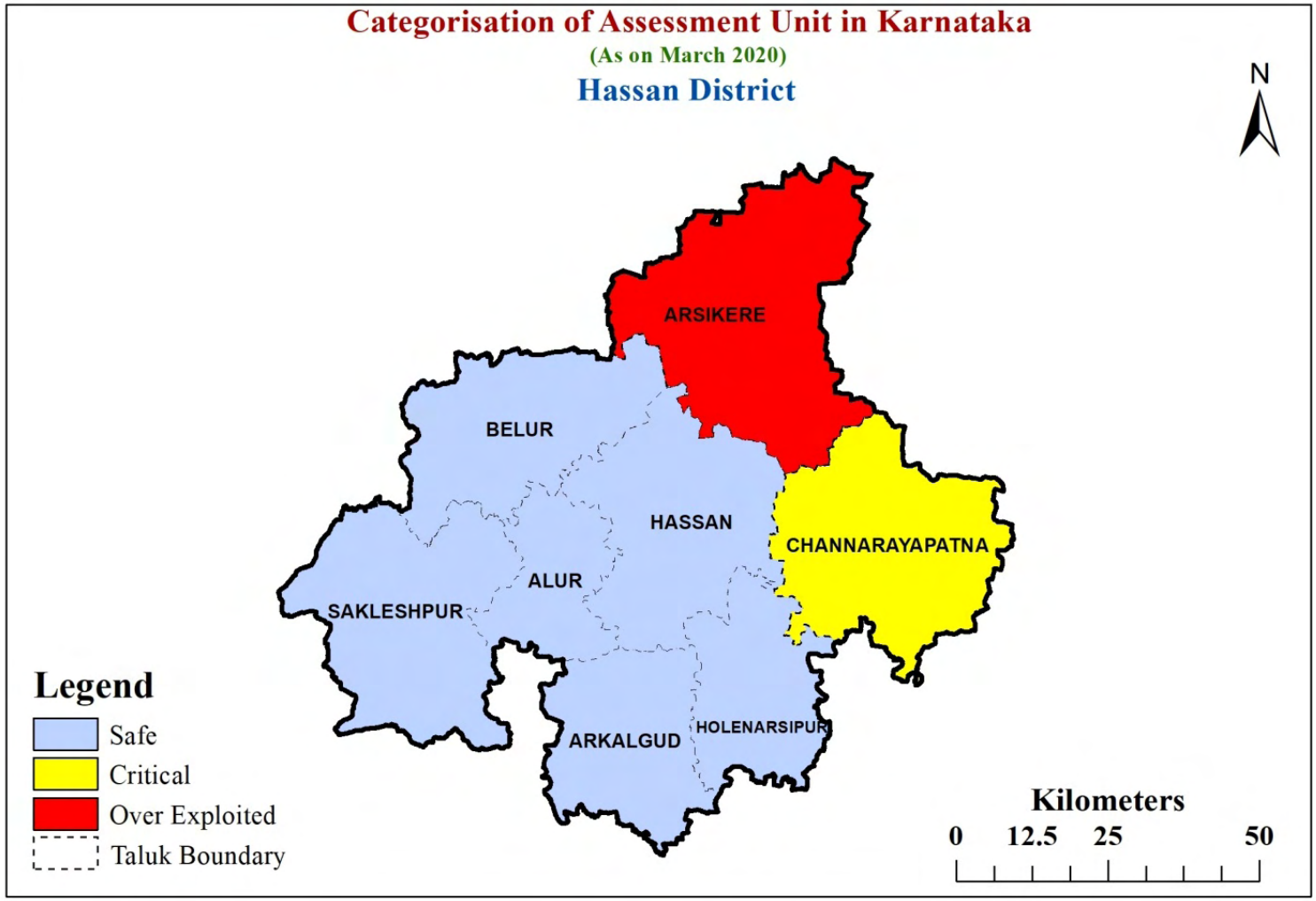

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Hassan District
N
ARSIKERE
BELUR
HASSAN
CHANNARAYAPATNA
ALUR
SAKLESHPUR
ARKALGUD
HOLENARSIPUR
Legend
Safe
Critical
Over Exploited
Taluk Boundary
Kilometers
0 12.5 25 50

Plate-26

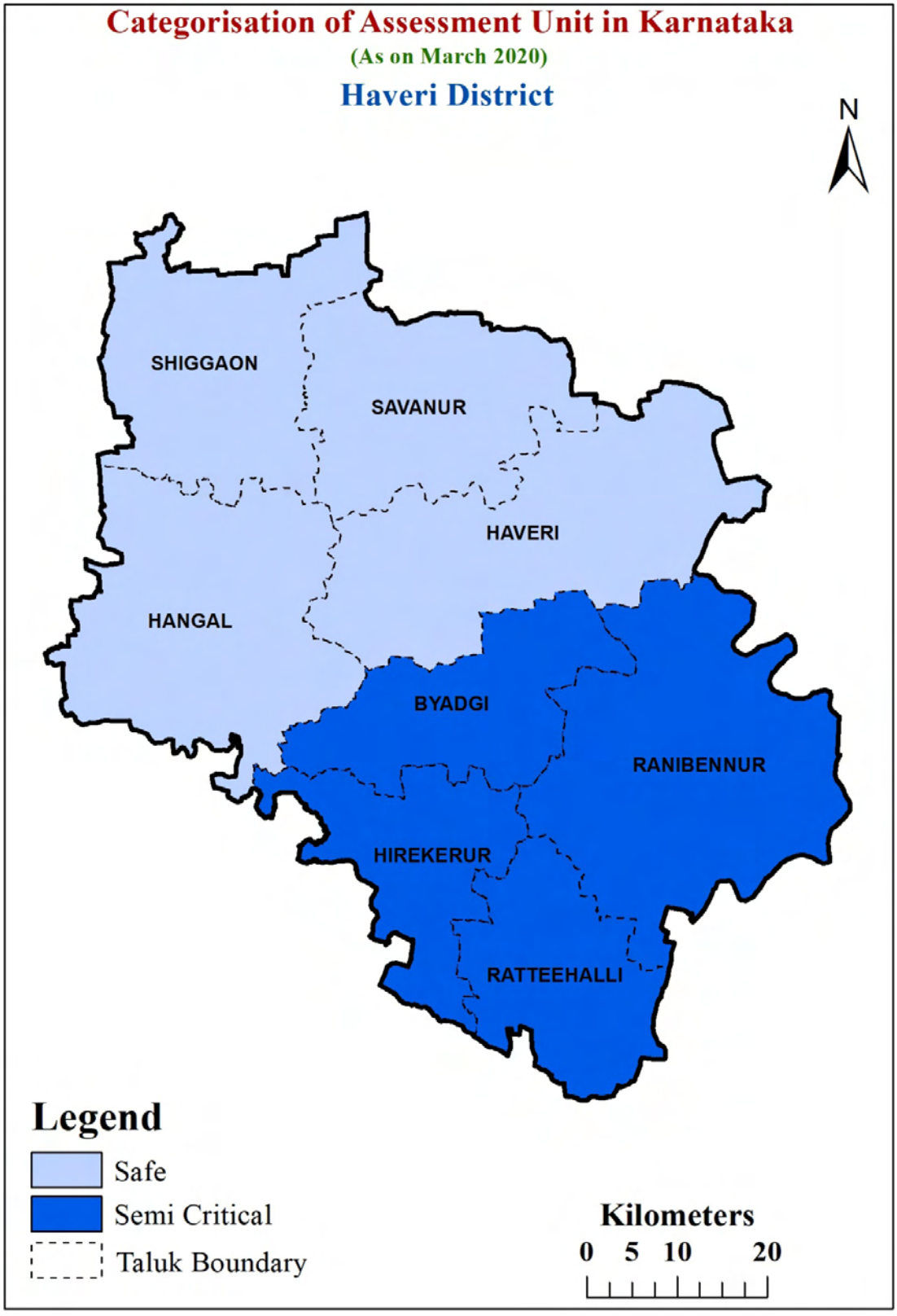

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Haveri District
N
SHIGGAON
SAVANUR
HAVERI
HANGAL
BYADGI
RANIBENNUR
HIREKERUR
RATTEEHALLI
Legend
Safe
Semi Critical
Taluk Boundary
Kilometers
0 5 10 20

Plate-27

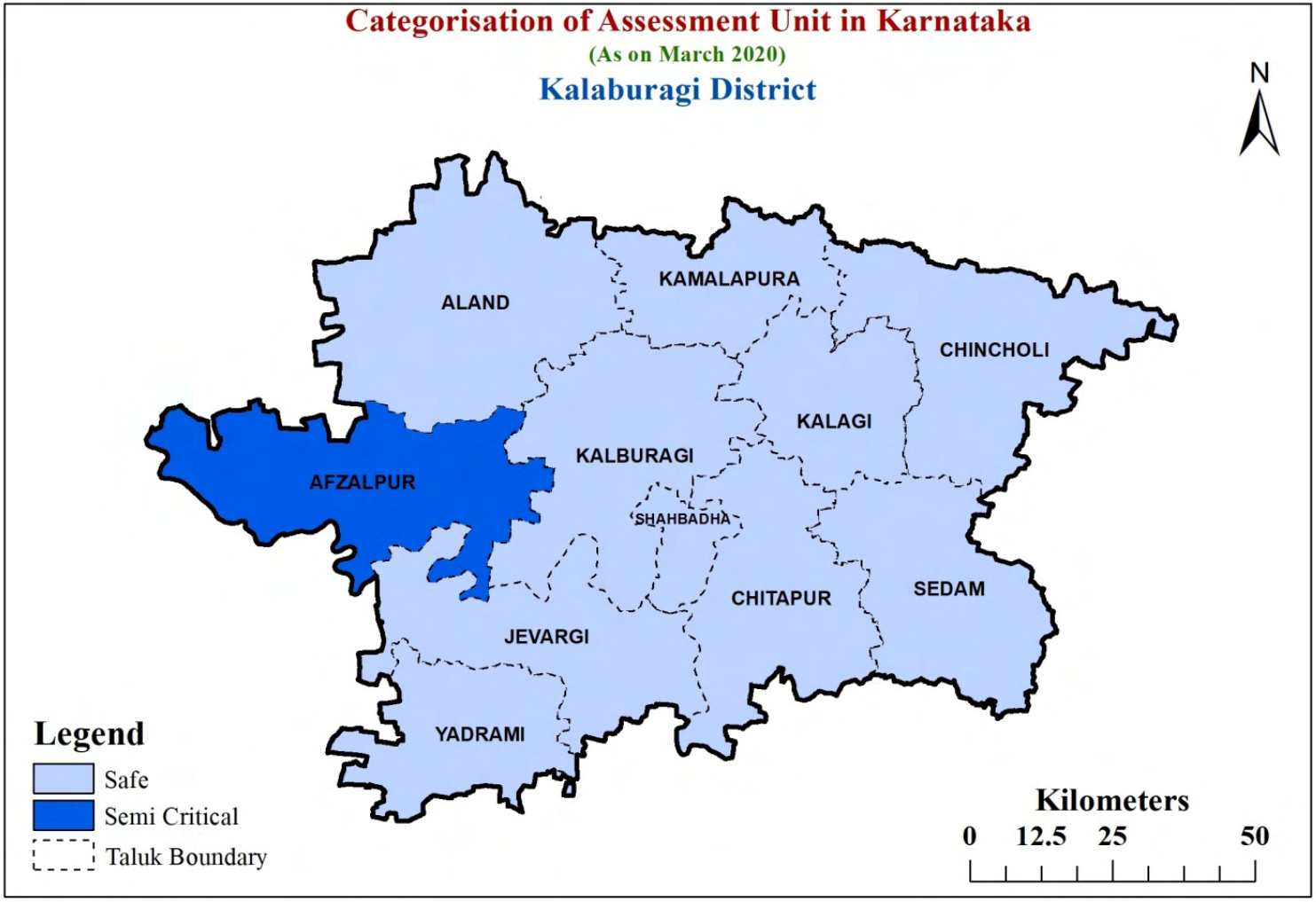

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Kalaburagi District
N
ALAND
KAMALAPURA
CHINCHOLI
KALAGI
KALBURAGI
AFZALPUR
SHAHBADHA
CHITAPUR
SEDAM
JEVARGI
YADRAMI
Legend
Safe
Semi Critical
Taluk Boundary
Kilometers
0 12.5 25 50

Plate-28

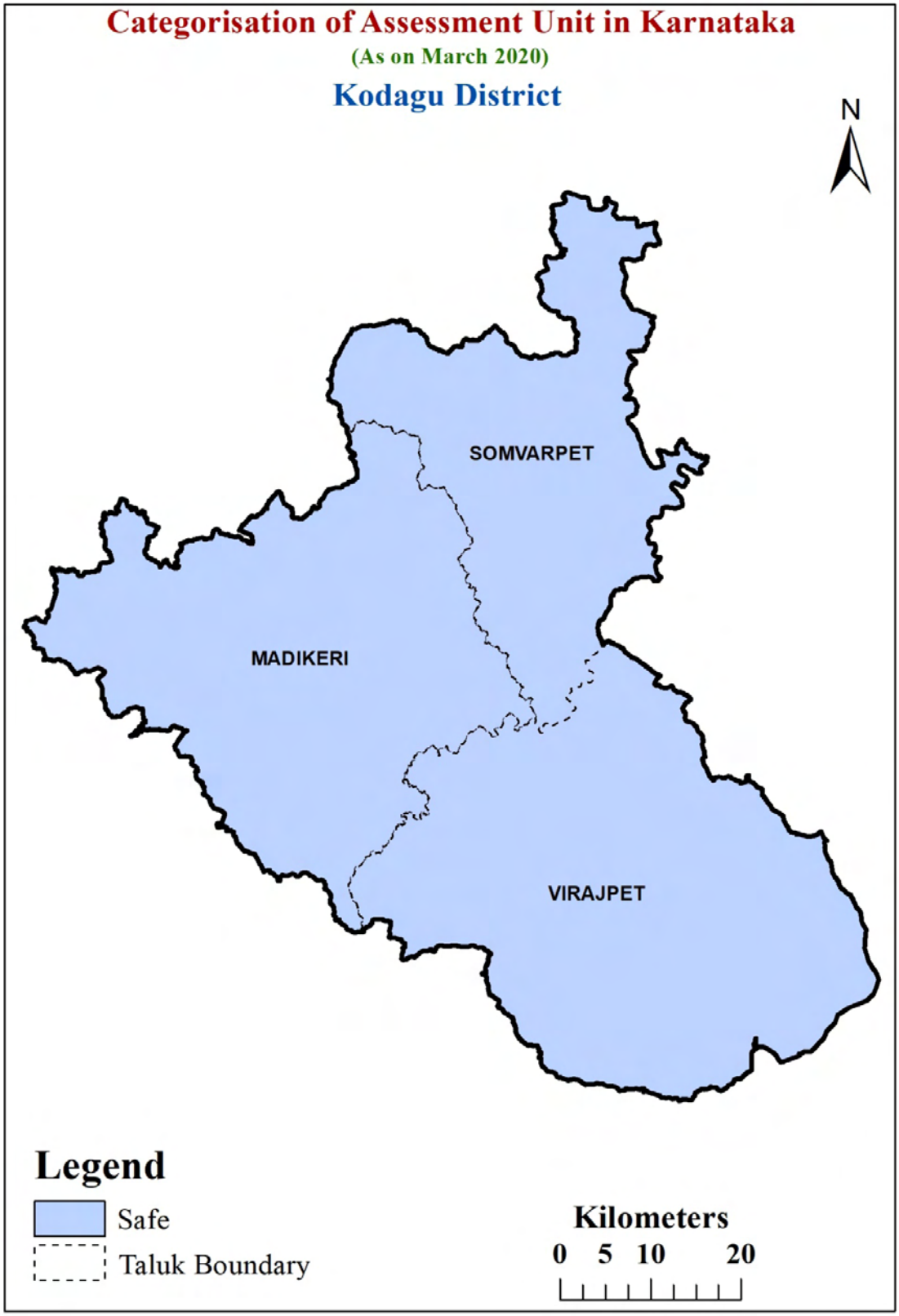

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Kodagu District
N
SOMVARPET
MADIKERI
VIRAJPET
Legend
Safe
Taluk Boundary
Kilometers
0 5 10 20

Plate-29

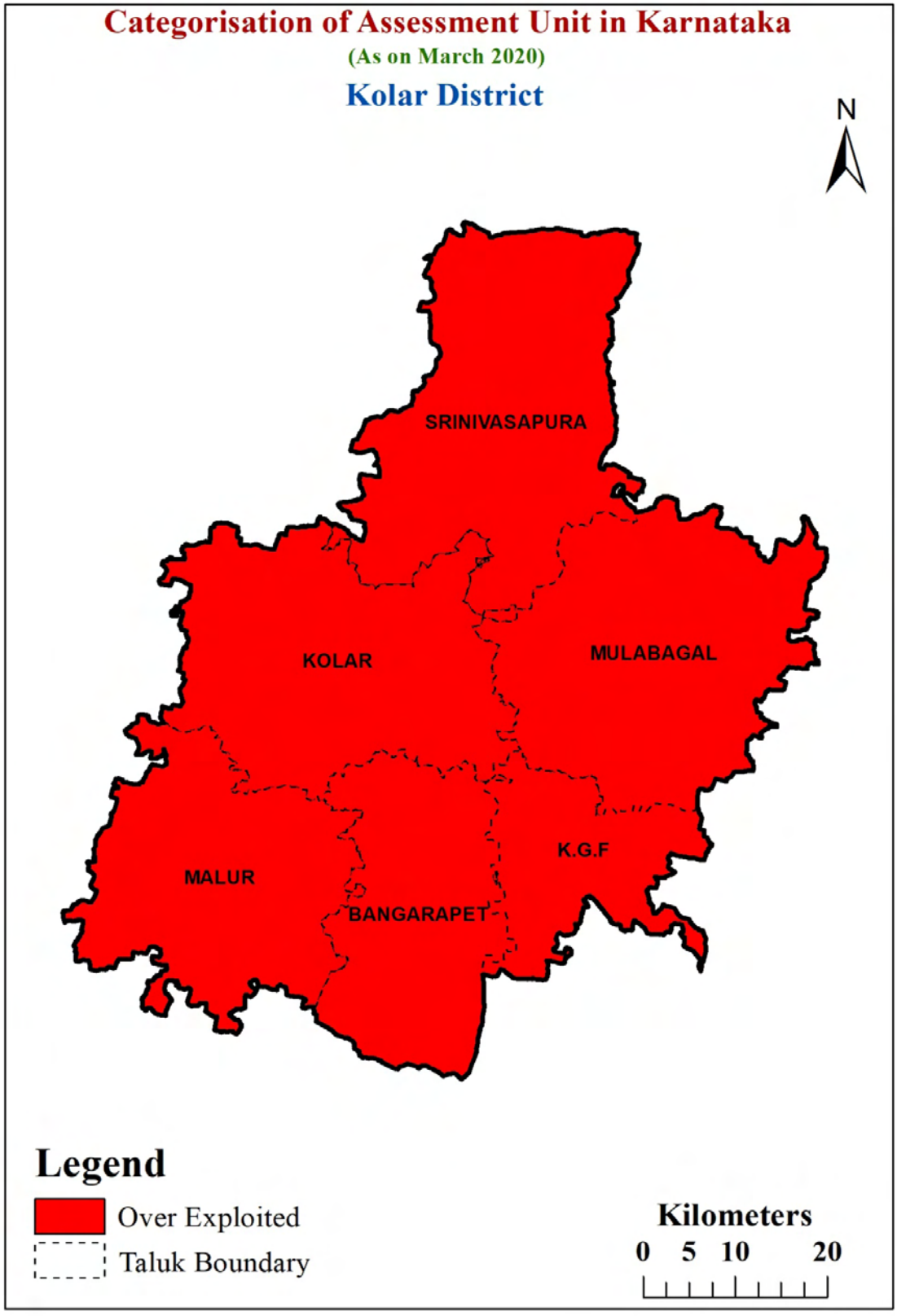

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Kolar District
N
SRINIVASAPURA
KOLAR
MULABAGAL
K.G.F
MALUR
BANGARAPET
Legend
Over Exploited
Taluk Boundary
Kilometers
0 5 10 20

Plate-30

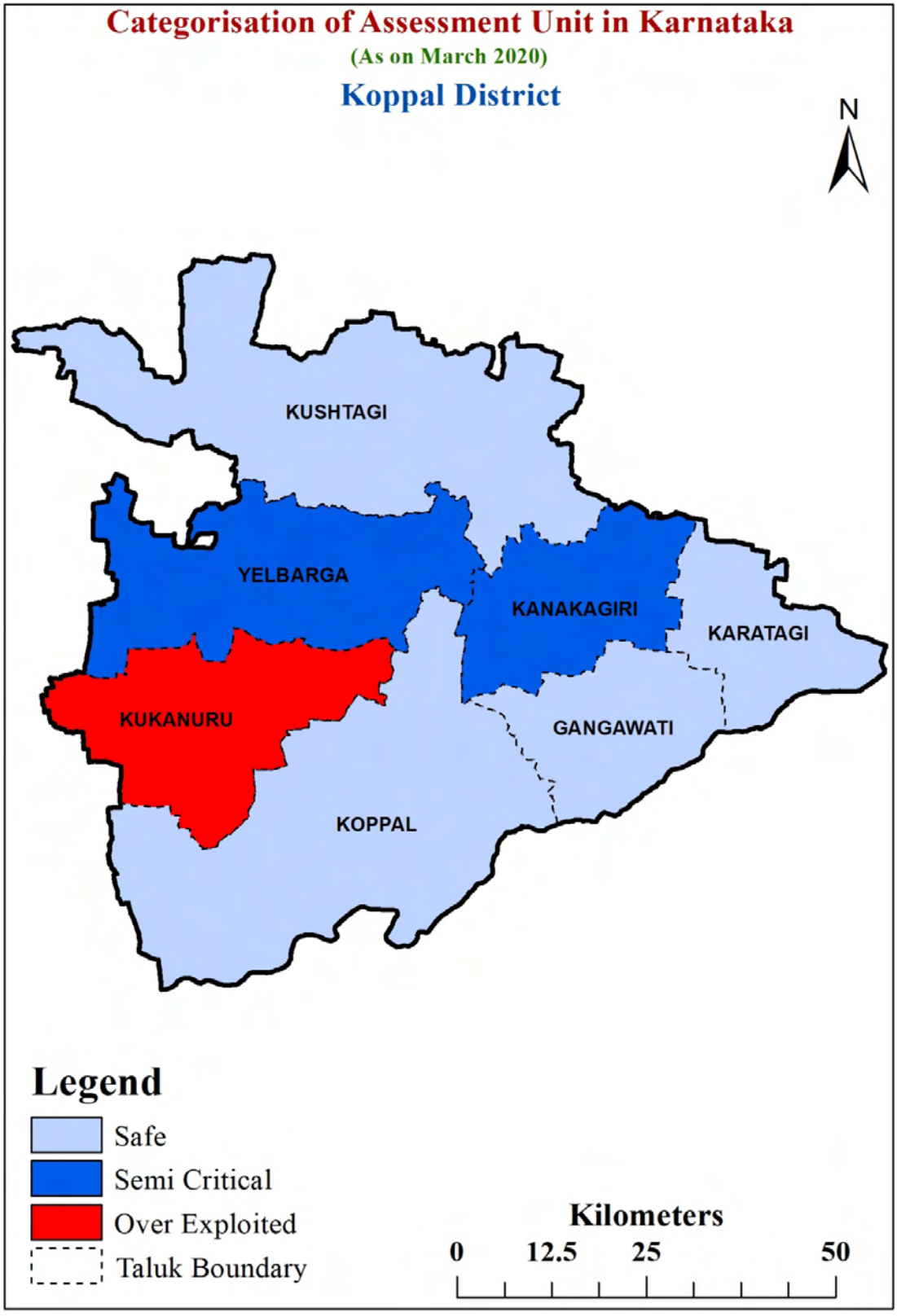

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Koppal District
N
KUSHTAGI
YELBARGA
KANAKAGIRI
KARATAGI
KUKANURU
GANGAWATI
KOPPAL
Legend
Safe
Semi Critical
Over Exploited
Taluk Boundary
Kilometers
0
12.5
25
50

Plate-31

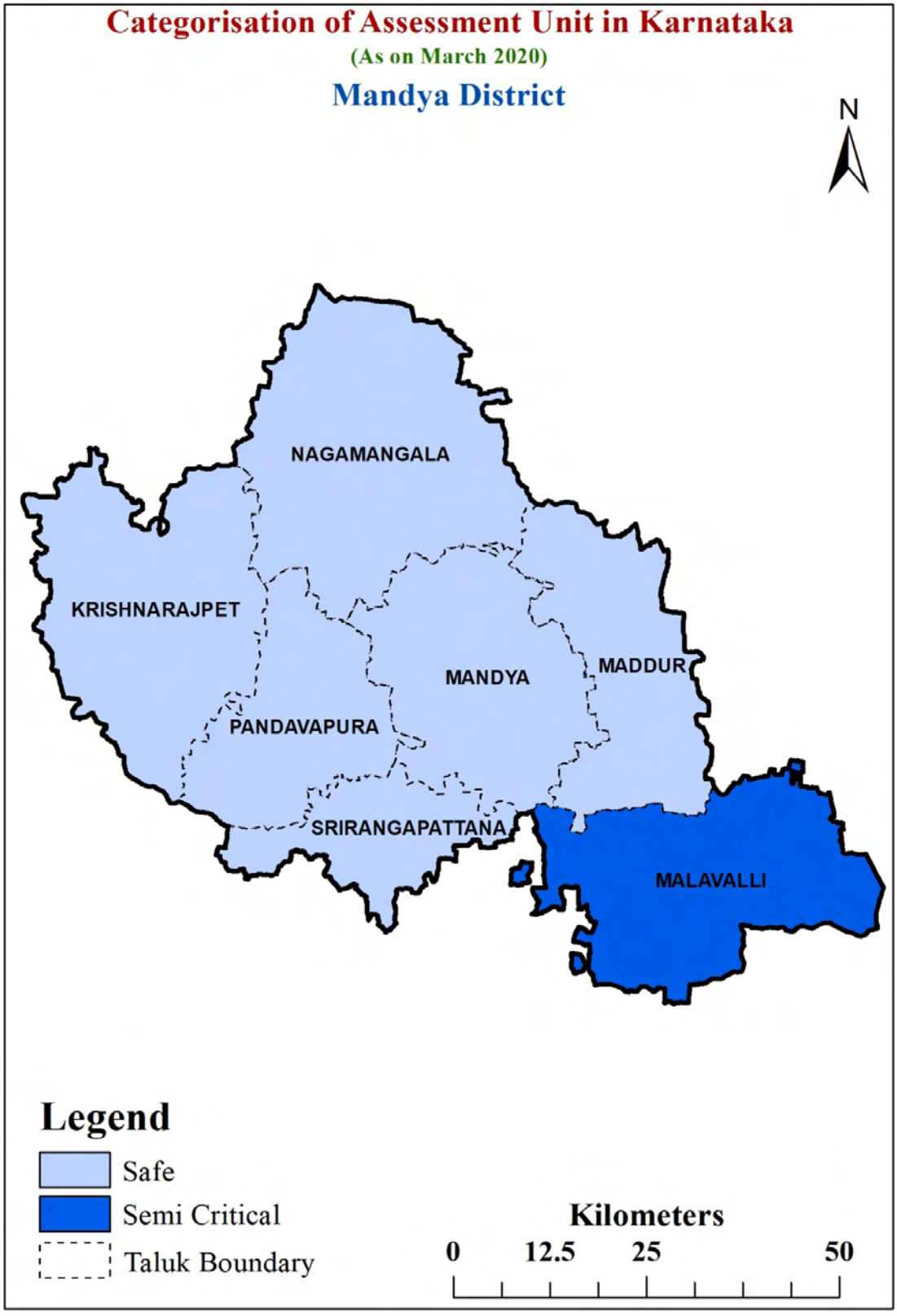

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Mandya District
N
NAGAMANGALA
KRISHNARAJPET
MANDYA
MADDUR
PANDAVAPURA
SRIRANGAPATTANA
MALAVALLI
Legend
Safe
Semi Critical
Taluk Boundary
Kilometers
0
12.5
25
50

Plate-32

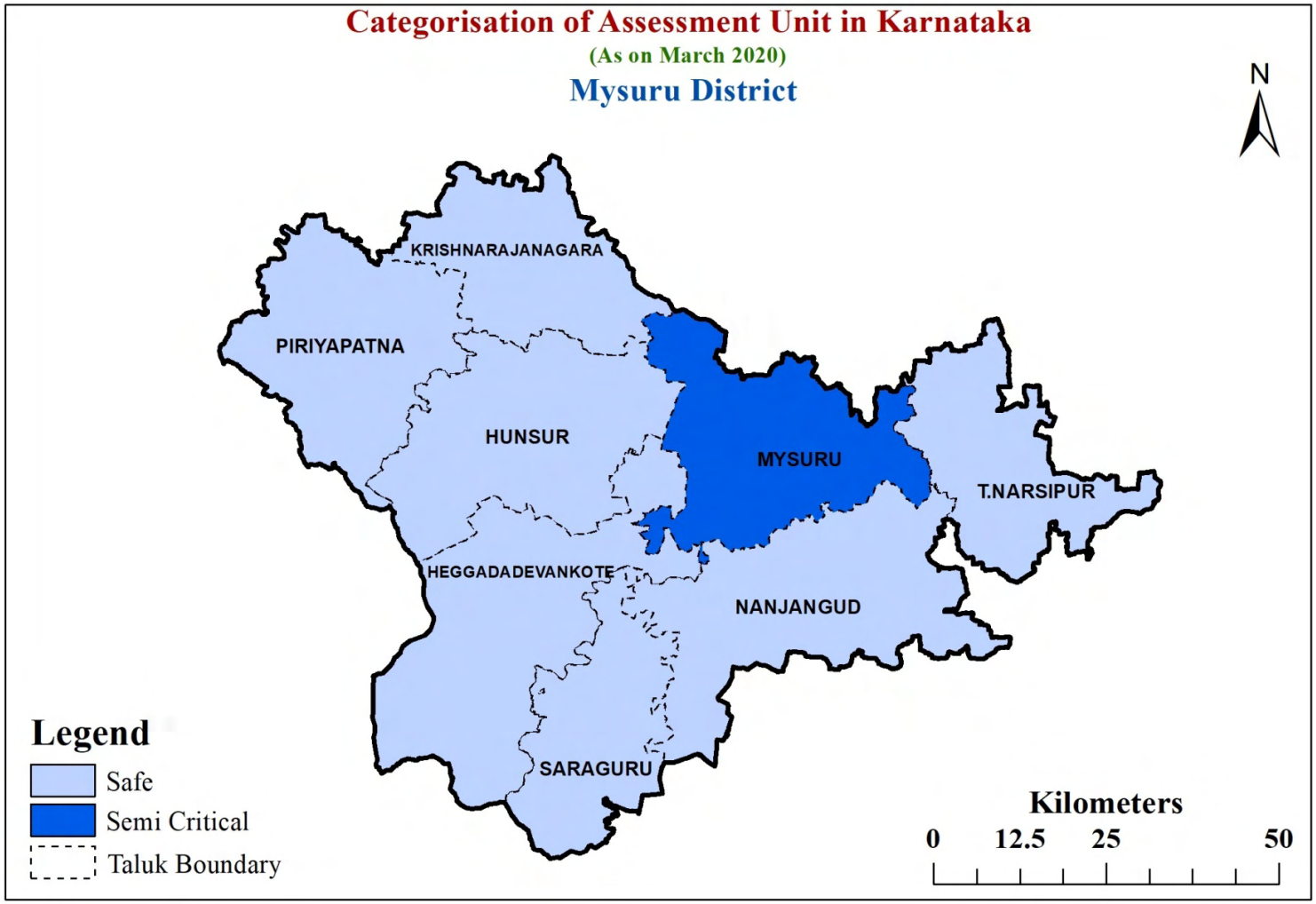

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Mysuru District
N
KRISHNARAJANAGARA
PIRIYAPATNA
HUNSUR
MYSURU
T.NARSIPUR
HEGGADADEVANKOTE
NANJANGUD
SARAGURU
Legend
Safe
Semi Critical
Taluk Boundary
Kilometers
0
12.5
25
50

Plate-33

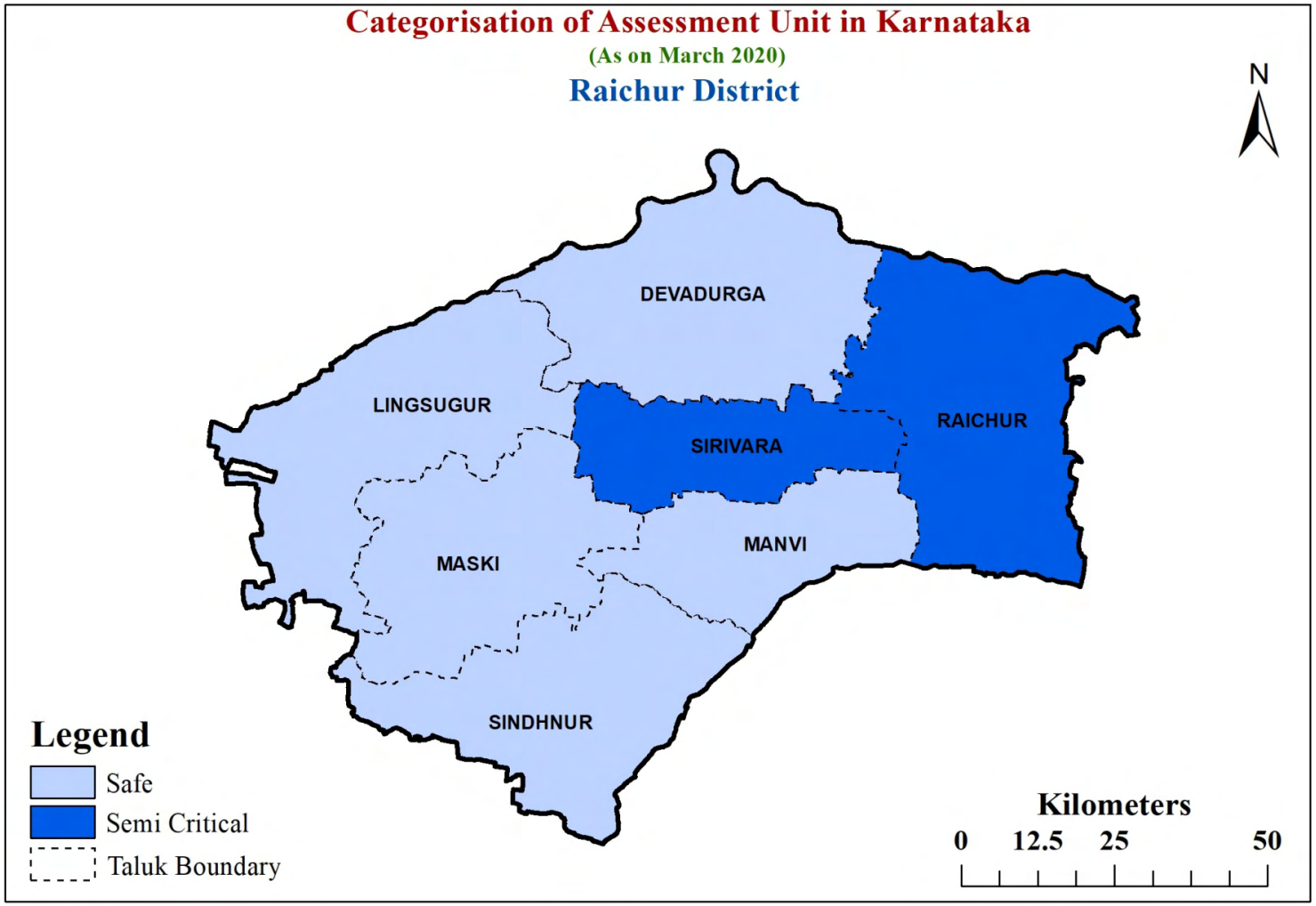

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Raichur District
N
DEVADURGA
LINGSUGUR
RAICHUR
SIRIVARA
MANVI
MASKI
SINDHNUR
Legend
Safe
Semi Critical
Taluk Boundary
Kilometers
0 12.5 25 50

Plate-34

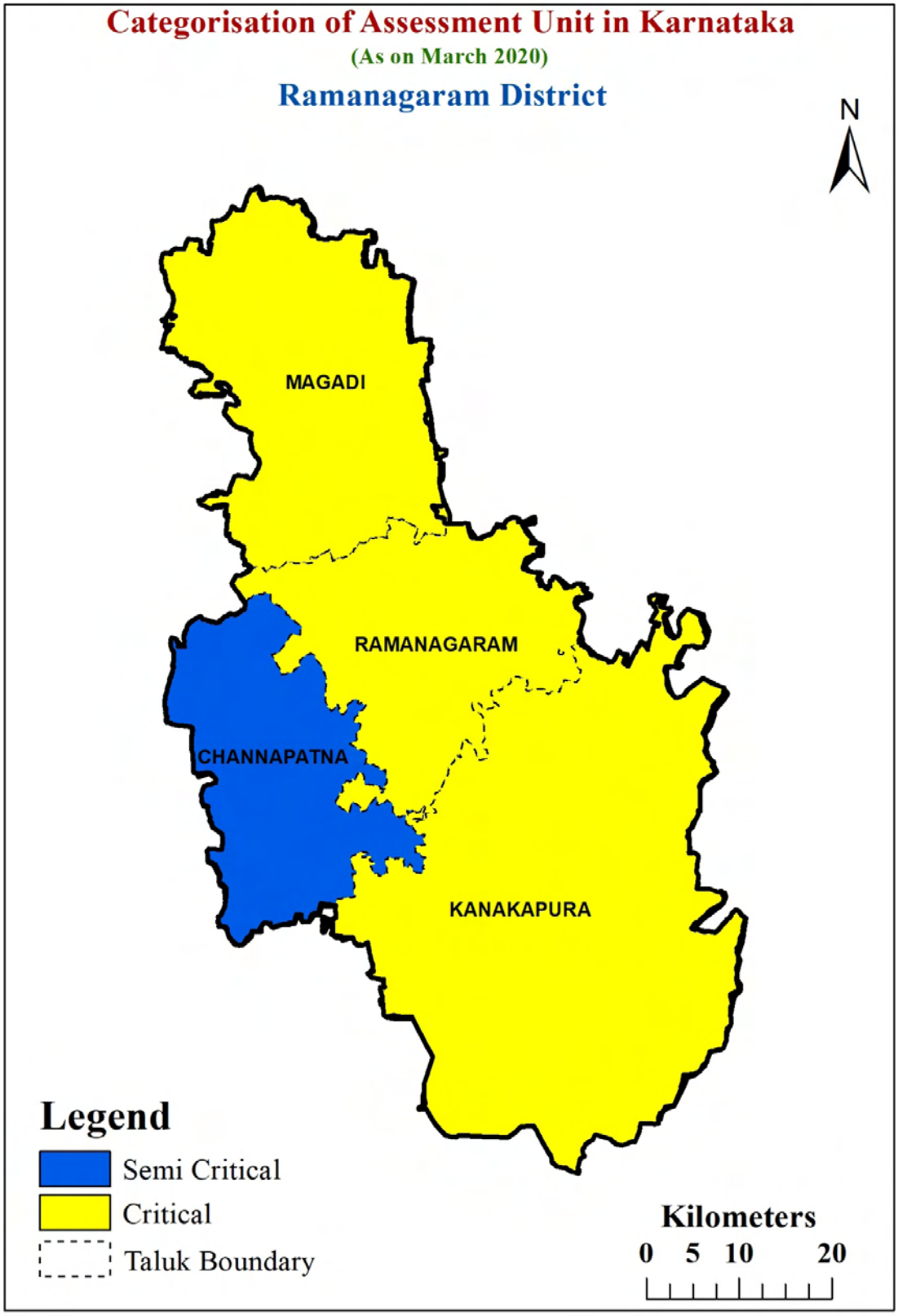

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Ramanagaram District
N
MAGADI
RAMANAGARAM
CHANNAPATNA
KANAKAPURA
Legend
Semi Critical
Critical
Taluk Boundary
Kilometers
0 5 10 20

Plate-35


Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Shivamogga District
N
SORAB
SHIKARIPUR
SAGAR
HOSANAGARA
SHIVAMOGGA
BHADRAVATI
TIRTHAHALLI
Legend
Safe
Taluk Boundary
Kilometers
0
12.5
25
50

Plate-36

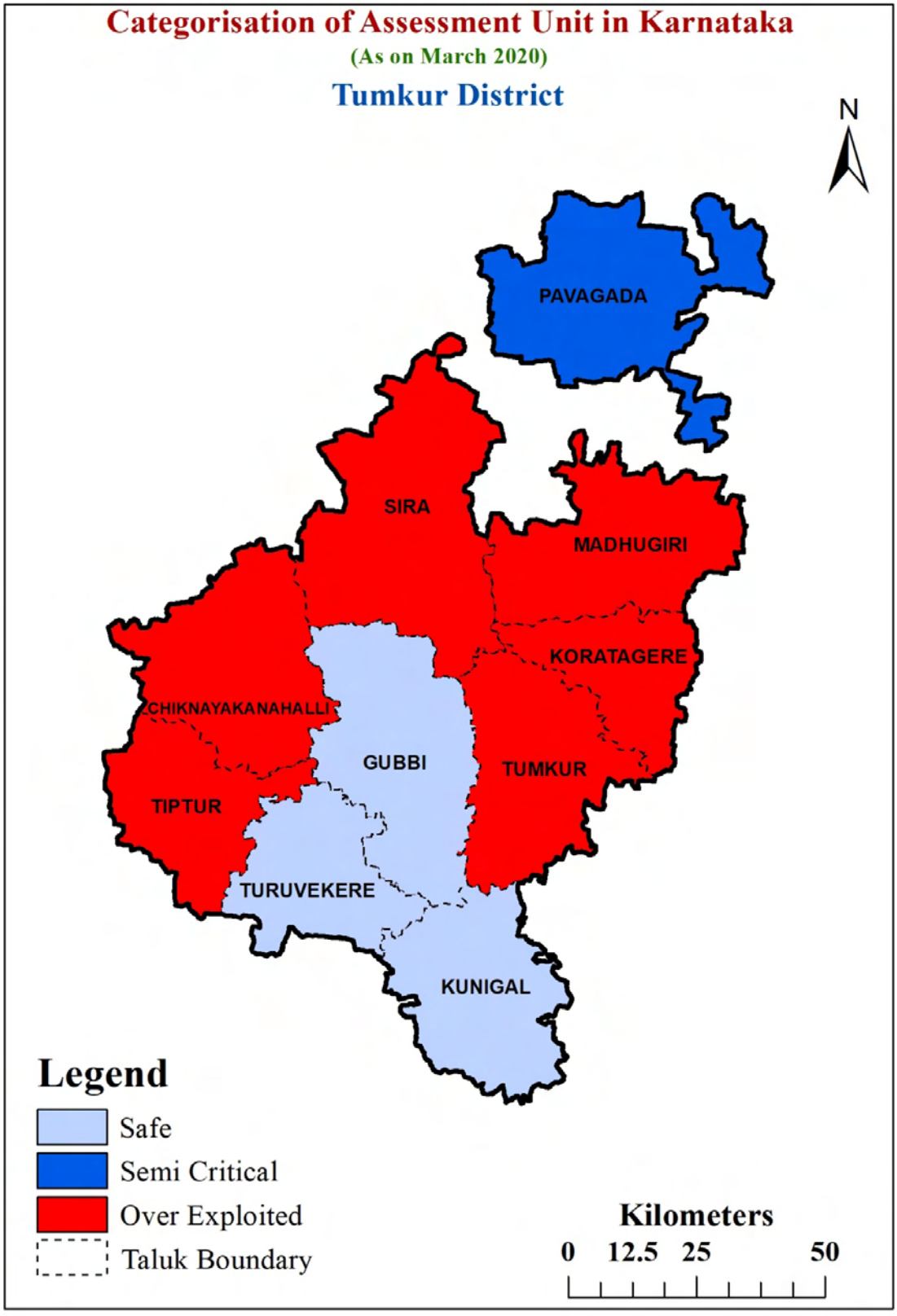

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Tumkur District
N
PAVAGADA
SIRA
MADHUGIRI
KORATAGERE
CHIKNAYAKANAHALLI
GUBBI
TUMKUR
TIPTUR
TURUVEKERE
KUNIGAL
Legend
Safe
Semi Critical
Over Exploited
Taluk Boundary
Kilometers
0 12.5 25 50

Plate-37

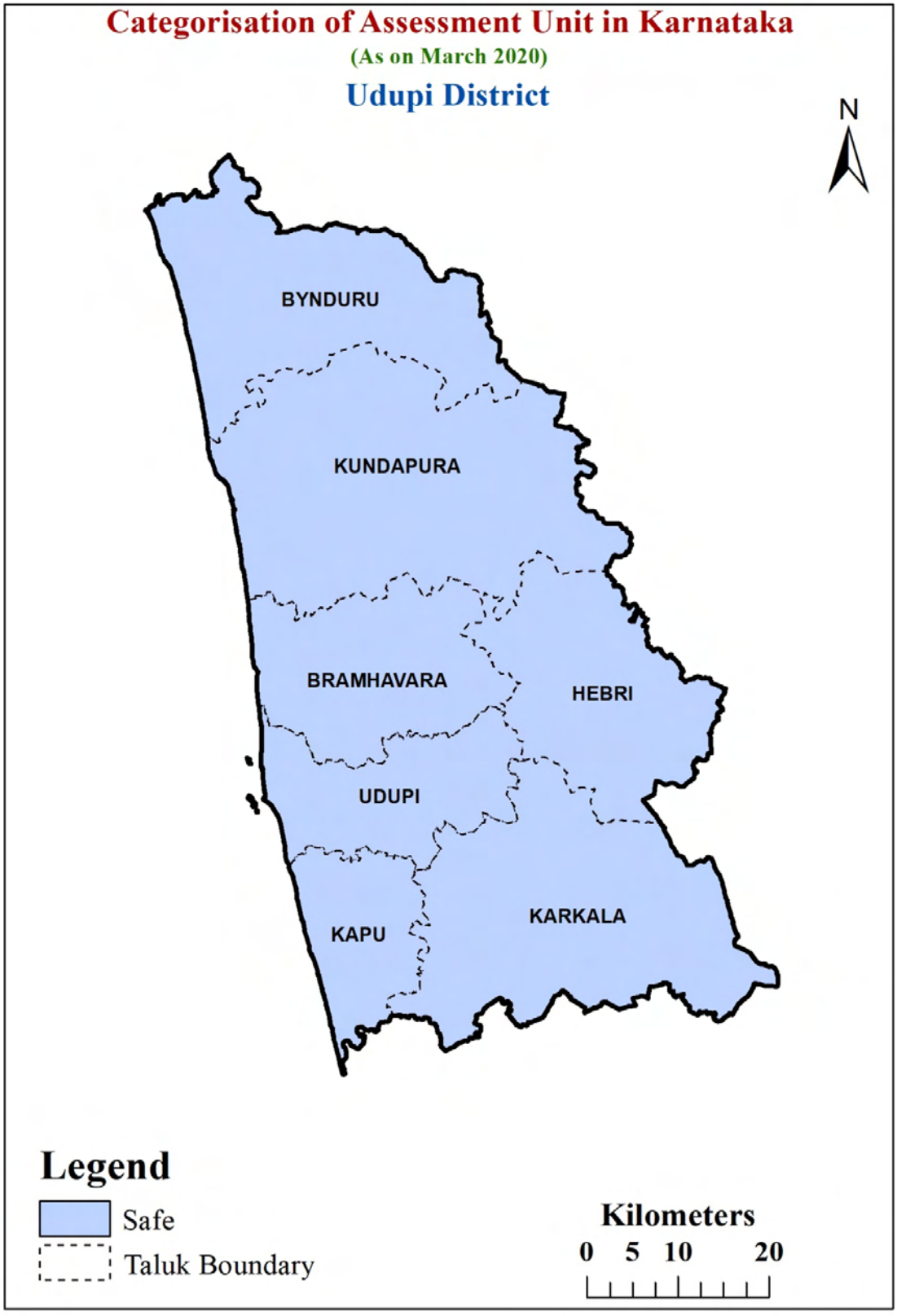

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Udupi District
N
BYNDURU
KUNDAPURA
BRAMHAVARA
HEBRI
UDUPI
KARKALA
KAPU
Legend
Safe
Taluk Boundary
Kilometers
0 5 10 20

Plate-38

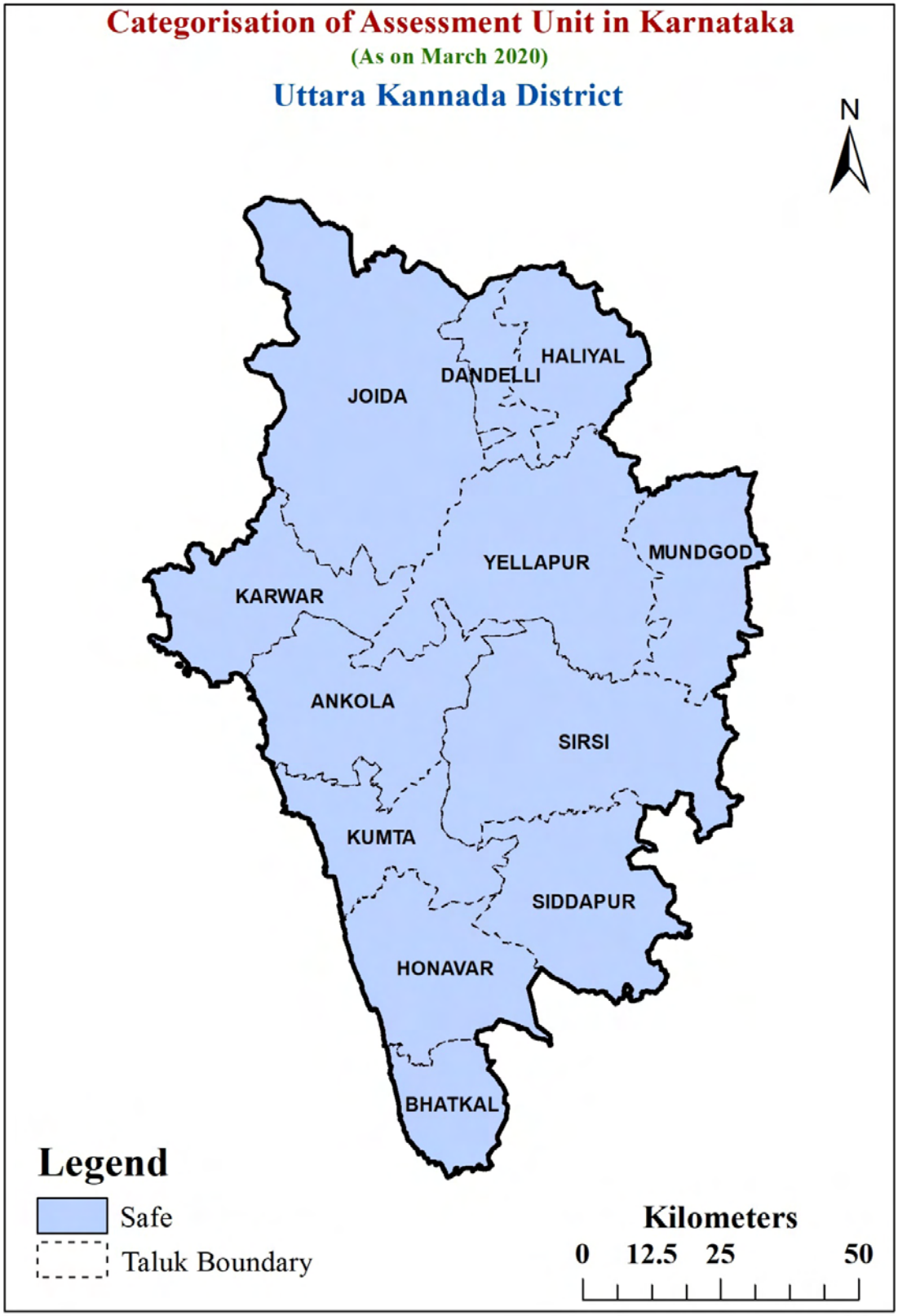

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Uttara Kannada District
N
HALIYAL
DANDELLI
JOIDA
YELLAPUR
MUNDGOD
KARWAR
ANKOLA
SIRSI
KUMTA
SIDDAPUR
HONAVAR
BHATKAL
Legend
Safe
Taluk Boundary
Kilometers
0 12.5 25 50

Plate-39

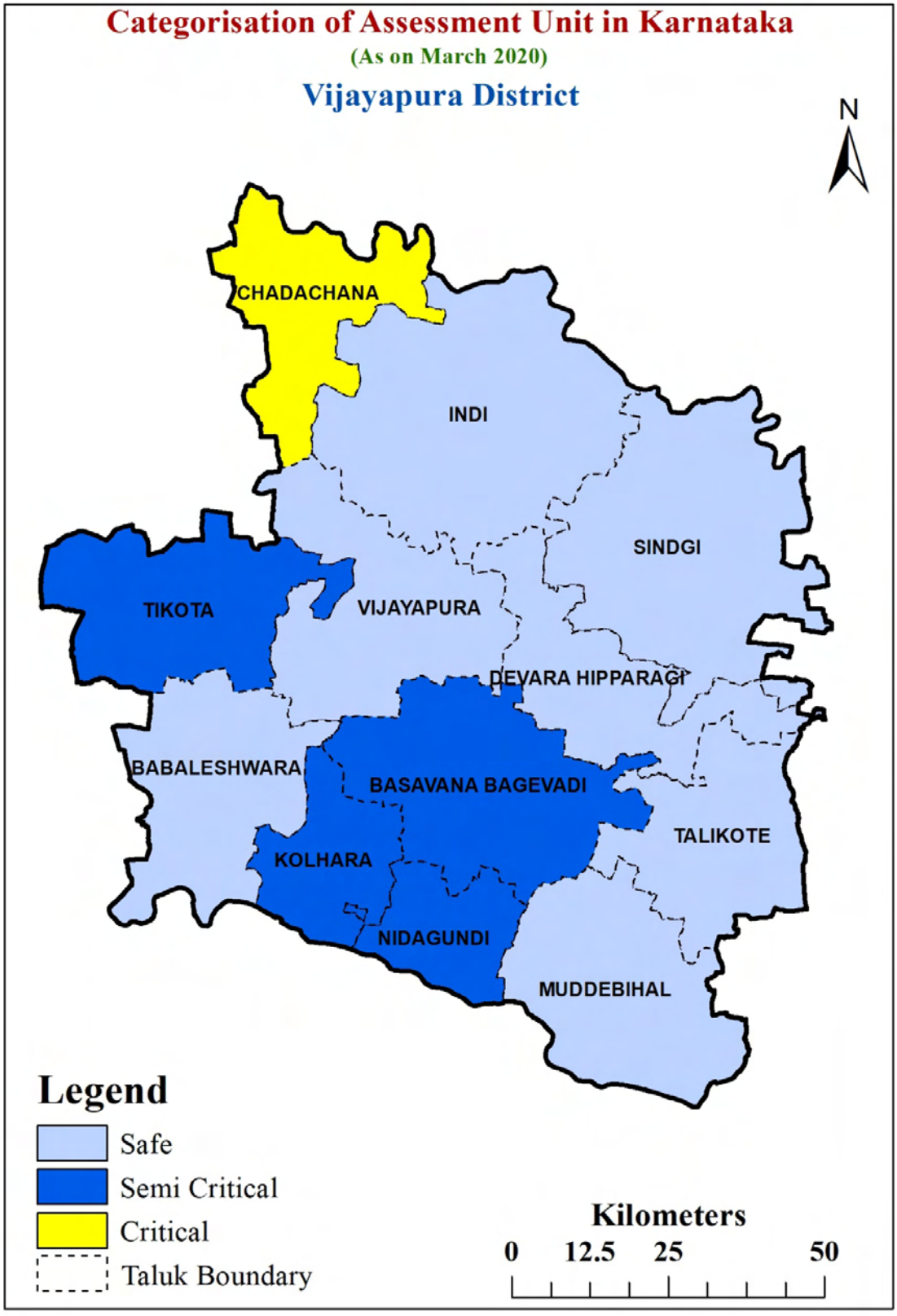
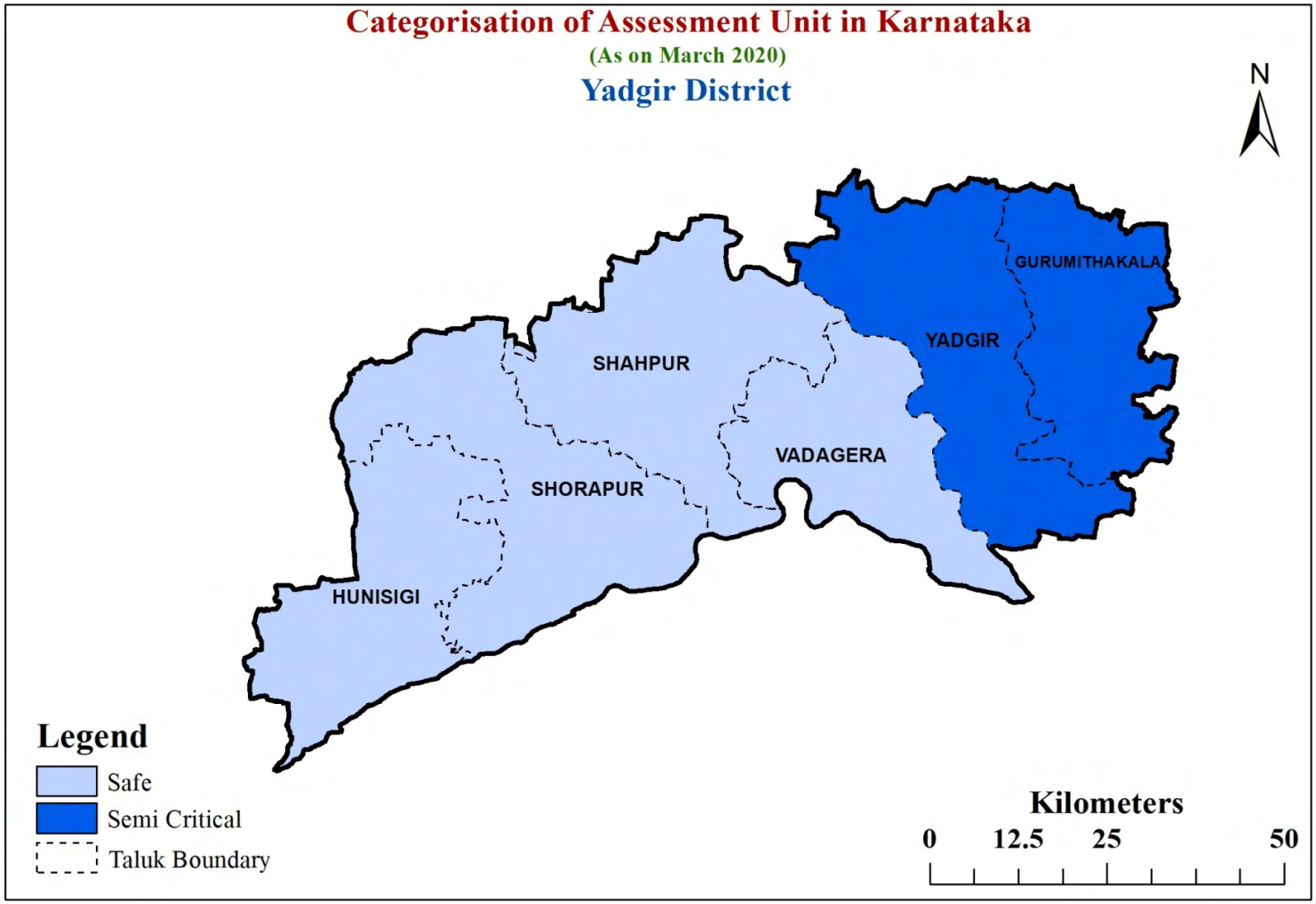

Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Vijayapura District
N
CHADACHANA
INDI
SINDGI
TIKOTA
VIJAYAPURA
DEVARA HIPPARAGI
BABALESHWARA
BASAVANA BAGEVADI
TALIKOTE
KOLHARA
NIDAGUNDI
MUDDEBIHAL
Legend
Safe
Semi Critical
Critical
Taluk Boundary
Kilometers
0 12.5 25 50

Plate-40


Categorisation of Assessment Unit in Karnataka
(As on March 2020)
Yadgir District
N
GURUMITHAKALA
YADGIR
SHAHPUR
VADAGERA
SHORAPUR
HUNISIGI
Legend
Safe
Semi Critical
Taluk Boundary
Kilometers
0
12.5
25
50

ANNEXURES

Annexure –I

Karnataka State Ground Water Resources Availability, Utilization and Stage of Extraction (as in 2020)

KARNATAKA STATE GROUND WATER RESOURCES OF INDIA, 2020 (in bcm)															
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 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	KARNATAKA	7.47	4.68	2.23	3.77	18.16	1.76	16.4	9.6	0	1.03	10.6	1.16	7.08	65

NOTE-Data on Ground Water Extraction for Industries is not available for Karnataka.

Annexure – II

DISTRICT WISE DYNAMIC GROUND WATER RESOURCES OF KARNATAKA STATE, 2020 (in Ham)

NAME OF STATE/UT - KARNATAKA STATE

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 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	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	12	13	14	15	16
1	BAGALKOT	11256.28	23990.18	5180.34	17354.82	57781.62	5723.09	52058.53	44546.20	3639.62	48185.81	3951.62	10148.48	93
2	BANGALORE RUR	6678.59	4177.63	4317.25	5173.38	20346.86	2015.49	18331.37	23679.34	1503.34	25182.69	1708.06	109.46	137
3	BANGALORE URB	4817.08	3762.47	3937.49	5107.21	17624.25	1762.43	15861.82	20573.93	1419.28	21993.21	1660.57	0.00	139
4	BELAGAVI	35987.75	37053.45	9641.96	22906.21	105589.36	9827.61	95761.75	60554.28	10641.69	71196.03	11510.24	31997.84	74
5	BELLARY	28358.71	21609.76	14524.66	15676.57	80169.70	7924.14	72245.56	39073.80	4348.48	43422.29	4745.15	32328.11	60
6	BIDAR	17850.20	2710.99	3345.95	4799.20	28706.34	2823.24	25883.10	12085.64	1020.59	13106.23	1103.80	12743.18	51
7	CHAMRAJNAGARA	16245.80	7688.50	7032.93	5690.75	36657.98	3665.82	32992.17	30401.86	3105.32	33507.16	3905.17	2477.15	102
8	CHIKBALLAPUR	11565.99	12485.10	7245.30	9873.16	41169.55	4116.94	37052.61	50780.88	3078.11	53858.98	3380.96	931.09	145
9	CHIKKAMAGALUR	44545.60	11262.29	10605.56	7401.10	73814.55	7014.41	66800.14	29005.13	2433.69	31438.80	2536.88	37269.31	47
10	CHITRADURGA	20748.20	9938.17	11569.17	11209.87	53465.42	5346.54	48118.88	47814.49	4358.18	52172.63	4721.16	6321.08	108
11	DAKSHIN KANNA	51614.42	3116.15	4081.54	3700.14	62512.26	6251.23	56261.03	18006.33	3077.12	21083.45	3262.79	34991.90	37
12	DAVANGERE	15417.44	13708.20	8161.47	24507.25	61794.35	5346.10	56448.24	43499.13	2681.48	46180.61	2854.27	18362.85	82
13	DHARWAD	14789.86	4529.45	5388.84	3942.03	28650.19	2555.31	26094.88	12667.49	1517.53	14185.02	1622.57	11815.93	54
14	GADAG	9843.45	6903.38	4934.22	7870.45	29551.50	2955.15	26596.35	21115.12	1997.33	23112.46	2127.01	5145.29	87
15	HASSAN	24085.90	30482.39	10728.39	20321.81	85618.49	8289.73	77328.75	43953.75	3740.60	47694.35	4018.81	35182.21	62
16	HAVERI	19737.22	25156.04	7109.86	23180.26	75183.37	6528.22	68655.15	34441.91	2947.80	37389.70	3169.49	31809.26	54
17	KALBURAGI	35171.21	4441.39	8401.37	7729.27	55743.25	5574.30	50168.94	17963.83	4376.94	22340.77	4803.35	28605.98	45
18	KODAGU	27102.50	2810.88	6400.96	3444.82	39759.15	3713.60	36045.56	9372.64	1734.50	11107.16	2392.38	24280.51	31

DISTRICT WISE DYNAMIC GROUND WATER RESOURCES OF KARNATAKA STATE, 2020 (in Ham)

NAME OF STATE/UT - KARNATAKA STATE

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 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	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	12	13	14	15	16
1	BAGALKOT	11256.28	23990.18	5180.34	17354.82	57781.62	5723.09	52058.53	44546.20	3639.62	48185.81	3951.62	10148.48	93
2	BANGALORE RUR	6678.59	4177.63	4317.25	5173.38	20346.86	2015.49	18331.37	23679.34	1503.34	25182.69	1708.06	109.46	137
3	BANGALORE URB	4817.08	3762.47	3937.49	5107.21	17624.25	1762.43	15861.82	20573.93	1419.28	21993.21	1660.57	0.00	139
4	BELAGAVI	35987.75	37053.45	9641.96	22906.21	105589.36	9827.61	95761.75	60554.28	10641.69	71196.03	11510.24	31997.84	74
5	BELLARY	28358.71	21609.76	14524.66	15676.57	80169.70	7924.14	72245.56	39073.80	4348.48	43422.29	4745.15	32328.11	60
6	BIDAR	17850.20	2710.99	3345.95	4799.20	28706.34	2823.24	25883.10	12085.64	1020.59	13106.23	1103.80	12743.18	51
7	CHAMRAJNAGARA	16245.80	7688.50	7032.93	5690.75	36657.98	3665.82	32992.17	30401.86	3105.32	33507.16	3905.17	2477.15	102
8	CHIKBALLAPUR	11565.99	12485.10	7245.30	9873.16	41169.55	4116.94	37052.61	50780.88	3078.11	53858.98	3380.96	931.09	145
9	CHIKKAMAGALUR	44545.60	11262.29	10605.56	7401.10	73814.55	7014.41	66800.14	29005.13	2433.69	31438.80	2536.88	37269.31	47
10	CHITRADURGA	20748.20	9938.17	11569.17	11209.87	53465.42	5346.54	48118.88	47814.49	4358.18	52172.63	4721.16	6321.08	108
11	DAKSHIN KANNA	51614.42	3116.15	4081.54	3700.14	62512.26	6251.23	56261.03	18006.33	3077.12	21083.45	3262.79	34991.90	37
12	DAVANGERE	15417.44	13708.20	8161.47	24507.25	61794.35	5346.10	56448.24	43499.13	2681.48	46180.61	2854.27	18362.85	82
13	DHARWAD	14789.86	4529.45	5388.84	3942.03	28650.19	2555.31	26094.88	12667.49	1517.53	14185.02	1622.57	11815.93	54
14	GADAG	9843.45	6903.38	4934.22	7870.45	29551.50	2955.15	26596.35	21115.12	1997.33	23112.46	2127.01	5145.29	87
15	HASSAN	24085.90	30482.39	10728.39	20321.81	85618.49	8289.73	77328.75	43953.75	3740.60	47694.35	4018.81	35182.21	62
16	HAVERI	19737.22	25156.04	7109.86	23180.26	75183.37	6528.22	68655.15	34441.91	2947.80	37389.70	3169.49	31809.26	54
17	KALBURAGI	35171.21	4441.39	8401.37	7729.27	55743.25	5574.30	50168.94	17963.83	4376.94	22340.77	4803.35	28605.98	45
18	KODAGU	27102.50	2810.88	6400.96	3444.82	39759.15	3713.60	36045.56	9372.64	1734.50	11107.16	2392.38	24280.51	31

ANNEXURE -III

CATEGORIZATION OF TALUKAS IN KARNATAKA STATE (2020)											
S.No.	Total No. of Assessed Units	Safe		Semi-Critical		Critical		Over-Exploited		Saline	
		Nos.	%	Nos.	%	Nos.	%	Nos.	%	Nos.	%
1	227	130	57	35	15	10	4	52	23	0	0

NOTE-
Assesment Unit

Type-TALUK

DISTRICT WISE CATEGORIZATION OF TALUKAS IN KARNATAKA STATE (2020)

ANNEXURE -IV

NAME OF STATE/UT - KARNATAKA STATE

S.No	Name of District	Total No. Of Assessed Units	Safe		Semi-Critical		Critical		Over-Exploited		Saline			
			No.	%	No.	%	No.	%	No.	%	No.	%		
1	BAGALKOT	9	3	33.3	2	22.2	1	11.1	3	33.3	0	0		
2	BANGALORE RUR	4	0	0.0	0	0.0	0	0.0	4	100.0	0	0		
3	BANGALORE URB	5	0	0.0	0	0.0	0	0.0	5	100.0	0	0		
4	BELAGAVI	14	5	35.7	4	28.6	1	7.1	4	28.6	0	0		
5	BELLARY	11	7	63.6	1	9.1	0	0.0	3	27.3	0	0		
6	BIDAR	8	6	75.0	2	25.0	0	0.0	0	0.0	0	0		
7	CHAMRAJNAGARA	5	0	0.0	2	40.0	1	20.0	2	40.0	0	0		
8	CHIKBALLAPUR	6	0	0.0	0	0.0	0	0.0	6	100.0	0	0		
9	CHIKKAMAGALUR	8	6	75.0	0	0.0	0	0.0	2	25.0	0	0		
10	CHITRADURGA	6	1	16.7	0	0.0	0	0.0	5	83.3	0	0		
11	DAKSHIN KANNA	7	7	100.0	0	0.0	0	0.0	0	0.0	0	0		
12	DAVANGERE	6	1	16.7	2	33.3	1	16.7	2	33.3	0	0		
13	DHARWAD	8	8	100.0	0	0.0	0	0.0	0	0.0	0	0		
14	GADAG	7	1	14.3	3	42.9	1	14.3	2	28.6	0	0		
15	HASSAN	8	6	75.0	0	0.0	1	12.5	1	12.5	0	0		
16	HAVERI	8	4	50.0	4	50.0	0	0.0	0	0.0	0	0		
17	KALBURAGI	11	10	90.9	1	9.1	0	0.0	0	0.0	0	0		
18	KODAGU	3	3	100.0	0	0.0	0	0.0	0	0.0	0	0		
19	KOLAR	6	0	0.0	0	0.0	0	0.0	6	100.0	0	0		
20	KOPPAL	7	4	57.1	2	28.6	0	0.0	1	14.3	0	0		
21	MANDYA	7	6	85.7	1	14.3	0	0.0	0	0.0	0	0		
22	MYSURU	8	7	87.5	1	12.5	0	0.0	0	0.0	0	0		
23	RAICHUR	7	5	71.4	2	28.6	0	0.0	0	0.0	0	0		
24	RAMANAGARAM	4	0	0.0	1	25.0	3	75.0	0	0.0	0	0		
25	SHIVAMOGGA	7	7	100.0	0	0.0	0	0.0	0	0.0	0	0		
26	TUMAKURU	10	3	30.0	1	10.0	0	0.0	6	60.0	0	0		
27	UDUPI	7	7	100.0	0	0.0	0	0.0	0	0.0	0	0		
28	UTTAR KANNADA	12	12	100.0	0	0.0	0	0.0	0	0.0	0	0		
29	VIJAYAPURA	12	7	58.3	4	33.3	1	8.3	0	0.0	0	0		
30	YADGIR	6	4	66.7	2	33.3	0	0.0	0	0.0	0	0		

ANNEXURE - V

TALUK WISE GROUND WATER RESOURCES OF KARNATAKA STATE - 2020

(in ham)

S. No.	Name of the District	Name of the Taluk	Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction			Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)	Categorization (Over-Exploite) dE/Critical/Semi critical/Safe/Saline
			Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge			Irrigation	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	17
1	BAGALKOT	BADAMI	1452.57	2150.79	680.64	1739.40	6023.40	602.35	5421.05	6209.65	668.15	6877.80	716.74	4.33	126.87	over_exploited
2	BAGALKOT	BAGALKOTE	1021.35	4447.62	524.74	4318.50	10312.22	1031.23	9280.99	11838.56	626.82	12465.38	669.17	29.71	134.31	over_exploited
3	BAGALKOT	BILGI	1413.68	664.10	620.86	918.25	3616.88	361.69	3255.20	1202.40	753.38	1955.78	830.49	1433.51	60.08	safe
4	BAGALKOT	GULEDAGUDDA	384.41	597.79	177.25	781.84	1941.28	194.13	1747.16	2086.37	41.41	2127.78	44.10	0.09	121.79	over_exploited
5	BAGALKOT	HUNGUND	1729.54	1362.81	800.74	2365.37	6258.47	625.85	5632.62	4364.91	60.11	4425.02	64.50	1656.01	78.56	semi_critical
6	BAGALKOT	ILKAL	1942.48	742.35	868.16	1661.34	5214.33	516.50	4697.83	2618.47	52.61	2671.08	57.70	2127.57	56.86	safe
7	BAGALKOT	JAMKHANDI	1233.11	2203.80	540.75	746.24	4723.89	472.10	4251.80	1823.59	475.65	2299.24	516.76	1948.37	54.08	safe
8	BAGALKOT	MUDHOL	1549.86	1678.13	733.87	3089.40	7051.25	672.13	6379.12	5732.88	580.48	6313.36	638.10	629.11	98.97	critical
9	BAGALKOT	RABAKAVI BANAHATTI	529.30	10142.79	233.34	1734.48	12639.90	1247.13	11392.76	8669.35	381.00	9050.35	414.06	2319.78	79.44	semi_critical
10	BANGALORE RUR	DEVENHALLI	2009.93	744.68	1257.38	1297.81	5309.80	530.98	4778.82	5660.55	429.16	6089.71	501.61	0.00	127.43	over_exploited
11	BANGALORE RUR	DODABALLAPUR	1741.83	1777.58	1041.65	1592.30	6153.36	615.34	5538.02	7556.60	355.92	7912.52	385.06	0.00	142.88	over_exploited
12	BANGALORE RUR	HOSKOTE	2068.53	978.42	1466.34	1589.48	6102.77	610.28	5492.49	7511.66	618.00	8129.66	711.23	0.00	148.01	over_exploited
13	BANGALORE RUR	NELAMANGALA	858.29	676.96	551.88	693.79	2780.93	258.89	2522.03	2950.54	100.26	3050.80	110.15	109.46	120.97	over_exploited
14	BANGALORE URB	ANEKAL	1083.89	543.90	999.58	906.53	3533.90	353.39	3180.51	4834.34	478.51	5312.85	552.02	0.00	167.04	over_exploited
15	BANGALORE URB	BENGALURU EAST	965.47	454.94	839.00	770.56	3029.97	303.00	2726.97	4004.96	388.42	4393.38	448.69	0.00	161.11	over_exploited
16	BANGALORE URB	BENGALURU NORTH	643.71	528.76	467.98	607.71	2248.16	224.82	2023.34	2808.70	123.27	2931.98	142.03	0.00	144.91	over_exploited
17	BANGALORE URB	BENGALURU SOUTH	918.70	1582.09	792.10	1892.77	5185.66	518.57	4667.09	4652.29	148.06	4800.35	191.67	0.00	102.86	over_exploited
18	BANGALORE URB	YELAHANKA	1205.31	652.78	838.83	929.65	3626.56	362.66	3263.91	4273.64	281.01	4554.64	326.16	0.00	139.55	over_exploited
19	BELAGAVI	ATHANI	1973.08	976.52	978.41	868.25	4796.25	474.29	4321.96	2469.14	1746.55	4215.71	1892.18	344.67	97.54	critical
20	BELAGAVI	BAILAHONGAL	1685.97	1277.24	675.72	1583.00	5221.94	420.35	4801.58	5374.55	353.34	5727.90	381.89	890.50	119.29	over_exploited
21	BELAGAVI	BELAGAVI	3999.63	3870.25	698.05	1802.07	10370.00	1024.21	9345.79	4119.49	894.46	5013.95	965.92	4290.16	53.65	safe

TALUK WISE GROUND WATER RESOURCES OF KARNATAKA STATE - 2020

(in ham)

S. No.	Name of the District	Name of the Taluk	Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction			Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)	Categorization (Over-Exploite) dE/Critical/Semi critical/Safe/Saline
			Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge			Irrigation	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	17
22	BELAGAVI	CHIKODI	1428.38	6628.92	502.74	3087.68	11647.73	1103.75	10543.98	7387.32	1173.06	8560.39	1266.73	1946.74	81.19	semi_critical
23	BELAGAVI	GOKAK	1701.17	2434.64	684.19	1665.07	6485.07	615.99	5869.08	3545.00	1269.29	4814.30	1379.53	1611.89	82.03	semi_critical
24	BELAGAVI	HUKKERI	2136.66	7082.41	888.91	3691.52	13799.50	1259.54	12539.96	7947.54	1237.69	9185.24	1338.43	3257.14	73.25	semi_critical
25	BELAGAVI	KAGAVADA	589.35	177.93	235.78	203.45	1206.51	120.66	1085.85	1129.80	167.21	1297.01	181.02	0.85	119.45	over_exploited
26	BELAGAVI	KHANAPUR	12015.43	930.21	793.15	51.27	13790.06	1375.98	12414.08	1022.69	425.83	1448.52	457.41	10933.98	11.67	safe
27	BELAGAVI	KITTHURU	2015.37	342.03	327.45	184.19	2869.04	245.86	2623.18	988.52	117.08	1105.61	126.00	1605.38	42.15	safe
28	BELAGAVI	MUDALAGI	732.21	989.29	434.75	2083.09	4239.34	372.94	3866.40	2518.55	213.79	2732.34	234.43	1163.62	70.67	semi_critical
29	BELAGAVI	NIPPANI	1115.50	6281.30	364.27	810.46	8571.53	822.51	7749.01	4164.48	979.80	5144.28	1051.10	2567.79	66.39	safe
30	BELAGAVI	RAMDURG	2100.77	2465.36	1019.23	3085.46	8670.83	814.53	7856.29	7968.55	676.91	8645.46	730.23	415.91	110.05	over_exploited
31	BELAGAVI	RAYBAG	1369.06	911.70	546.91	406.25	3233.91	278.21	2955.70	1010.95	610.13	1621.08	667.42	1305.55	54.85	safe
32	BELAGAVI	SAUNDATTI	3125.18	2685.64	1492.39	3384.46	10687.67	898.77	9788.89	10907.70	776.53	11684.24	837.93	1663.65	119.36	over_exploited
33	BELLARY	BALLARI	2069.45	3013.23	1107.66	1931.84	8122.18	812.22	7309.97	3849.33	188.91	4038.24	204.64	3332.21	55.24	safe
34	BELLARY	H.B.HALLI	2822.78	890.11	1366.44	966.39	6045.72	604.57	5441.15	5298.43	400.20	5698.63	445.71	718.77	104.73	over_exploited
35	BELLARY	HADAGALLI	2520.97	3055.44	1597.02	2428.29	9601.72	960.17	8641.55	5960.28	636.79	6597.08	715.24	2515.73	76.34	semi_critical
36	BELLARY	HARAPANAHALLI	3030.57	1210.90	1687.77	1921.34	7850.57	785.06	7065.52	8099.11	638.35	8737.46	710.58	203.89	123.66	over_exploited
37	BELLARY	HOSAPETE	2861.09	2073.36	1196.64	1553.90	7684.99	718.45	6966.54	2652.11	624.47	3276.58	661.83	3653.21	47.03	safe
38	BELLARY	KAMPLI	1126.21	2770.27	532.83	1244.34	5673.64	567.36	5106.28	1216.41	324.79	1541.20	348.78	3541.09	30.18	safe
39	BELLARY	KOTTURU	1561.25	509.21	744.78	509.56	3324.81	332.48	2992.33	2850.44	189.78	3040.22	213.17	80.05	101.60	over_exploited
40	BELLARY	KUDLIGI	3621.25	425.25	2133.05	485.12	6664.66	666.46	5998.20	2710.58	126.40	2836.98	141.05	3284.93	47.30	safe
41	BELLARY	KURUGODU	1152.26	2420.54	598.94	1137.65	5309.40	530.94	4778.46	915.04	186.32	1101.36	200.10	3673.20	23.05	safe
42	BELLARY	SANDUR	5101.69	1299.13	2252.57	1287.29	9940.68	951.30	8989.38	4155.25	614.96	4770.21	656.35	4183.34	53.06	safe
43	BELLARY	SIRUGUPPA	2491.18	3942.33	1306.95	2210.87	9951.33	995.13	8956.20	1366.82	417.50	1784.32	447.68	7141.70	19.92	safe
44	BIDAR	AURAD	2609.02	292.09	388.00	454.21	3743.33	374.33	3369.00	1107.68	153.42	1261.10	165.46	2095.86	37.43	safe

TALUK WISE GROUND WATER RESOURCES OF KARNATAKA STATE - 2020

(in ham)

S. No.	Name of the District	Name of the Taluk	Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction			Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)	Categorization (Over-Exploite)dE/Critical/Semi critical/Safe/Saline
			Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge			Irrigation	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	17
45	BIDAR	BASAVAKALYAN	3194.74	326.31	625.06	618.15	4764.26	476.43	4287.83	1533.11	372.61	1905.71	404.99	2353.10	44.44	safe
46	BIDAR	BHALKI	3728.40	864.23	726.22	1458.31	6777.17	630.32	6146.84	4033.90	274.50	4308.41	295.81	1836.12	70.09	semi_critical
47	BIDAR	BIDAR	3789.40	393.17	773.94	641.20	5597.71	559.77	5037.94	1605.82	35.89	1641.71	38.68	3393.44	32.59	safe
48	BIDAR	CHITTAGUPPA	1472.41	256.38	286.29	405.76	2420.84	242.08	2178.76	853.99	45.65	899.64	49.48	1275.30	41.29	safe
49	BIDAR	HOMNABAD	1116.93	334.12	215.67	504.70	2171.42	217.14	1954.28	1249.80	19.82	1269.62	21.47	683.01	64.97	safe
50	BIDAR	HULASURU	706.56	120.44	140.81	207.89	1175.71	117.57	1058.14	683.06	118.53	801.59	127.73	274.50	75.75	semi_critical
51	BIDAR	KAMALANAGARA	1232.74	124.26	189.94	508.97	2055.91	205.60	1850.31	1018.29	0.16	1018.45	0.17	831.85	55.04	safe
52	CHAMRAJNAGARA	CHAMRAJNAGARA	5572.66	2596.13	2198.13	2069.86	12436.78	1243.68	11193.10	10844.71	982.07	11826.78	1269.28	351.87	105.66	over_exploited
53	CHAMRAJNAGARA	GUNDLUPET	4153.42	896.18	1487.96	1509.68	8047.25	804.73	7242.52	7775.50	1007.12	8782.62	1373.70	262.02	121.26	over_exploited
54	CHAMRAJNAGARA	KOLLEGAL	1442.67	1816.37	1220.57	608.09	5087.70	508.77	4578.93	3404.31	349.78	3754.08	388.31	786.32	81.99	semi_critical
55	CHAMRAJNAGARA	KOLLEGALA(HANUR)	3883.79	1063.52	1762.91	1017.35	7727.58	772.77	6954.80	5665.32	577.70	6243.00	637.91	1002.13	89.77	semi_critical
56	CHAMRAJNAGARA	YELANDUR	1193.24	1316.30	363.37	485.77	3358.68	335.87	3022.81	2712.03	188.65	2900.68	235.98	74.81	95.96	critical
57	CHIKBALLAPUR	BAGEPALLI	2676.95	2467.51	1666.51	1473.31	8284.28	828.42	7455.86	7775.59	331.91	8107.50	363.35	931.09	108.74	over_exploited
58	CHIKBALLAPUR	CHIKBALLAPUR	2078.19	1402.36	1262.69	1519.17	6262.40	626.24	5636.16	7516.12	488.24	8004.35	551.10	0.00	142.02	over_exploited
59	CHIKBALLAPUR	CHINTAMANI	2282.56	3311.19	1573.26	2717.13	9884.13	988.41	8895.72	13646.38	640.72	14287.10	697.04	0.00	160.61	over_exploited
60	CHIKBALLAPUR	GAURIBIDALUR	2209.88	3168.10	1241.29	2195.05	8814.31	881.43	7932.88	12323.73	1064.24	13387.97	1146.17	0.00	168.77	over_exploited
61	CHIKBALLAPUR	GUDIBANDA	120.06	172.12	67.44	119.26	478.89	47.89	431.00	669.56	57.82	727.38	62.27	0.00	168.77	over_exploited
62	CHIKBALLAPUR	SIDLAGHATA	2198.35	1963.83	1434.13	1849.25	7445.55	744.55	6701.00	8849.50	495.17	9344.68	561.03	0.00	139.45	over_exploited
63	CHIKKAMAGALUR	AJJAMPURA	1655.07	870.74	1172.31	985.22	4683.34	468.33	4215.01	5456.91	143.36	5600.27	151.49	0.45	132.86	over_exploited
64	CHIKKAMAGALUR	CHIKKAMAGALURU	7366.84	2104.34	2493.55	979.05	12943.78	1160.81	11782.96	4731.25	458.72	5189.97	477.49	6664.50	44.05	safe
65	CHIKKAMAGALUR	KADUR	3462.58	2167.53	2858.56	1697.06	10185.73	1018.57	9167.16	8953.84	507.10	9460.94	535.24	66.78	103.20	over_exploited
66	CHIKKAMAGALUR	KOPPA	7377.29	682.57	423.28	257.77	8740.92	874.09	7866.83	839.60	148.38	987.98	154.17	6873.05	12.56	safe

TALUK WISE GROUND WATER RESOURCES OF KARNATAKA STATE - 2020

(in ham)

S. No.	Name of the District	Name of the Taluk	Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction			Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)	Categorization (Over-Exploite) dE/Critical/Semi critical/Safe/Saline
			Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge			Irrigation	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	17
67	CHIKKAMAGALUR	MUDIGERE	9025.87	910.21	990.14	301.84	11228.06	1020.34	10207.72	1022.36	335.36	1357.71	352.20	8833.16	13.30	safe
68	CHIKKAMAGALUR	N R PURA	5953.86	822.77	798.84	269.33	7844.80	677.23	7167.57	1029.48	188.35	1217.83	197.11	5944.07	16.99	safe
69	CHIKKAMAGALUR	SRINGERI	5849.24	486.60	380.28	185.12	6901.24	690.13	6211.11	604.17	104.53	708.69	110.06	5496.89	11.41	safe
70	CHIKKAMAGALUR	TARIKERE	3854.84	3217.52	1488.60	2725.72	11286.68	1104.90	10181.78	6367.52	547.90	6915.42	559.12	3390.40	67.92	safe
71	CHITRADURGA	CHALLAKERE	5070.78	1695.87	1806.94	2012.25	10585.84	1058.58	9527.26	9258.21	891.83	10150.02	959.00	896.32	106.54	over_exploited
72	CHITRADURGA	CHITRADURGA	3231.14	852.67	1701.67	1422.75	7208.23	720.82	6487.41	6459.31	675.01	7134.32	726.85	61.62	109.97	over_exploited
73	CHITRADURGA	HIRIYUR	3227.47	2461.79	2141.51	2278.28	10109.05	1010.91	9098.14	11252.43	786.40	12038.83	844.85	313.66	132.32	over_exploited
74	CHITRADURGA	HOLALKERE	3438.29	1196.09	1839.22	2075.48	8549.08	854.91	7694.17	10679.57	532.06	11211.63	567.68	26.45	145.72	over_exploited
75	CHITRADURGA	HOSADURGA	3320.61	1460.20	2593.90	1676.60	9051.31	905.13	8146.18	8913.34	500.53	9413.87	534.05	83.82	115.56	over_exploited
76	CHITRADURGA	MOLAKALMURU	2459.93	2271.55	1485.93	1744.50	7961.90	796.19	7165.71	1251.62	972.34	2223.96	1088.73	4939.20	31.04	safe
77	DAKSHIN KANNA	BANTVAL	9660.52	708.94	739.10	837.26	11945.82	1194.58	10751.24	4423.18	673.41	5096.58	713.80	5614.27	47.40	safe
78	DAKSHIN KANNA	BELTHANGADI	11854.47	1211.64	950.22	1396.09	15412.42	1541.25	13871.17	5717.85	760.78	6478.63	806.40	7346.91	46.71	safe
79	DAKSHIN KANNA	KADABA	5418.68	253.62	437.63	291.78	6401.71	640.17	5761.54	1448.52	281.48	1730.00	298.36	4014.65	30.03	safe
80	DAKSHIN KANNA	MANGALURU	9284.73	396.22	686.06	466.47	10833.48	1083.35	9750.13	2545.49	687.45	3232.94	728.68	6475.96	33.16	safe
81	DAKSHIN KANNA	MUDABIDRI	5198.18	165.50	385.57	191.87	5941.13	594.11	5347.02	1069.08	379.71	1448.79	402.48	3875.46	27.10	safe
82	DAKSHIN KANNA	PUTTUR	3631.89	197.97	315.43	225.97	4371.27	437.13	3934.14	1108.40	184.11	1292.51	195.22	2630.52	32.85	safe
83	DAKSHIN KANNA	SULYA	6565.95	182.26	567.52	290.70	7606.43	760.64	6845.79	1693.81	110.19	1804.00	117.85	5034.13	26.35	safe
84	DAVANGERE	CHANNAGIRI	4022.88	2085.97	2020.03	3259.34	11388.22	1138.82	10249.40	13856.30	606.97	14463.27	640.32	194.94	141.11	over_exploited
85	DAVANGERE	DAVANGERE	2202.45	2704.15	1237.75	3130.32	9274.68	927.47	8347.21	7584.00	676.49	8260.49	735.62	2005.52	98.96	critical
86	DAVANGERE	HARIHAR	3812.01	4147.76	1950.43	13229.35	23139.56	1480.62	21658.93	9039.67	647.27	9686.94	693.32	12909.17	44.72	safe
87	DAVANGERE	HONNALLI	1463.15	2381.12	754.63	2457.87	7056.77	705.68	6351.10	4379.77	364.95	4744.72	374.48	1790.49	74.71	semi_critical
88	DAVANGERE	JAGALUR	2282.56	595.01	1537.95	1100.84	5516.36	551.63	4964.72	5358.68	234.43	5593.11	251.65	25.43	112.66	over_exploited
89	DAVANGERE	NYAMATI	1634.38	1794.19	660.67	1329.53	5418.76	541.88	4876.88	3280.70	151.37	3432.08	158.88	1437.30	70.37	semi_critical
90	DHARWAD	ALNAVARA	719.79	0.24	107.35	0.24	827.61	82.76	744.85	491.56	9.88	501.44	10.53	242.77	67.32	safe

TALUK WISE GROUND WATER RESOURCES OF KARNATAKA STATE - 2020

(in ham)

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			Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge			Irrigation	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	17
91	DHARWAD	ANNIGERI	877.74	642.91	420.24	728.26	2669.15	236.52	2432.64	1447.75	244.53	1692.28	261.53	734.18	69.57	safe
92	DHARWAD	DHARWAD	3433.37	1278.57	1289.84	1031.64	7033.42	481.95	6551.47	3226.79	152.82	3379.61	163.00	3161.98	51.59	safe
93	DHARWAD	HUBBALLI	586.86	197.25	204.61	125.96	1114.69	111.47	1003.22	427.37	39.58	466.96	42.12	533.73	46.55	safe
94	DHARWAD	HUBLI	1755.92	652.91	694.83	539.54	3643.20	357.64	3285.56	1425.68	275.03	1700.72	295.70	1564.18	51.76	safe
95	DHARWAD	KALGHATGI	3063.22	561.22	743.03	212.83	4580.30	458.03	4122.27	1818.39	112.67	1931.06	119.44	2184.44	46.84	safe
96	DHARWAD	KUNDAGOL	1753.82	754.17	786.14	821.51	4115.62	392.83	3722.79	1797.51	183.65	1981.15	196.29	1729.00	53.22	safe
97	DHARWAD	NAVALGUND	2599.15	442.18	1142.81	482.06	4666.20	434.12	4232.08	2032.44	499.38	2531.82	533.97	1665.67	59.82	safe
98	GADAG	GADAG	1924.46	2009.37	901.49	2513.98	7349.29	734.93	6614.36	5750.08	543.42	6293.50	578.40	793.72	95.15	critical
99	GADAG	GANJENDRAGAD	779.16	250.13	305.42	570.70	1905.41	190.54	1714.87	2241.01	120.30	2361.32	130.21	11.31	137.70	over_exploited
100	GADAG	LAXMESHWAR	1337.42	552.28	661.08	465.51	3016.30	301.63	2714.67	1440.79	188.43	1629.22	199.87	1074.01	60.02	safe
101	GADAG	MUNDARGI	2059.75	3235.23	1278.23	3093.94	9667.16	966.71	8700.45	6380.97	355.43	6736.40	376.57	1944.42	77.43	semi_critical
102	GADAG	NARGUND	655.30	188.36	323.40	268.12	1435.17	143.52	1291.66	860.95	184.33	1045.27	197.32	320.68	80.93	semi_critical
103	GADAG	RON	1471.73	335.72	637.95	617.70	3063.11	306.31	2756.80	2731.87	337.39	3069.26	360.62	191.06	111.33	over_exploited
104	GADAG	SHIRHATTI	1615.63	332.28	826.66	340.49	3115.06	311.51	2803.55	1709.45	268.03	1977.49	284.01	810.08	70.54	semi_critical
105	HASSAN	ALUR	1339.61	1919.13	622.38	724.40	4605.53	424.18	4181.34	1135.46	151.92	1287.39	153.83	2892.05	30.79	safe
106	HASSAN	ARKALGUD	3631.12	5681.19	901.65	2248.58	12462.53	1189.84	11272.69	3062.72	435.57	3498.29	529.39	7902.41	31.03	safe
107	HASSAN	ARSIKERE	3710.78	2017.33	2909.05	2336.53	10973.69	1097.37	9876.32	10682.34	632.84	11315.18	669.30	75.53	114.57	over_exploited
108	HASSAN	BELUR	2489.32	2194.27	1550.82	1104.84	7339.25	709.40	6629.85	3902.20	304.05	4206.25	308.91	2636.23	63.44	safe
109	HASSAN	C R PATNA	3217.01	6444.14	1275.30	4937.00	15873.45	1587.35	14286.10	12250.71	693.21	12943.92	755.13	3726.07	90.61	critical
110	HASSAN	HASSAN	2567.11	6199.42	1805.42	4583.26	15155.21	1515.52	13639.69	6285.86	704.29	6990.15	719.21	7128.35	51.25	safe
111	HASSAN	HOLENARSIPUR	1459.36	5146.62	949.15	4155.34	11710.46	1171.05	10539.42	5543.97	515.38	6059.35	566.16	5325.57	57.49	safe
112	HASSAN	SAKLESHPUR	5671.59	880.29	714.62	231.86	7498.37	595.03	6903.35	1090.47	303.35	1393.82	316.87	5495.99	20.19	safe
113	HAVERI	BYADGI	1535.37	1154.38	615.24	1725.07	5030.05	503.01	4527.05	3225.31	253.99	3479.30	273.89	1036.39	76.86	semi_critical
114	HAVERI	HANGAL	4422.24	11997.72	1159.68	5993.52	23573.16	2028.81	21544.35	6731.85	799.47	7531.32	861.91	13950.59	34.96	safe

TALUK WISE GROUND WATER RESOURCES OF KARNATAKA STATE - 2020

(in ham)

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			Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge			Irrigation	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	17
115	HAVERI	HAVERI	3093.99	2311.03	1191.26	3022.62	9618.89	961.77	8657.12	5182.34	431.82	5614.16	466.19	3036.31	64.85	safe
116	HAVERI	HIREKERUR	1275.64	1361.27	399.31	651.48	3687.70	368.77	3318.93	2678.67	242.03	2920.70	256.65	576.52	88.00	semi_critical
117	HAVERI	RANIBENNUR	2753.14	3933.86	1465.36	7214.38	15366.74	1309.40	14057.34	9744.60	744.93	10489.52	803.71	3806.75	74.62	semi_critical
118	HAVERI	RATTEEHALLI	984.27	1887.13	476.26	1097.74	4445.39	444.54	4000.85	3221.61	226.47	3448.08	239.10	778.75	86.18	semi_critical
119	HAVERI	SAVANNUR	2662.63	1696.39	931.49	1916.61	7207.12	527.51	6679.61	2014.56	121.45	2136.00	130.39	4534.67	31.98	safe
120	HAVERI	SHIGGAON	3009.94	814.26	871.26	1558.86	6254.32	384.41	5869.90	1642.97	127.65	1770.62	137.65	4089.29	30.16	safe
121	KALBURAGI	AFZALPUR	5976.39	858.28	1411.61	1791.15	10037.43	1003.73	9033.70	5849.70	612.92	6462.63	680.55	3258.63	71.54	semi_critical
122	KALBURAGI	ALAND	7810.47	781.38	1760.32	1615.12	11967.28	1196.73	10770.56	5176.73	672.78	5849.51	741.73	5278.12	54.31	safe
123	KALBURAGI	CHINCHOLI	4513.73	333.83	929.59	708.06	6485.21	648.52	5836.69	1415.14	505.32	1920.45	546.26	3875.30	32.90	safe
124	KALBURAGI	CHITHAPUR	1659.61	385.99	425.33	412.43	2883.36	288.34	2595.02	1219.58	474.09	1693.67	514.90	860.54	65.27	safe
125	KALBURAGI	JEVARGI	4363.12	394.35	1194.91	714.82	6667.20	666.72	6000.48	385.81	150.78	536.59	170.00	5467.68	8.94	safe
126	KALBURAGI	KALABURAGI	2314.01	422.29	556.94	804.93	4098.18	409.82	3688.36	1912.32	545.33	2457.64	600.41	1175.64	66.63	safe
127	KALBURAGI	KALAGI	1731.41	132.92	362.59	178.18	2405.10	240.51	2164.59	436.42	381.49	817.91	415.97	1312.20	37.79	safe
128	KALBURAGI	KAMALAPURA	1944.26	157.73	385.87	286.26	2774.12	277.42	2496.71	588.62	370.06	958.68	403.02	1505.07	38.40	safe
129	KALBURAGI	SEDAM	2153.44	274.32	527.71	176.77	3132.25	313.22	2819.04	477.86	388.10	865.96	417.74	1923.44	30.72	safe
130	KALBURAGI	SHAHBADHA	339.36	55.50	90.13	65.04	550.03	55.00	495.03	182.78	95.17	277.95	103.43	208.82	56.15	safe
131	KALBURAGI	YADRAMI	2365.42	644.79	756.37	976.51	4743.08	474.31	4268.78	318.87	180.90	499.77	209.35	3740.55	11.71	safe
132	KODAGU	MADIKERI	12441.26	643.11	1562.89	934.22	15581.48	1409.16	14172.33	1877.33	564.32	2441.65	772.49	11522.50	17.23	safe
133	KODAGU	SOMVARPET	6565.76	805.11	1134.65	1093.72	9599.24	957.95	8641.28	1822.12	423.71	2245.84	554.24	6264.91	25.99	safe
134	KODAGU	VIRAJPET	8095.48	1362.65	3703.41	1416.88	14578.44	1346.49	13231.95	5673.20	746.47	6419.67	1065.65	6493.10	48.52	safe
135	KOLAR	BANGARPET	1534.46	1077.40	1112.14	1387.47	5111.47	511.15	4600.32	7646.14	597.59	8243.74	648.98	0.00	179.20	over_exploited
136	KOLAR	K.G.F	874.36	890.32	607.65	1334.52	3706.84	370.68	3336.16	5798.50	927.23	6725.72	1010.89	0.00	201.60	over_exploited
137	KOLAR	KOLAR	2314.55	2680.53	1577.34	3233.92	9806.33	980.63	8825.69	15282.94	1031.22	16314.16	1121.08	0.00	184.85	over_exploited
138	KOLAR	MALUR	1861.85	1156.65	1438.69	1545.80	6002.98	600.30	5402.68	8787.58	605.52	9393.11	670.50	0.00	173.86	over_exploited

TALUK WISE GROUND WATER RESOURCES OF KARNATAKA STATE - 2020

(in ham)

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139	KOLAR	MULBAGAL	2806.26	4137.43	1920.69	7025.52	15889.90	1589.00	14300.90	32338.52	1188.58	33527.11	1295.21	0.00	234.44	over_exploited
140	KOLAR	SRINIVASPUR	1110.69	1066.11	720.80	986.66	3884.25	388.43	3495.83	5516.52	187.54	5704.06	204.44	0.00	163.17	over_exploited
141	KOPPAL	GANGAWATI	605.79	6752.59	271.09	5354.88	12984.34	1298.43	11685.91	1272.83	304.89	1577.72	331.83	10083.46	13.50	safe
142	KOPPAL	KANAKAGIRI	1356.47	2461.72	546.29	3816.89	8181.37	818.13	7363.23	4835.41	352.42	5187.83	387.50	2321.68	70.46	semi_critical
143	KOPPAL	KARATAGI	1008.76	1651.21	402.85	1955.94	5018.77	501.87	4516.89	783.21	242.96	1026.18	269.43	3464.25	22.72	safe
144	KOPPAL	KOPPAL	3981.67	4435.86	1680.28	4552.93	14650.74	1465.07	13185.67	8033.71	513.49	8547.21	554.52	5015.79	64.82	safe
145	KOPPAL	KUKANURU	2095.26	863.18	744.71	1416.33	5119.49	511.95	4607.54	4666.76	59.03	4725.79	62.53	172.70	102.57	over_exploited
146	KOPPAL	KUSHTAGI	3473.79	3865.79	1614.77	6482.19	15436.54	1466.68	13969.86	7847.73	559.13	8406.86	641.12	5643.07	60.18	safe
147	KOPPAL	YELBARGA	2450.51	2101.66	888.97	3499.19	8940.33	882.38	8057.95	6550.40	223.57	6773.98	247.49	1668.64	84.07	semi_critical
148	MANDYA	KRISHNARAJPET	2496.49	4415.18	526.12	2293.45	9731.24	973.13	8758.12	2710.88	361.42	3072.30	399.45	5661.13	35.08	safe
149	MANDYA	MADDUR	1541.09	4618.02	977.89	1923.42	9060.42	906.04	8154.38	4040.45	452.85	4493.30	488.45	3625.49	55.10	safe
150	MANDYA	MALAVALLI	1550.19	10003.54	1643.44	5384.85	18582.01	1858.20	16723.81	11351.57	455.54	11807.11	512.56	5343.51	70.60	semi_critical
151	MANDYA	MANDYA	1480.46	9338.07	889.56	2762.15	14470.23	1447.02	13023.21	5374.03	803.35	6177.38	869.31	6779.87	47.43	safe
152	MANDYA	NAGAMANGALA	2884.68	16646.24	1175.31	4241.55	24947.79	2494.78	22453.00	13486.13	491.82	13977.95	567.01	8777.44	62.25	safe
153	MANDYA	PANDAVAPURA	1570.21	5306.69	367.40	1783.58	9027.88	902.79	8125.09	4263.20	785.96	5049.17	935.08	3393.99	62.14	safe
154	MANDYA	SHRIRANGAPATTANA	593.56	5401.99	512.75	1416.88	7925.19	792.52	7132.67	2828.84	394.05	3222.90	445.73	3858.09	45.19	safe
155	MYSURU	HEGGADADEVANKOTE	2850.10	1996.60	2584.39	1390.17	8821.27	655.52	8165.75	3261.89	652.24	3914.13	976.94	3926.92	47.93	safe
156	MYSURU	HUNSUR	5134.64	3860.42	2982.36	1036.66	13014.08	1182.48	11831.61	4751.14	603.02	5354.16	904.56	6175.91	45.25	safe
157	MYSURU	KRISHNRAJANAGARA	1226.34	10189.90	942.87	5171.37	17530.49	1753.05	15777.45	3289.89	583.03	3872.91	719.67	11897.25	24.55	safe
158	MYSURU	MYSURU	2431.84	1050.14	2325.82	519.45	6327.26	581.54	5745.71	2236.75	1861.31	4098.06	2928.90	1576.47	71.32	semi_critical
159	MYSURU	NANJANGUD	3535.02	5331.67	1446.40	1310.14	11623.22	1151.51	10471.70	3490.18	1667.63	5157.81	2418.13	4825.25	49.25	safe
160	MYSURU	PRIYAPATNA	4910.45	2612.06	1869.94	1513.34	10905.79	1090.58	9815.21	5079.03	620.61	5699.64	847.95	4449.71	58.07	safe
161	MYSURU	SARAGURU	478.93	664.25	372.53	373.83	1889.55	188.95	1700.59	388.86	147.27	536.12	176.23	1135.50	31.53	safe

TALUK WISE GROUND WATER RESOURCES OF KARNATAKA STATE - 2020

(in ham)

S. No.	Name of the District	Name of the Taluk	Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction			Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)	Categorization (Over-Exploite) dE/Critical/Semi critical/Safe/Saline
			Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge			Irrigation	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	17
162	MYSURU	TIRUMAKUDAL NARSIPUR	1425.59	5515.66	1403.91	1696.47	10041.63	1004.16	9037.47	4503.82	565.71	5069.53	710.98	4020.46	56.09	safe
163	RAICHUR	DEODRUG	2043.60	1157.58	650.00	1896.79	5747.98	574.80	5173.18	2573.09	439.65	3012.75	555.53	2049.16	58.24	safe
164	RAICHUR	LINGSUGUR	2430.98	529.74	1184.15	799.41	4944.28	458.92	4485.36	2593.85	508.46	3102.30	662.02	1246.14	69.17	safe
165	RAICHUR	MANVI	1620.02	3522.50	650.80	5702.10	11495.42	1105.46	10389.96	2238.60	353.70	2592.31	433.87	7717.49	24.95	safe
166	RAICHUR	MASKI	2149.50	1340.87	1128.33	2967.70	7586.39	731.20	6855.20	3035.76	696.75	3732.50	829.85	2989.59	54.45	safe
167	RAICHUR	RAICHUR	3264.67	1658.17	947.22	2709.60	8579.66	723.95	7855.71	5002.23	658.91	5661.15	788.07	2190.49	72.06	semi_critical
168	RAICHUR	SINDHNUR	2687.80	5492.77	1235.95	8457.82	17874.33	1787.43	16086.90	3067.08	571.74	3638.82	662.00	12357.81	22.62	safe
169	RAICHUR	SIRIVARA	1231.54	4037.24	556.91	6549.68	12375.37	1213.83	11161.55	7594.73	498.29	8093.01	588.54	2978.28	72.51	semi_critical
170	RAMANAGARAM	CHANNAPATANA	2258.76	1593.36	1631.92	2107.56	7591.60	759.16	6832.44	4914.24	316.49	5230.73	345.65	1572.56	76.56	semi_critical
171	RAMANAGARAM	KANAKAPURA	1931.97	7580.68	1656.58	6821.11	17990.34	1799.03	16191.31	14349.68	606.32	14956.00	755.25	1274.54	92.37	critical
172	RAMANAGARAM	MAGADI	2227.44	2372.24	1443.78	1767.53	7810.99	781.09	7029.89	5959.05	549.93	6508.98	602.66	733.63	92.59	critical
173	RAMANAGARAM	RANMANAGARA	1888.22	2163.13	1402.70	2880.23	8334.27	833.44	7500.84	6737.91	527.83	7265.74	1054.64	282.57	96.87	critical
174	SHIVAMOGGA	BHADRAVATI	3000.08	5001.61	1302.95	5160.53	14465.16	1445.79	13019.37	4537.22	945.22	5482.44	961.94	7562.43	42.11	safe
175	SHIVAMOGGA	HOSANAGARA	14675.91	746.35	480.42	322.66	16225.34	1622.53	14602.81	2522.90	383.23	2906.12	400.50	11679.41	19.90	safe
176	SHIVAMOGGA	SAGAR	18418.13	1470.18	529.84	598.04	21016.19	2101.62	18914.57	3877.43	476.16	4353.58	496.32	14541.30	23.02	safe
177	SHIVAMOGGA	SHIKARIPUR	3978.46	6215.94	985.68	1235.30	12415.39	1241.54	11173.85	5585.43	501.11	6086.55	526.68	5439.16	54.47	safe
178	SHIVAMOGGA	SHIVAMOGGA	5987.17	4709.70	1548.28	3343.43	15588.58	1558.86	14029.73	4143.62	430.20	4573.82	454.58	9431.65	32.60	safe
179	SHIVAMOGGA	SORAB	8162.46	4184.21	849.84	1634.62	14831.13	1440.16	13390.97	6613.28	677.03	7290.31	712.40	6107.12	54.44	safe
180	SHIVAMOGGA	TIRTHAHALLI	15646.45	2077.68	722.46	835.39	19281.98	1928.20	17353.78	3009.20	415.13	3424.33	426.70	13917.88	19.73	safe
181	TUMAKURU	CHICKNAYAKANHALLI	2957.37	1041.14	2119.18	1225.52	7343.20	734.32	6608.88	6440.05	530.69	6970.75	576.57	0.90	105.48	over_exploited
182	TUMAKURU	GUBBI	3446.24	2674.83	2367.68	1928.15	10416.90	963.48	9453.43	3880.12	446.72	4326.84	486.67	5427.19	45.77	safe
183	TUMAKURU	KORATAGERE	1757.06	916.70	1162.57	962.43	4798.76	469.41	4329.34	4552.28	411.96	4964.24	445.86	122.01	114.66	over_exploited
184	TUMAKURU	KUNIGAL	2789.22	4076.35	2141.60	1844.59	10851.76	1085.18	9766.58	5804.41	589.32	6393.73	644.21	3317.96	65.47	safe
185	TUMAKURU	MADHUGIRI	2850.40	2888.69	1893.49	1689.10	9321.67	932.17	8389.50	8367.73	692.61	9060.34	749.35	538.96	108.00	over_exploited

TALUK WISE GROUND WATER RESOURCES OF KARNATAKA STATE - 2020

(in ham)

S. No.	Name of the District	Name of the Taluk	Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction			Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)	Categorization (Over-Exploite) dE/Critical/Semi critical/Safe/Saline
			Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge			Irrigation	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	17
186	TUMAKURU	PAVAGADA	3545.10	463.93	2317.59	858.96	7185.57	718.55	6467.02	4652.04	587.72	5239.76	633.47	1330.14	81.02	semi_critical
187	TUMAKURU	SIRA	3114.72	4053.06	2258.48	1836.61	11262.88	1126.29	10136.59	9703.88	537.30	10241.18	577.63	1168.85	101.03	over_exploited
188	TUMAKURU	TIPTUR	1599.79	1436.42	1221.41	1254.79	5512.41	551.24	4961.17	5587.87	512.48	6100.35	558.28	538.72	122.96	over_exploited
189	TUMAKURU	TUMAKURU	3421.69	2751.56	2408.72	2813.67	11395.63	946.62	10449.01	11249.63	1081.34	12330.96	1183.78	3025.45	118.01	over_exploited
190	TUMAKURU	TURUVEKERE	1375.98	2846.88	1148.01	1174.55	6545.42	654.54	5890.88	3377.70	141.60	3519.30	156.59	2689.88	59.74	safe
191	UDUPI	BRAMHAVARA	7588.71	618.24	373.48	450.22	9030.65	903.07	8127.58	2378.06	347.33	2725.39	362.55	5386.97	33.53	safe
192	UDUPI	BYNDURU	5591.25	266.68	114.25	248.50	6220.69	622.07	5598.62	1317.71	281.91	1599.62	292.01	3988.90	28.57	safe
193	UDUPI	HEBRI	8693.72	550.95	487.37	398.47	10130.50	1013.05	9117.45	2109.68	463.52	2573.20	486.70	6521.08	28.22	safe
194	UDUPI	KAPU	4119.60	77.83	290.73	85.79	4573.94	457.39	4116.55	472.72	420.35	893.07	445.56	3198.27	21.69	safe
195	UDUPI	KARKAL	14721.71	401.95	1132.46	342.23	16598.35	1659.83	14938.51	1865.87	1237.46	3103.33	1311.67	11760.97	20.77	safe
196	UDUPI	KUNDAPURA	12308.27	455.35	217.27	323.39	13304.27	1330.42	11973.85	1704.01	476.87	2180.88	493.95	9775.89	18.21	safe
197	UDUPI	UDUPI	6449.85	181.62	503.71	144.83	7280.01	728.00	6552.01	786.11	531.03	1317.15	562.88	5203.02	20.10	safe
198	UTTAR KANNADA	ANKOLA	5932.67	3636.82	2.29	326.45	9898.22	989.82	8908.40	2846.36	586.23	3432.59	625.96	5436.07	38.53	safe
199	UTTAR KANNADA	BHATKAL	3747.00	145.49	90.51	127.65	4110.65	411.07	3699.59	642.46	157.29	799.75	162.93	2894.20	21.62	safe
200	UTTAR KANNADA	DANDELLI	1851.36	5.47	33.65	7.57	1898.04	189.80	1708.24	67.56	17.39	84.95	18.32	1622.36	4.97	safe
201	UTTAR KANNADA	HALIYAL	3666.63	3.17	393.95	3.12	4066.87	406.69	3660.18	1727.21	42.01	1769.21	44.66	1888.32	48.34	safe
202	UTTAR KANNADA	HONAVAR	6812.13	179.47	83.66	232.90	7308.15	730.82	6577.33	1285.02	185.26	1470.28	197.02	5095.30	22.35	safe
203	UTTAR KANNADA	KARVAR	2504.19	12227.54	7.57	1065.90	15805.21	1580.52	14224.69	3207.32	930.02	4137.34	1002.14	10015.22	29.09	safe
204	UTTAR KANNADA	KUMTA	4149.11	1067.09	11.42	720.84	5948.46	594.85	5353.61	834.05	157.06	991.11	161.77	4357.79	18.51	safe
205	UTTAR KANNADA	MUNDOG	4532.44	385.13	522.87	409.48	5849.91	528.40	5321.51	1114.05	103.86	1217.91	110.53	4096.93	22.89	safe
206	UTTAR KANNADA	SIDDAPUR	6958.34	1506.95	17.18	914.30	9396.77	939.68	8457.09	1515.07	249.65	1764.71	256.86	6685.17	20.87	safe
207	UTTAR KANNADA	SIRSI	10540.77	1339.21	286.75	873.58	13040.31	1260.15	11780.16	2363.03	335.93	2698.95	349.54	9067.59	22.91	safe
208	UTTAR KANNADA	SUPA	11858.35	1316.64	156.17	235.05	13566.21	1356.61	12209.59	1187.56	304.30	1491.86	323.13	10698.91	12.22	safe
209	UTTAR KANNADA	YELLAPUR	9493.45	1073.28	339.72	138.35	11044.79	1104.48	9940.30	2245.81	329.46	2575.26	350.00	7344.50	25.91	safe
210	VIJAYAPURA	BABALESHWARA	1688.62	130.76	714.91	207.65	2741.94	274.19	2467.75	958.00	159.75	1117.75	173.16	1396.22	45.29	safe

TALUK WISE GROUND WATER RESOURCES OF KARNATAKA STATE - 2020

(in ham)

S. No.	Name of the District	Name of the Taluk	Ground Water Recharge					Total Natural Discharges	Annual Extractable Ground Water Resource	Current Annual Ground Water Extraction			Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)	Categorization (Over-Exploite) dE/Critical/Semi critical/Safe/Saline
			Monsoon Season		Non-monsoon Season		Total Annual Ground Water Recharge			Irrigation	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	17
211	VIJAYAPURA	BASAVANA BAGEVADI	1930.80	277.94	1012.57	537.47	3758.78	375.88	3382.91	2117.80	334.88	2452.68	362.96	902.14	72.50	semi_critical
212	VIJAYAPURA	CHADACHANA	1682.49	841.86	517.27	1631.04	4672.67	467.24	4205.43	3540.77	416.30	3957.06	451.20	1160.61	94.09	critical
213	VIJAYAPURA	DEVARA HIPPARAGI	1327.39	338.78	561.52	469.30	2696.99	269.70	2427.29	999.86	204.08	1203.95	225.60	1233.71	49.60	safe
214	VIJAYAPURA	INDI	4563.10	2669.68	1455.49	4709.40	13397.67	1306.12	12091.55	6405.08	730.26	7135.35	791.50	4901.08	59.01	safe
215	VIJAYAPURA	KOLHARA	878.34	237.32	367.26	535.37	2018.29	201.83	1816.46	1438.38	177.36	1615.75	192.30	185.78	88.95	semi_critical
216	VIJAYAPURA	MUDDEBIHAL	1129.54	236.45	610.00	338.61	2314.60	231.46	2083.15	1046.88	378.58	1425.46	410.31	627.05	68.43	safe
217	VIJAYAPURA	NIDAGUNDI	810.03	292.36	341.26	554.65	1998.30	199.83	1798.47	1391.65	208.72	1600.37	226.21	181.26	88.99	semi_critical
218	VIJAYAPURA	SINDGI	1369.24	412.50	447.29	812.67	3041.70	304.17	2737.52	1519.64	268.24	1787.88	290.77	1139.31	65.31	safe
219	VIJAYAPURA	TALIKOTA	1146.33	478.89	610.80	444.33	2680.35	268.03	2412.31	1079.49	195.39	1274.88	213.92	1118.90	52.85	safe
220	VIJAYAPURA	TIKOTA	2602.11	417.90	1183.49	696.01	4899.52	347.35	4552.17	3500.38	270.03	3770.41	292.67	1100.19	82.83	semi_critical
221	VIJAYAPURA	VIJAYAPURA	3687.33	274.92	1361.60	454.80	5778.65	381.62	5397.03	1995.72	389.91	2385.63	422.61	2979.95	44.20	safe
222	YADGIR	GURUMITHAKALA	3179.38	1162.71	613.78	893.91	5849.79	584.98	5264.81	3636.68	338.92	3975.61	363.21	1264.92	75.51	semi_critical
223	YADGIR	HUNISIGI	1386.43	1601.63	587.10	2729.02	6304.18	630.42	5673.75	1292.15	496.88	1789.03	536.72	3845.01	31.53	safe
224	YADGIR	SHAHPUR	4546.33	2778.96	1146.41	3621.92	12093.62	1209.36	10884.26	1154.94	280.50	1435.44	301.18	9428.14	13.19	safe
225	YADGIR	SHORAPUR	2602.81	1880.53	920.50	2286.98	7690.82	769.08	6921.74	773.89	266.15	1040.04	292.86	5854.99	15.03	safe
226	YADGIR	VADAGERA	1379.40	1173.87	380.18	1102.51	4035.96	403.60	3632.37	433.08	130.04	563.12	139.61	3059.68	15.50	safe
227	YADGIR	YADGIR	4016.39	2514.64	776.10	1693.29	9000.41	900.04	8100.37	5370.95	598.15	5969.10	642.03	2087.38	73.69	semi_critical

ANNEXURE – VI

LIST OF OCS TALUKS IN KARNATAKA STATE, 2020							
S. No	**Name of District**	**S. No**	**Name of Semi-Critical Assessment Unit**	**S. No**	**Name of Critical Assessment Unit**	**S. No**	**Name of Over-Exploited Assessment Unit**
1	**BAGALKOT**	**1**	HUNGUND	**1**	MUDHOL	**1**	BADAMI
		2	RABAKAVI BANAHATTI	-	-	**2**	BAGALKOTE
		-	-			**3**	GULEDAGUDDA
2	**BANGALORE RUR**	-	-	-	-	**1**	DEVENHALLI
						2	DODABALLAPUR
						3	HOSKOTE
						4	NELAMANGALA
3	**BANGALORE URB**	-	-	-	-	**1**	ANEKAL
						2	BENGALURU EAST
						3	BENGALURU NORTH
						4	BENGALURU SOUTH
						5	YELAHANKA
4	**BELAGAVI**	**1**	CHIKODI	**1**	ATHANI	**1**	BAILAHONGAL
		2	GOKAK	-	-	**2**	KAGAVADA
		3	HUKKERI			**3**	RAMDURG
		4	MUDALAGI			**4**	SAUNDATTI
5	**BELLARY**	**1**	HADAGALLI	-	-	**1**	H.B.HALLI
		-	-			**2**	HARAPANAHALLI
						3	KOTTURU
6	**BIDAR**	**1**	BHALKI	-	-	-	-
		2	HULASURU				
7	**CHAMRAJNAGARA**	**1**	KOLLEGAL	**1**	YELANDUR	**1**	CHAMRAJNAGARA
		2	KOLLEGALA(HANUR)	-	-	**2**	GUNDLUPET

LIST OF OCS TALUKS IN KARNATAKA STATE, 2020							
S. No	Name of District	S. No	Name of Semi-Critical Assessment Unit	S. No	Name of Critical Assessment Unit	S. No	Name of Over-Exploited Assessment Unit
8	CHIKBALLAPUR	-	-	-	-	1	BAGEPALLI
						2	CHIKBALLAPUR
						3	CHINTAMANI
						4	GAURIBIDALUR
						5	GUDIBANDA
						6	SIDLAGHATA
9	CHIKKAMAGALUR	-	-	-	-	1	AJJAMPURA
						2	KADUR
10	CHITRADURGA	-	-	-	-	1	CHALLAKERE
						2	CHITRADURGA
						3	HIRIYUR
						4	HOLALKERE
						5	HOSADURGA
11	DAVANGERE	1	HONNALLI	1	DAVANGERE	1	CHANNAGIRI
		2	NYAMATI	-	-	2	JAGALUR
12	GADAG	1	MUNDARGI	1	GADAG	1	GAJENDRAGAD
		2	NARGUND	-	-	2	RON
		3	SHIRHATTI			-	-
13	HASSAN		-	1	C R PATNA	1	ARSIKERE
14	HAVERI	1	BYADGI	-	-	-	-
		2	HIREKERUR				
		3	RANIBENNUR				
		4	RATTEEHALLI				
15	KALBURAGI	1	AFZALPUR	-	-	-	-
16	KOLAR	-	-	-	-	1	BANGARPET
						2	K.G.F
						3	KOLAR
						4	MALUR
						5	MULBAGAL
						6	SRINIVASPUR
17	KOPPAL	1	KANAKAGIRI	-	-	1	KUKANURU

LIST OF OCS TALUKS IN KARNATAKA STATE, 2020							
S. No	**Name of District**	**S. No**	**Name of Semi-Critical Assessment Unit**	**S. No**	**Name of Critical Assessment Unit**	**S. No**	**Name of Over-Exploited Assessment Unit**
		2	YELBARGA			**-**	**-**
18	**MANDYA**	**1**	MALAVALLI	**-**	**-**	**-**	**-**
19	**MYSURU**	**1**	MYSURU	**-**	**-**	**-**	**-**
20	**RAICHUR**	**1**	RAICHUR	**-**	**-**	**-**	**-**
		2	SIRIVARA	**-**	**-**	**-**	**-**
21	**RAMANAGARAM**	**1**	CHANNAPATANA	**1**	KANAKAPURA	**-**	**-**
		-	**-**	**2**	MAGADI		
				3	RANMANAGARA		
22	**TUMAKURU**	**1**	PAVAGADA	**-**	**-**	**1**	CHICKNAYAKANHALLI
		-	**-**			**2**	KORATAGERE
						3	MADHUGIRI
						4	SIRA
						5	TIPTUR
						6	TUMAKURU
23	**VIJAYAPURA**	**1**	BASAVANA BAGEVADI	**1**	Chadachana	**-**	**-**
		2	KOLHARA	**-**	**-**		
		3	NIDAGUNDI				
		4	TIKOTA				
24	**YADGIR**	**1**	GURUMITHAKALA	**-**	**-**	**-**	**-**
		2	YADGIR				
ABSTRACT							
Total No. of Assessed Units		**Number of Semicritical Assessment Unit**		**Number of Critical Assessment Unit**		**Number of Over Exploited Assessment Unit**	
227		**35**		**10**		**52**	

ANNEXURE - VII

COMPARISON OF CATEGORIZATION OF ASSESSMENT UNITS (2020 AND 2017)									
STATE/UT NAME - KARNATAKA STATE									
S. No	**Name of District**	**Name of Assessment Unit**	**Stage of Ground Water Extraction (%) in 2017**	**Categorization in 2017**	**Name of District**	**Name of Assessment Unit**	**Stage of Ground Water Extraction (%) in 2020**	**Categorization in 2020**	**Remark**
Improved									
1	DHARWAD	KALGHATGI	75	semi_critical	DHARWAD	KALGHATGI	46.84	safe	**Improved**
2	GADAG	GADAG	101	over_exploited	GADAG	GADAG	95.15	critical	**Improved**
3	HAVERI	RANIBENNUR	92	critical	HAVERI	RANIBENNUR	74.62	semi_critical	**Improved**
4	RAMANAGARAM	KANAKAPURA	102	over_exploited	RAMANAGARAM	KANAKAPURA	92.37	critical	**Improved**
5	RAMANAGARAM	RANMANAGARA	105	over_exploited	RAMANAGARAM	RANMANAGARA	96.87	critical	**Improved**
6	UTTAR KANNADA	HALIYAL	74	semi_critical	UTTAR KANNADA	HALIYAL	48.34	safe	**Improved**
7	VIJAYAPURA	INDI	91	critical	VIJAYAPURA	INDI	59.01	safe	**Improved**
Deteriorated									
1	CHAMRAJNAGARA	CHAMRAJNAGARA	75	semi_critical	CHAMRAJNAGARA	CHAMRAJNAGARA	over_exploited	105.66	**Deteriorated**
2	KALBURAGI	AFZALPUR	40	safe	KALBURAGI	AFZALPUR	semi_critical	71.54	**Deteriorated**
3	TUMAKURU	SIRA	96	critical	TUMAKURU	SIRA	over_exploited	101.03	**Deteriorated**

Annexure-VIII

(TO BE PUBLISHED IN THE GAZETTE OF INDIA PART-I, SECTION -I)

Government of India
Ministry of JAL SHAKTI
Department of Water Resources, River Development & Ganga Rejuvenation
****

Shram Shakti Bhavan, Rafi Marg,
New Delhi, Dated: 15.06.2020

RESOLUTION

Sub: Constitution of Central Level Expert Group (CLEG) for overall re-assessment of ground water resources of the country as on 31 Mar 2020.

The last assessment of state-wise annual ground water recharge for the entire country has been made as on 31st March 2017 based on the methodology finalized byGround Water Resources Estimation Committee (GEC) - 2015. Since then there have been changes in ground water scenario in many places of the country and accordingly, a Central Level Expert Group (CLEG) is hereby constituted for over-all supervision of the re-assessment of ground water resources (as on 31st March 2020) in the entire country. The composition and terms of reference of the Expert Group are as follows:-

1. **Composition:**

S.No.	Names/Designation	Committee
1.	Chairman, CGWB	Chairman
2.	Member(RM),CWC	Member
3.	Member (WP & P), CWC or, representative	Member
4.	Member (CGWA), CGWB	Member
5.	Member (HQ), CGWB	Member
6.	Member (ED & MM), CGWB	Member
7.	Member (RGI), CGWB	Member
8.	Additional Director General (Stat), DoWR,RD & GR	Member
9.	Chief General Manager, NABARD	Member

मुकेश कुमार/MUKESH KUMAR
उप सचिव/Deputy Secretary
जल शक्ति मंत्रालय/Ministry of Jal Shakti
जल संसाधन, नदी विकास एवं गंगा संरक्षण वि

10.	Director, NIH, Roorkee or representative	Member
11.	Representative of NITI Aayog	Member
12.	Joint Secretary, Ministry of Agriculture & Farmer Welfare	Member
13.	Joint Secretary, Ministry of Environment, Forests & Climate Change	Member
14. (a)	Joint Secretary, Ministry of Rural Development (Watershed Development Programme)	Member
14 . (b)	Joint Secretary, Ministry of Rural Development (MGNREGS)	Member
15.	Joint Secretary, Department of Drinking Water Supply & Sanitation, Ministry of Jal Shakti	Member
16.	Joint Secretary, Ministry of Housing & Urban Affairs	Member
17.	Representative of IIT, Delhi (Water Resources Section), Civil Engineering Department	Member
18.	Chief Engineer (HQ), NWDA or representative	Member
19.	Technical Expert (WM), NRAA, Ministry of Agriculture & Farmer Welfare	Member
20.	Representative of India Meteorological Department, Ministry of Earth Sciences	Member
21.	Representative of Geological Survey of India, Ministry of Mines	Member
22.	Secretary In-Charge, Water Resources Department, Uttar Pradesh	Member
23.	Secretary In-Charge, Water Resources Department, Punjab	Member
24.	Secretary In-Charge, Water Resources Department, Maharashtra	Member
25.	Secretary In-Charge, Water Resources Department, Andhra Pradesh	Member
26.	Secretary In-Charge, Water Resources Department, Rajasthan	Member

मुकेश कुमार/MUKESH KUMAR
उप सचिव/Deputy Secretary
जल शक्ति मंत्रालय/Ministry of Jal Shakti

3/ continue

27.	Secretary In- Charge, Water Resources Department, Madhya Pradesh	Member
28.	Secretary In- Charge, Water Resources Department, Gujarat	Member
29.	Secretary In- Charge, Water Resources Department, West Bengal	Member
30.	Secretary In- Charge, Water Resources Department, Tamil Nadu	Member
31.	Secretary In- Charge, Water Resources Department, Haryana	Member
32.	Secretary In- Charge, Water Resources Department, Karnataka	Member
33.	Secretary In- Charge, Water Resources Department, Telangana	Member
34.	Representative of Department of Civil Engg., Indian Institute of Science (IISc), Bangalore	Member
35.	Representative of Department of Civil Engg., Indian Institute of Technology-Hyderabad	Member
36.	Member (WQ & TT), CGWB	Member Secretary

The committee may co-opt any other Member(s), if necessary.

2. **Terms of Reference: –**

i. To ensure the assessment of annual ground water recharge of the States/UTs in coordination with the respective state level committees for the reference year 2020. The Committee will work on ground water assessments in accordance with the methodology and will adopt improved procedures and practices wherever possible for the sake of achieving greater accuracy of assessment(s).

ii. To supervise the estimation of status of utilization of the annual extractable ground water resource as on 31st March 2020 of the States/UTs to be carried by the respective State/UT level committees.

iii. To supervise compilation of a National level report on assessment of ground water resources and status of its utilization as on 31st March, 2020.

iv. To work towards integration of ground water and surface water data with a view to facilitate planning for conjunctive use of water resources.

v. Any other aspect relevant to the terms referred to above.

3. **Time frame:-**

The Committee will submit its report on or before 31.03.2021.

4. **Expenditure**

मुकेश कुमार/MUKESH KUMAR
उप सचिव/Deputy Secretary
जल शक्ति मंत्रालय/Ministry of Jal Shakti

Expenditure on account of TA/DA to official Members of the Expert Group will be met from the source from which they draw their salaries and that of non-official Members (if any), will be borne by the Central Ground Water Board as per Govt. norms.

This issues with the approval of Hon'ble Minister (JAL SHAKTI).

(Mukesh Kumar)
Deputy Secretary (EA&IC)
email: dirgw-mowr@nic.in

मुकेश कुमार/MUKESH KUMAR
उप सचिव/Deputy Secretary
जल शक्ति मंत्रालय/Ministry of Jal Shakti
जल संसाधन, नदी विकास एवं गंगा संरक्षण विभाग
Deptt. of Water Resources, River Development and Ganga Rejuvanation
भारत सरकार/Government of India
नई दिल्ली/New Delhi-110001

ORDER

Ordered that the Resolution be published in the Gazette of India for general information.

Ordered that a copy of the Resolution published be communicated to this Ministry for record.

(Mukesh Kumar)
Deputy Secretary (EA&IC)
email: dirgw-mowr@nic.in

मुकेश कुमार/MUKESH KUMAR
उप सचिव/Deputy Secretary
जल शक्ति मंत्रालय/Ministry of Jal Shakti
जल संसाधन, नदी विकास एवं गंगा संरक्षण विभाग
Deptt. of Water Resources, River Development and Ganga Rejuvanation
भारत सरकार/Government of India
नई दिल्ली/New Delhi-110001

To
The Manager,
Government of India Press,
Faridabad (Haryana).

Copy to:

1. PS to Minister (JAL SHAKTI)
2. PS to MoS (JAL SHAKTI)
3. Sr PPS to Secretary (DoWR, RD & GR)
4. PPS to Joint Secretary (IC & GW)
5. All members concerned.
6. Chairman, CGWB, Faridabad.
7. Member (WQ & TT) and Member Secretary of the CLEG-2020, CGWB, Faridabad for information and necessary action.

Copy also to:
NIC for uploading the Resolution on Ministry's website.

(Mukesh Kumar)
Deputy Secretary (EA&IC)

मुकेश कुमार/MUKESH KUMAR
उप सचिव/Deputy Secretary
जल शक्ति मंत्रालय/Ministry of Jal Shakti
जल संसाधन, नदी विकास एवं गंगा संरक्षण विभाग

Annexure-IX

Proceedings of the Government of Karnataka
Minor Irrigation and Ground Water Development Department

Sub: Constitution of State Level Committee for re-estimation of Ground Water Resources – Estimation of Annual Replenishable Ground water Resources – reg.

Read:

Letter No. TA – 25 / CGWB /SWR / DGWRA / 2020-550 dated:10.07.2020, Government of India, Ministry of Water Resources, River Development & Ganga Rejuvenation Shram Shakthi Bhawan, Rafi Marg, New Delhi.

Preamble:

The Government of India Ministry of Water resources, Shram Shakti Bhawan, Rafi Marg, New Delhi in its letter read above has informed that the last assessment of State-wise Annual Replenishable Ground Water Resources for the entire country was made in the year 2017 based on the Methodology adopted by the Ground Water Resources Estimation Committee – 2015. Since then, changes in ground water scenario in many parts of the country has been observed. The National Water Policy, 2002 has also recommended that the ground water resources of the country should be re-assessed periodically. With a view to re-estimate Ground Water Resources as in 31st March 2020, the State Level Committee in accordance with the Ground Water Resources Estimation Methodology. Also CGWB in their letter dated 10.07.2020 has requested to add the following member.

Chief Engineer, Advanced Center for Integrated Water Resources Management Center, Bangalore.

Hence the following order.

Government Order No.MID 22 AAJAA 2020(E)
Bangalore, dated: 20/August/ 2020.

In view of the above, Government is pleased to constitute the State Level Committee for re-estimation of Ground Water Resources with the composition of following members with immediate effect and until further orders:

1. Secretary to Government, Minor Irrigation and Ground water development department. **Chairman**
2. Chief Engineer, Minor Irrigation & Ground Water Development department, South Zone, Bangalore. **Member**

3.	Chief Engineer, Minor Irrigation & Ground Water Development North Zone, Bijapur	**Member**
4.	Director, Ground water Directorate	**Member**
5.	Chief Engineer, Karnataka Urban Water Supply and Drainage Board	**Member**
6.	Director, Department of Agriculture	**Member**
7.	Chief Engineer, Water Resources Development Organisation	**Member**
8.	Chief Engineer, Rural Water Supply & Sanitation Department	**Member**
9.	Commissioner/Director for department of Industries	**Member**
10.	General Manager, NABARD	**Member**
11.	Chief Engineer, Advanced Center for Integrated Water Resources Management Center, Bangalore.	**Member**
12.	Regional Director, Central Ground Water Board, Government of India, Bangalore	**Member Secretary**

The Committee may co-opt any other member/special invitee if necessary.

2. **Terms of Reference**: The broad terms of reference of the Committee would be as follows:

(v) To estimate annual replenishable Ground Water Resources of Karnataka State in accordance with the Ground Water Resource Estimation Methodology;

(vi) To estimate the status of utilization of annual replenishable ground water resource.

3. **Time Frame**: The Committee shall submit its report at the earliest from the date of its constitution.

4. **Expenditure**: Expenditure on account of TA/DA to official Members of the Committee will be met from the source from which they draw their salaries.

By order and in the name of the
Governor of Karnataka,

(M.S JYOTHI)
Under Secretary to Government
Minor Irrigation and Ground Water
Development Department

To:

1. The Compiler, Karnataka Gazette to publish in the next issue of the Gazette and supply 100 copies to Government.

..3..

2. Principal Accountant General in Karnataka, Bangalore.
3. Accountant General(Accounts-I & II) Karnataka, Bangalore.
4. Accountant General(Audit-I & II), Karnataka, Bangalore.
5. The Secretary to Government of India, Ministry of Water Resources, Shram Shakti Bhavan, New-Delhi-110 001.
6. The Joint Secretary(A) to Government of India, Ministry of Water Resources, Shram Shakti Bhavan, New-Delhi-110 001.
7. Special Officer & Ex-officio Deputy Secretary to Govt., P.W.D.(Finance Cell), Vidhana Soudha, Bangalore.
8. Chief Engineer, Minor Irrigation & Ground Water Development, South Zone, Bangalore.
9. Chief Engineer, Minor Irrigation & Ground Water Development, North Zone, Bijapur.
10. Chief Engineer, Karnataka Urban Water Supply and Drainage Board, Cauvery Bhavan, Bangalore.
11. Commissioner, Department of Agriculture, Sheshadri Road, Bangalore.
12. Chief Engineer, Rural Water Supply & Sanitation Department Cauvery Bhavan, KG Road, Banglaore.
13. Chief Engineer, Advanced Center for Integrated Water Resources Management Centern 1st Floor, KSFC Bhavan, # 1/1, Thimmaiah Road, Vasanth Nagr, Bengaluru, Karnatka-560052.
14. Commissioner for Industries & Director for department of Industries & Commerce, Khanija Bhavan, Race Course Road, Bangalore.
15. Director, Ground Water Directorate, Khanija Bhavan, Race Course Road, Bangalore.
16. General Manager, NABARD, No.46 K.G. Road, Bangalore-09.
17. Chief Engineer, Water Resources Development Organisation, Ananda Rao Circle, Bangalore
18. Regional Director, Central Ground Water Board, Government of India, Bhujal Bhavan, 27th Main, 7th Cross, HSR Layout Bangalore-560102.
19. P.S.to Hon'ble Minister for Minor Irrigation and Ground Water Development Department.
20. P.S. to Secretary to Government, Minor Irrigation and Ground Water Development Department.
21. Weekly Gazette/S.G.F./Spare copies.

Annexure-X

Minutes of Meeting convened at the Office of the Director, Ground Water Directorate, Government of Karnataka, Khanija Bhavana, Bengaluru on 10/08/2020 regarding the re-assessment of blocks which are continuously Over-exploited during the previous five Ground water resource assessments.

The following Officers attended the meeting

Sl.No	Name	Designation/Department
1	Shri. M Raveendrappa	Director, GWD
2	Shri. V. Kunhambu	Regional Director, CGWB, SWR, Bangalore
3	Shri. G. Jayanna	Deputy Director, GWD
4	Smt. Jagadeshwari.M	Geologist, GWD
5	Shri. Shafeeulla	Geologist, GWD
6	Shri. J. Sivaramakrishnan	Sc-B,CGWB, SWR, Bangalore

During the meeting it was discussed on the Re-assessment of ground water resources for the assessment units which are categorized as "Over-exploited" each time in all the previous 5 assessment years, ie. 2004, 2009, 2011, 2013, 2017" as per the CGWB, Central Head Quarters, Faridabad, letter No: 10/CGWB/V14/10/2020/GWR Estimation–2626, dated 06.08.2020 urging to complete the report in time to apprise the Hon'ble NGT. Regional Director, CGWB briefed for calling the meeting, and need for assessing the five time Over-exploited blocks for the water year 2019-20.

The Director, GWD enquired for the need of re-assessing the ground water resource for Over-exploited blocks separately as the regular re-assessment of Ground Water Resources for the base year 2019-20 is already initiated by CGWB vide Resolution dated 15.06.2020.

The Regional Director CGWB, SWR, Bangalore explained the background for re-assessing the ground water resources for over-exploited blocks for the water year 2019-20.

Further, it was discussed on the procedure to be followed in carrying out the re-assessment and following points were put forth.

1. To identify the assessment units which are categorized as "Over-exploited" each time in all the previous 5 assessment years, ie. 2004, 2009, 2011, 2013, 2017 in Karnataka.

2. To initiate the collection of data for the water sheds falling in these over-exploited taluks through district level officers.
3. Decision to be taken in the event of delay in receipt of data from the concerned departments, considering the urgency and the cut-off date prescribed for the completing the exercise i.e. 20-09-2020
4. It is also decided to nominate two officers each from Ground Water Directorate, Government of Karnataka and Central Ground Water Board, SWR, Bangalore to carry out the exercise in consultation with the concerned Head of the Departments.

Based on the detailed discussions, the following decisions were taken.

1. The list of assessment units (Over-exploited taluks) identified and to be taken up for the re-assessment for the period 2019-20 are given below.

LIST OFBLOCKS CATEGORIZED AS OE DURING PREVIOUS 5 ASSESSMENTS IN KARNATAKA (2004 -2017)		
S.No	**District**	**Taluk**
1	Bagalkote	Badami
2	Bangalore Rural	Devanahalli
3	Bangalore Rural	Dodaballapur
4	Bangalore Rural	Hoskote
5	Bangalore Rural	Ramanagaram
6	Bangalore Urban	Anekal
7	Belgaum	Ramdurg
8	Gadag	Ron
9	Kolar	Bangarpet
10	Chikaballapur	Chikaballapur
11	Chikaballapur	Chintamani
12	Chikaballapur	Gauribidanur
13	Chikaballapur	Gudibanda
14	Kolar	Kolar
15	Kolar	Malur
16	Kolar	Mulbagal
17	Chikaballapur	Sidlaghatta
18	Kolar	Srinivasapura

2. Regarding the data requirement, it is found that the latest MI Census data is not available compared to last GEC 2017. Hence, projection of figures suitable for 2019-20 estimation is proposed. For Ground Water Abstraction structures, water conservation structures, it is fixed as 2% increment per year for 3 consecutive years. Also, population figures to be updated assessment year 2019-20 based on the population growth rate. Rainfall and water level fluctuations to be updated based on actual data available with both CGWB, GWD and other line departments.
3. All line departments in the State Level Committee shall provide additional data required to CGWB, State GWD for incorporating the same in the report.
4. The following officers were nominated for compiling the report.

1. Shri. J. Sivaramakrishnan, Scientist	CGWB, SWR, Bangalore
2. Smt. Sangita P. Bhatacharjee, Scientist	CGWB, SWR, Bangalore
3. Smt. M. Jagadeshwari, Geologist	GWD, Bengaluru.
4. Shri. Shafeeulla, Geologist	GWD, Bengaluru

The meeting ended with the thanks to the chair and its members.

10/08/2020

M. Raveendrappa
Director,
Groundwater Directorate,
Government of Karnataka.

Annexure-XI

Minutes of 2nd Meeting of Central Level Expert Group for Re-assessment of Ground Water Resources of India for 2020 (held through Video Conferencing)

Date: 31.03.2021

The 2nd meeting of the Central Level Expert Group (CLEG) for re-assessment of the Ground Water Resources of India for 2020 was held under the Chairmanship of Shri G. C. Pati, Chairman, Central Ground Water Board (CGWB) through Video Conferencing on 31.03.2021 at 10.30Hrs. The list of participants is attached (Annexure).

Dr P. Nandakumaran, Member (South), CGWB & Member Secretary, CLEG, welcomed all the Members of Central Level Expert Group and participants. He briefed the participants about the Ground Water Resource Assessment 2020 and requested Chairman, CGWB to address the participants. Chairman, Central Ground Water Board, congratulated all Officers of State GW/Nodal Departments, Regional offices of CGWB and IIT Hyderabad for their sincere efforts for completion of GW Resource Assessment for 2020 through web based application ''INDIA-GROUNDWATER RESOURCE ESTIMATION SYSTEM (IN-GRES)''. He also appreciated the CLEG members for their valuable inputs which have helped in the realistic assessment of ground water resources in the country. He also intimated the members about the directions of the DoWR, RD & GR, Ministry of Jal Shakti regarding the need to complete the assessment and to publish the report without further delay. He then requested the Member Secretary to take up the Agenda items:

Agenda 2.1: Confirmation of Minutes of 1st CLEG Meeting & Action Taken on Decisions:

As no comments were received from any of the members, minutes of the 1st meeting of CLEG held on 19.01.2021 were confirmed.

Dr P. Nandakumaran, Member Secretary, CLEG mentioned that various actions for improvements in the IN-GRES software, as discussed during the previous meeting have been initiated in consultation with IIT Hyderabad and that all such improvements will be carried out over the next couple of years in a phased manner.

Agenda 2.2: Status of Ground Water Resource Assessment 2020:

A brief presentation on status of 'Ground Water Resource Assessment-2020 (GWRA-2020)' as in 2020 was made by Dr. Ratikanta Nayak, Scientist-D, CGWB, CHQ, Faridabad. It was informed that all the States/UTs (except Telangana, Tamil Nadu and West Bengal) have already assessed their ground water resources jointly with CGWB. State Level Committees (SLCs) of 28 States/UTs have approved the GW Resource Assessment for their respective States/UTs.

Salient features of the national scenario of dynamic ground water resources of India, based on the outputs of assessment as in 2020 in respect of 33 States and outputs of

assessment as in 2017 in respect of Tamil Nadu, Telangana and West Bengal were presented and discussed. The members appreciated the work done by CGWB, State Departments and IIT Hyderabad and expressed their agreement with the whole process of assessment.

The presentations were followed by detailed discussions, during which the following requests were made

1. State GW/Nodal Department of Telangana and Tamil Nadu requested for 15 days more time for completing GWRA-2020.
2. State GW/Nodal Department of West Bengal requested for 3 months more time for completing GWRA-2020.

The following decisions were taken during the meeting after the discussions:-

1. In view of the fact that incorporation of ground water resources Tamil Nadu, Telangana and West Bengal as in 2020 are not considered to cause any significant change in the national scenario, members of CLEG gave their consent/approval for the results of GWRA-2020 as finalized, subject to incorporation of final results of the remaining States/UTs.
2. The national report on Dynamic GW Resources of India, 2020 will be prepared by CGWB based on the assessment carried out jointly by State GW/Nodal departments and CGWB.
3. It was decided by the CLEG that 15 days time will be given to the three States (Telangana, Tamil Nadu and West Bengal) to submit their assessment results as in 2020 (with the approval of State Level Committee) so that the assessment results for 2020 can be included in national compilation report. In case data in respect of these States are not made available by the prescribed date, CGWB may proceed with finalization and publication of the national report by incorporating results of the previous assessment results for these States.
4. It was also decided to request the States for which assessment is yet to be approved by their respective SLCs to get the same approved at the earliest and latest by 15.04.2021 positively.

The meeting ended with thanks to the Chair.

List of participants of the 2nd meeting of Central Level Expert Group (CLEG) on 31.03.2021

S.No	Participants
1.	Shri. G. C. Pati, Chairman, Central Ground Water Board
2.	Dr. P. Nandakumaran, Member (South), Central Ground Water Board
3.	Shri. Sunil Kumar, Member (CGWA), Central Ground Water Board
4.	Shri. Sanjay Marwaha, Member (HQ), Central Ground Water Board
5.	Shri. G. L. Meena, Member (N&W), Central Ground Water Board
6.	Shri. Rohit Kumar, Joint Secretary, Ministry of Rural development(MGNREGS), Govt. of India
7.	Ms. Veditha Reddy, IAS, Secretary (PWD), Andaman & Nicobar Administration
8.	Shri. C. Mruthyunjaya Swamy, K.E.S, Secretary to Government, Minor Irrigation & Ground Water Development Department, Govt. of Karnataka
9.	Shri. Suren Karkidhali, PCE cum Secretary, Water Resource Department, Govt. of Sikkim
10.	Shri S.K. Tripathi, DDG & RMH-IV, Southern Region, Geological Survey of India
11.	Dr. Pulak Guhathakurta, Scientist F & Head, Climate Research Division, IMD, Pune
12.	Dr. Anupma Sharma, Scientist 'F', National Institute of Hydrology, Roorkee
13.	Dr. Sekhar M, Professor, Department of Civil Engg., Indian Institute of Science (IISc), Bangalore
14.	Dr.B.R.Chahar, Professor, Department of Civil Engineering, Indian Institute of Technology -Delhi
15.	Dr. Mallinath Kalshetti, IAS , Director, Ground Water Survey and Development Agency (GSDA), Govt. of Maharashtra
16.	Dr. K B V N Phanindra, Associate Professor, Department of Civil Engg., Indian Institute of Technology-Hyderabad
17.	Shri Sunil Kumar, Director, Basin Planning-1, Directorate, Basin Planning Management Organization, Central Water Commission
18.	Smt. Soumya P Kumar, Director, MI-Stat. Wing, D/o Water Resources, RD & GR, M/o Jal Shakti, Govt. of India
19.	Shri. B Rath, Technical Expert (WM), NRAA, Ministry of Agriculture & Farmer Welfare
20.	Shri.Avinash Mishra, Joint Advisor (WR&LR), NITI Aayog, New Delhi
21.	Shri. V S Patel, Managing Director, Gujarat Water Resources Development Corporation Ltd., Gandhinagar, Govt. of Gujarat
22.	Dr. Pandith Madhnure, Director, Ground Water Department , Govt. of Telangana
23.	Shri. A Varaprasad Rao, Director, State Ground Water & Water Audit Department, Govt. of Andhra Pradesh
24.	Er. Hirak Dey, Director, State Water Investigation Directorate, Govt. of West Bengal
25.	Shri. Narinder Kumar Garg, Chief Engineer, Ground Water Cum Project Co-ordination-NHP, Department of Water Resources, Govt. of Punjab
26.	Shri Gopal Prasad Sharma, Superintending Hydrogeologist, Ground Water Department, Government of Rajasthan, Jaipur.
27.	Dr. Bijendra Baghel, GW Data Center, WRD, Bhopal, Government of Madhya Pradesh
28.	Shri. Rakesh Ku. Gupta, Chief Hydrogeolgist, Office of Hydrologist, Karnal, Government of Haryana
29.	Dr. R C Jain, Advisor (GW), Gujarat Water Resources Development Corporation Ltd., Gandhinagar, Govt. of Gujarat
30.	Shri. B. S. Nirola, Additional Chief Engineer, Water Resource Department, Govt. of Sikkim
31.	Dr. S. Raja, Executive Engineer, SG&SWRDC, Govt. of Tamil Nadu

Table - 11
References

Central GroundwaterBoard (SWR) Bangalore	1994	Report of the Group on the Estimation of Groundwater Resources and Irrigation Potential from Groundwater in Karnataka State as on 1994
Department of Minor Irrigation, Government of Karnataka	2000	Data on Minor Irrigation Structures
Directorate of Economics & Statistics, Government of Karnataka	2000-01	State at a Glance
Directorate of Census Operations, Karnataka	2010-11	District Census Books-30 Districts
Directorate of Economics and Statistics, Government of Karnataka	2000-01	Annual Season Crop Report
Ministry of Water Resources, Government of India	1984	Groundwater Estimation Committee Report
Ministry of Water Resources, Government of India	1997	Groundwater Estimation Methodology 1997
Ministry of Water Resources, Government of India	2004	Methodology for Groundwater Resources Estimation in Hard Rock Terrain
Ministry of Water Resources, Government of India	2004	Methodology for Groundwater Resources Estimation in Hard Rock Terrain
Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India	2017	Report of the Groundwater Resource Estimation Committee
Central Groundwater Board (SWR) Bangalore	2017	Groundwater Year Book of Karnataka (2016-17)
Central Groundwater Board (SWR) Bangalore	2018	Groundwater Year Book of Karnataka (2017-18)
Najeeb. K.Md, Sooryanarayana, K.R and Afaque Manzar	2006	Pricing policy and its role in Groundwater management – A Karnataka Experience, Groundwater Governance, Capital Publishers. New Delhi

Table-12

CONTRIBUTORS PAGE

Sl. No.	District	Officers Name	Designation
Central Ground Water Borad, SWR, Bengaluru			
1.	Bengaluru	Shri. V. Kunhambu	Regional Director
2.	Bengaluru	T.S.Anitha Shyam	Scientist-D
3.	Bengaluru	Ms. D.Dhayamalar	Scientist-D
4.	Bengaluru	Dr. Lubna Kouser	AH
5.	Bengaluru	Smt. Rakhi U.R,	Scientist-B
6.	Bengaluru	Smt. Sangita P.B	Scientist-B
7.	Bengaluru	Shri. J.Sivaramakrishnan	Scientist-B
Groundwater Directorate, Government of Karnataka, Bengaluru			
8.	Bengaluru	Shri. G. Jayanna	Director I/c
9.	Bengaluru	Smt. M. Jagadeshwari	Geologist
10.	Bengaluru	Shri. H.M. Nagaraja	Geologist
District Groundwater Office, Groundwater Directorate			
11.	Bengaluru Urban	Shri. S.R. Babu,	Senior Geologist
12.	Bengaluru Rural	Smt. N. Pallavi	Senior Geologist
13.	Belagavi	Dr. M.B. Baligar	Senior Geologist
14.	Bellary and Koppal	Shri. D.E Arun	Senior Geologist
15.	Bagalkote and Vijayapura	Shri. Mahesh B. Birajanavar	Senior Geologist
16.	Bidar and Kalburgi	Shri. R. Mujibur Rehaman	Senior Geologist
17.	Chikkaballapura	Shri. Borappa.S	Senior Geologist
18.	Chikkamagaluru	Smt. N.R. Nandini	Senior Geologist
19.	Chamarajanagara	Smt. Dhanalakshmi .R	Senior Geologist
20.	Chitradurga	Shri. Basanth.V	Senior Geologist
21.	Dharwad	Shri. Rajashekhar Reddy .M Hiregowda	Senior Geologist
22.	Davanagere	Shri. Basavaraju	Senior Geologist
23.	Gadag and Haveri	Shri. Santhosh Patiganiger	Senior Geologist
24.	Hassan	Smt. S. Sudha	Senior Geologist
25.	Karwar and Udupi	Dr. M. Dinakar Shetty	Senior Geologist
26.	Kolar	Shri. A. Thippeswamy	Senior Geologist
27.	Kodagu	Smt. K.G. Sowmya	Senior Geologist
28.	Mysore	Shri. K.V.R Chowdari	Senior Geologist
29.	Mangalore	Smt. P. Janaki	Senior Geologist
30.	Mandya	Smt. T. Ambika	Senior Geologist
31.	Raichur and Yadagiri	Shri. S.M. Krishna	Senior Geologist
32.	Ramanagara	Smt. Rajasree .S.R	Senior Geologist
33.	Shivamoga	Shri. Shek Davood	Senior Geologist
34.	Tumkuru	Smt. Nagaveni.K.S	Senior Geologist

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